Codes for ECF home work 1

July 23, 2021

This code has been written for the course Empercial Corporate Finance's first assignment, Summer 2021. This code investigates the effect of family firms on the firm performance, which is a replication for Anderson, Ronald C, and David Reeb, 2003, Founding-family ownership and firm performance:evidence from the s&P 500,The journal of finance58, 1301–1328.

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1 Introduction

[ ]:
```
import numpy as np
import pandas as pd
import stat
import scipy
import statsmodels.api as sm
import matplotlib.pyplot as plt
!pip install linearmodels
from linearmodels import IV2SLS
```

1.1 Importing the data

[ ]:
```
path = '/content/drive/MyDrive/PhD/ECF/Merge.xlsx'
data = pd.read_excel(path, sheet_name='Sheet2')

data = data[data.columns[:14]]
data
```

[ ]:
```
     Ticker  Year  ... nonfounderfam                industry name
0     9441B  1992  ...             0  Chemical & Allied Products
1     9441B  1993  ...             0  Chemical & Allied Products
2        AA  1992  ...             0    Primary Metal Industries
3        AA  1993  ...             0    Primary Metal Industries
4        AA  1994  ...             0    Primary Metal Industries
...     ...   ...  ...           ...                         ...
2197      Z  1993  ...             0  Apparel & Accessory Stores
2198      Z  1994  ...             0  Apparel & Accessory Stores
2199      Z  1995  ...             0  Apparel & Accessory Stores
```

```
2200      Z  1996  ...              0  Apparel & Accessory Stores
2201      Z  1997  ...              0  Apparel & Accessory Stores

[2202 rows x 14 columns]
```

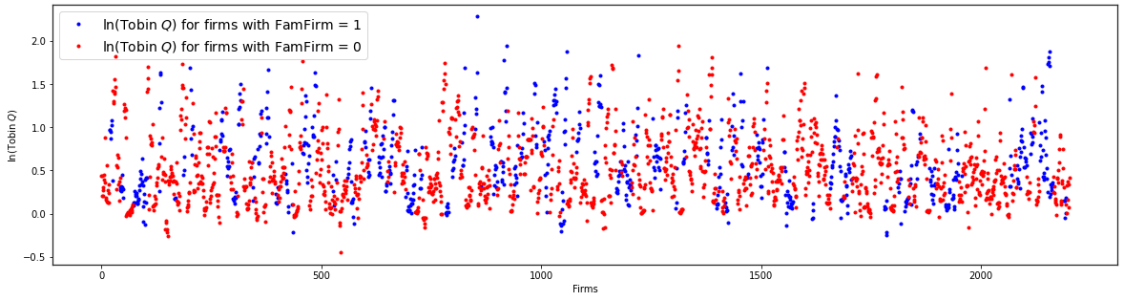
[ ]:
```
data2 = data.reset_index().set_index(['Ticker', 'Year'])
data2['assets'] = np.log(data2['assets'])
```

1.2 Statistics of Data

[ ]:
```
#plt.scatter(data['Q'][data['FamFirm'] == 1], data['Q'][data['FamFirm'] == 0])

plt.figure(figsize= (20, 5), facecolor=(1, 1, 1), edgecolor='black')
plt.rcParams['axes.facecolor'] = 'none'
plt.rcParams["axes.edgecolor"] = "0.15"
plt.rcParams["axes.linewidth"]  = 1.25
plt.plot(np.log(data['Q'][data['FamFirm'] == 1]), '.',  color = 'blue', label =␣
↪'$\ln($Tobin $Q)$ for firms with FamFirm = 1')
plt.plot(np.log(data['Q'][data['FamFirm'] == 0]), '.', color = 'red', label =␣
↪'$\ln($Tobin $Q)$ for firms with FamFirm = 0')
plt.legend(fontsize = 14)
plt.ylabel('$\ln($Tobin $Q)$')
plt.xlabel('Firms')
```

[ ]:
```
Text(0.5, 0, 'Firms')
```



[ ]:
```
scipy.stats.ks_2samp(data['Q'][data['FamFirm'] == 1], data['Q'][data['FamFirm']␣
↪== 0])
```

[ ]:
```
Ks_2sampResult(statistic=0.12059869908842935, pvalue=1.2344792866825216e-06)
```

[ ]:
```
data['Q'][data['FamFirm'] == 1].mean() - data['Q'][data['FamFirm'] == 0].mean()
```

[ ]:
```
0.1917600270322375
```

[ ]:
```
print(scipy.stats.ttest_ind(data['Q'][data['FamFirm'] == 1],␣
↪data['Q'][data['FamFirm'] == 0]))
print(scipy.stats.ttest_ind(data['Q'][data['founderCEO'] == 1],␣
↪data['Q'][data['founderCEO'] == 0]))
```

```
print(scipy.stats.ttest_ind(data['Q'][data['nonfounderfam'] == 1],␣
 ↪data['Q'][data['nonfounderfam'] == 0]))
```

```
Ttest_indResult(statistic=4.540403903173263, pvalue=5.917755129690558e-06)
Ttest_indResult(statistic=3.2861620518380636, pvalue=0.0010315868029052836)
Ttest_indResult(statistic=2.872260224455943, pvalue=0.00411450341109251)
```

[ ]:
```
statistics_A = pd.DataFrame(index = data2.mean().index,
                            columns = ['mean', 'median', 'std', 'max', 'min'])


statistics_A['mean'] = data2.mean()
statistics_A['median'] = data2.median()
statistics_A['std'] = data2.std()
statistics_A['max'] = data2.max()
statistics_A['min'] = data2.min()
statistics_A
```

[ ]:

	mean	median	std	max	min
index	1100.500000	1100.500000	635.806968	2201	0
FamFirm	0.330154	0.000000	0.470375	1	0
meanagef	58.105359	95.000000	44.457991	95	0
assets	8.624517	8.517563	1.197309	12.701	5.74918
bs_volatility	0.273944	0.253000	0.097042	1.052	0
roa	5.407104	5.349500	5.829786	46.206	-49.401
founderCEO	0.068120	0.000000	0.252009	1	0
Q	1.894827	1.582859	0.936149	9.84748	0.635376
digit2_in	39.704360	36.000000	16.033452	87	10
hightech	0.196639	0.000000	0.397548	1	0
nonfounderfam	0.265668	0.000000	0.441788	1	0

[ ]:
```
data2[data2['FamFirm'] == 1].mean()

statistics_B = pd.DataFrame(index = statistics_A.index.drop(['FamFirm',␣
 ↪'nonfounderfam']),
                            columns = ['FamFirm', 'non FamFirm',␣
 ↪'nonfounderfam', 'founderfam', 't1', 't2'])

statistics_B['FamFirm'] = data2[data2['FamFirm'] == 1].mean().drop(['FamFirm',␣
 ↪'nonfounderfam'])
statistics_B['non FamFirm'] = data2[data2['FamFirm'] == 0].mean().
 ↪drop(['FamFirm', 'nonfounderfam'])
statistics_B['nonfounderfam'] = data2[data2['nonfounderfam'] == 1].mean().
 ↪drop(['FamFirm', 'nonfounderfam'])
statistics_B['founderfam'] = data2[data2['nonfounderfam'] == 0].mean().
 ↪drop(['FamFirm', 'nonfounderfam'])

statistics_B
```

[ ]:

	FamFirm	non FamFirm	nonfounderfam	founderfam	t1	t2
index	1109.547455	1096.040678	1110.340171	1096.940012	NaN	NaN
meanagef	52.741747	60.748983	56.441168	58.707431	NaN	NaN
assets	8.247712	8.810238	8.287006	8.746623	NaN	NaN
bs_volatility	0.276905	0.272484	0.256467	0.280267	NaN	NaN
roa	6.260246	4.986607	6.143802	5.140581	NaN	NaN
founderCEO	0.195323	0.005424	0.000000	0.092764	NaN	NaN
Q	2.023277	1.831517	1.989937	1.860419	NaN	NaN
digit2_in	39.862448	39.626441	38.001709	40.320346	NaN	NaN
hightech	0.178817	0.205424	0.128205	0.221398	NaN	NaN

[ ]:
```
print(scipy.stats.ttest_ind(data2[data2['FamFirm'] == 1]['meanagef'],
                data2[data2['FamFirm'] == 0]['meanagef']))

print(scipy.stats.ttest_ind(data2[data2['FamFirm'] == 1]['assets'],
                data2[data2['FamFirm'] == 0]['assets']))

print(scipy.stats.ttest_ind(data2[data2['FamFirm'] == 1]['bs_volatility'],
                data2[data2['FamFirm'] == 0]['bs_volatility']))

print(scipy.stats.ttest_ind(data2[data2['FamFirm'] == 1]['roa'],
                data2[data2['FamFirm'] == 0]['roa']))

print(scipy.stats.ttest_ind(data2[data2['FamFirm'] == 1]['founderCEO'],
                data2[data2['FamFirm'] == 0]['founderCEO']))

print(scipy.stats.ttest_ind(data2[data2['FamFirm'] == 1]['Q'],
                data2[data2['FamFirm'] == 0]['Q']))

print(scipy.stats.ttest_ind(data2[data2['FamFirm'] == 1]['hightech'],
                data2[data2['FamFirm'] == 0]['hightech']))
```

```
Ttest_indResult(statistic=-3.987978333252495, pvalue=6.881474371217645e-05)
Ttest_indResult(statistic=-10.628328159430952, pvalue=9.167955906653053e-26)
Ttest_indResult(statistic=1.0053504740807087, pvalue=0.31483867966258744)
Ttest_indResult(statistic=4.845684267761467, pvalue=1.349780389198809e-06)
Ttest_indResult(statistic=17.779410612325275, pvalue=3.488294110055846e-66)
Ttest_indResult(statistic=4.540403903173263, pvalue=5.917755129690558e-06)
Ttest_indResult(statistic=-1.4773131464731586, pvalue=0.13973484757749732)
```

[ ]:
```
print(scipy.stats.ttest_ind(data2[data2['nonfounderfam'] == 1]['meanagef'],
                data2[data2['nonfounderfam'] == 0]['meanagef']))

print(scipy.stats.ttest_ind(data2[data2['nonfounderfam'] == 1]['assets'],
                data2[data2['nonfounderfam'] == 0]['assets']))

print(scipy.stats.ttest_ind(data2[data2['nonfounderfam'] == 1]['bs_volatility'],
                data2[data2['nonfounderfam'] == 0]['bs_volatility']))
```

```
print(scipy.stats.ttest_ind(data2[data2['nonfounderfam'] == 1]['roa'],
                data2[data2['nonfounderfam'] == 0]['roa']))

print(scipy.stats.ttest_ind(data2[data2['nonfounderfam'] == 1]['founderCEO'],
                data2[data2['nonfounderfam'] == 0]['founderCEO']))

print(scipy.stats.ttest_ind(data2[data2['nonfounderfam'] == 1]['Q'],
                data2[data2['nonfounderfam'] == 0]['Q']))

print(scipy.stats.ttest_ind(data2[data2['nonfounderfam'] == 1]['hightech'],
                data2[data2['nonfounderfam'] == 0]['hightech']))
```

```
Ttest_indResult(statistic=-1.056565185127851, pvalue=0.2908260819108915)
Ttest_indResult(statistic=-8.071461245079425, pvalue=1.1309875531909429e-15)
Ttest_indResult(statistic=-5.112153436439325, pvalue=3.460093019159489e-07)
Ttest_indResult(statistic=3.576251660983644, pvalue=0.00035607634372594954)
Ttest_indResult(statistic=-7.730564156180037, pvalue=1.6165051345893094e-14)
Ttest_indResult(statistic=2.872260224455943, pvalue=0.00411450341109251)
Ttest_indResult(statistic=-4.88381322649482, pvalue=1.1154161712692212e-06)
```

[ ]:
```
data.drop(columns = ['Year', 'digit2_in']).corr()
```

[ ]:
```
                FamFirm  meanagef    assets  ...         Q  hightech
nonfounderfam
FamFirm        1.000000 -0.084718 -0.076455  ...  0.096351 -0.031481
0.856745
meanagef      -0.084718  1.000000  0.017074  ...  0.028807 -0.091321
-0.022520
assets        -0.076455  0.017074  1.000000  ... -0.144178 -0.095094
-0.041223
bs_volatility  0.021429 -0.199915 -0.094113  ... -0.074501  0.245069
-0.108350
roa            0.102763  0.066070 -0.124309  ...  0.588249  0.011368
0.076025
founderCEO     0.354448 -0.121824 -0.074708  ...  0.069890  0.115660
-0.162622
Q              0.096351  0.028807 -0.144178  ...  1.000000  0.063640
0.061122
hightech      -0.031481 -0.091321 -0.095094  ...  0.063640  1.000000
-0.103563
nonfounderfam  0.856745 -0.022520 -0.041223  ...  0.061122 -0.103563
1.000000

[9 rows x 9 columns]
```

2 Part 4: Multivariate Analysis

This is column 1: The results of estimating the following performance model ($y = $Tobin's Q) using *OLS*:

[ ]:
```
#Defining X and Y
X = pd.concat([pd.DataFrame(np.ones(len(data)), columns=['constant']),␣
 ↪data[['FamFirm', 'bs_volatility']], np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)



y = data['Q']
X
```

[ ]:
```
      constant  ...  Wholesale Trade - Nondurable Goods
0          1.0  ...                                   0
1          1.0  ...                                   0
2          1.0  ...                                   0
3          1.0  ...                                   0
4          1.0  ...                                   0
...        ...  ...                                 ...
2197       1.0  ...                                   0
2198       1.0  ...                                   0
2199       1.0  ...                                   0
2200       1.0  ...                                   0
2201       1.0  ...                                   0

[2202 rows x 65 columns]
```

Running the regression:

[ ]:
```
model = sm.OLS(y, X).fit()
predictions = model.predict(X) # make the predictions by the model

# Print out the statistics
model.summary()
```

[ ]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                      Q   R-squared:                       0.300
Model:                            OLS   Adj. R-squared:                  0.280
Method:                 Least Squares   F-statistic:                     15.05
Date:                Fri, 23 Jul 2021   Prob (F-statistic):          3.81e-124
Time:                        16:55:41   Log-Likelihood:                -2585.7
No. Observations:                2202   AIC:                             5295.
Df Residuals:                    2140   BIC:                             5649.
```

```
Df Model:                           61
Covariance Type:            nonrobust
==============================================================================
============================
                                              coef    std err          t
P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
----------------------------
constant                                    2.2521      0.167     13.522
0.000       1.925       2.579
FamFirm                                     0.1152      0.041      2.809
0.005       0.035       0.196
bs_volatility                              -0.6628      0.209     -3.172
0.002      -1.073      -0.253
assets                                     -0.0797      0.019     -4.097
0.000      -0.118      -0.042
hightech                                    0.3164      0.039      8.144
0.000       0.240       0.393
1992                                        0.2428      0.056      4.317
0.000       0.132       0.353
1993                                        0.1611      0.046      3.466
0.001       0.070       0.252
1994                                        0.0915      0.047      1.943
0.052      -0.001       0.184
1995                                        0.1747      0.047      3.712
0.000       0.082       0.267
1996                                        0.2653      0.048      5.583
0.000       0.172       0.358
1997                                        0.4115      0.049      8.404
0.000       0.316       0.508
1998                                        0.4925      0.051      9.639
0.000       0.392       0.593
1999                                        0.4128      0.055      7.439
0.000       0.304       0.522
Amusement & Recreation Services             0.1029      0.231      0.445
0.656      -0.350       0.556
Apparel & Accessory Stores                  0.4249      0.125      3.396
0.001       0.180       0.670
Apparel & Other Textile Products            0.0358      0.197      0.182
0.856      -0.350       0.422
Auto Repair, Services, & Parking           -0.5308      0.277     -1.918
0.055      -1.074       0.012
Automative Dealers & Service Stations      -0.3460      0.297     -1.165
0.244      -0.928       0.236
Building Materials & Gardening Supplies     1.1857      0.168      7.055
0.000       0.856       1.515
Business Services                           0.3925      0.082      4.809
```

```
0.000       0.232       0.553
Chemical & Allied Products                 0.9321      0.059     15.730
0.000       0.816       1.048
Communications                             0.2696      0.130      2.070
0.039       0.014       0.525
Depository Institutions                   -0.2461      0.279     -0.881
0.379      -0.794       0.302
Eating & Drinking Places                   0.4237      0.210      2.017
0.044       0.012       0.836
Electric, Gas, & Sanitary Services        -0.2246      0.219     -1.028
0.304      -0.653       0.204
Electronic & Other Electric Equipment      0.0021      0.066      0.032
0.974      -0.127       0.131
Engineering & Management Services          1.2255      0.297      4.126
0.000       0.643       1.808
Fabricated Metal Products                  0.2015      0.111      1.821
0.069      -0.015       0.418
Food & Kindred Products                    1.0349      0.078     13.323
0.000       0.883       1.187
Food Stores                                0.0956      0.127      0.751
0.453      -0.154       0.345
Furniture & Fixtures                      -0.4054      0.277     -1.464
0.143      -0.948       0.138
Furniture & Homefurnishings Stores         0.3327      0.204      1.631
0.103      -0.067       0.733
General Building Contractors              -0.6961      0.237     -2.942
0.003      -1.160      -0.232
General Merchandise Stores                -0.1359      0.109     -1.246
0.213      -0.350       0.078
Health Services                           -0.4213      0.218     -1.930
0.054      -0.849       0.007
Heavy Construction, Except Building       -0.1932      0.203     -0.950
0.342      -0.592       0.205
Hotels & Other Lodging Places             -0.0519      0.205     -0.253
0.800      -0.453       0.349
Industrial Machinery & Equipment          -0.2780      0.060     -4.659
0.000      -0.395      -0.161
Instruments & Related Products             0.1998      0.072      2.782
0.005       0.059       0.341
Insurance Agents, Brokers, & Service       0.3107      0.237      1.311
0.190      -0.154       0.775
Insurance Carriers                        -0.4354      0.086     -5.075
0.000      -0.604      -0.267
Leather & Leather Products                -0.2491      0.208     -1.200
0.230      -0.656       0.158
Lumber & Wood Products                    -0.2293      0.181     -1.268
0.205      -0.584       0.125
```

```
Metal, Mining                                0.5470      0.198      2.763
0.006       0.159       0.935
Miscellaneous Manufacturing Industries       0.1557      0.165      0.945
0.345      -0.167       0.479
Miscellaneous Retail                         0.1241      0.133      0.930
0.353      -0.138       0.386
Motion Pictures                              0.3719      0.196      1.893
0.058      -0.013       0.757
Nondepository Institutions                  -0.3408      0.178     -1.916
0.055      -0.690       0.008
Oil & Gas Extraction                        -0.0767      0.120     -0.639
0.523      -0.312       0.159
Paper & Allied Products                     -0.0399      0.095     -0.420
0.675      -0.226       0.146
Personal Services                            0.2683      0.174      1.546
0.122      -0.072       0.609
Petroleum & Coal Products                   -0.1575      0.103     -1.530
0.126      -0.360       0.044
Primary Metal Industries                     0.0234      0.090      0.260
0.795      -0.153       0.200
Printing & Publishing                        0.1954      0.091      2.150
0.032       0.017       0.374
Railroad Transportation                     -0.2709      0.138     -1.958
0.050      -0.542       0.000
Rubber & Miscellaneous Plastics Products     0.2862      0.113      2.539
0.011       0.065       0.507
Security & Commodity Brokers                -0.3192      0.286     -1.114
0.265      -0.881       0.243
Stone, Clay, & Glass Products               -0.0167      0.296     -0.056
0.955      -0.597       0.564
Textile Mill Products                       -0.7382      0.212     -3.476
0.001      -1.155      -0.322
Tobacco Products                             0.9422      0.264      3.573
0.000       0.425       1.459
Transportation Equipment                    -0.2424      0.076     -3.174
0.002      -0.392      -0.093
Transportation by Air                       -0.3483      0.125     -2.787
0.005      -0.593      -0.103
Trucking & Warehousing                      -0.7441      0.297     -2.509
0.012      -1.326      -0.163
Wholesale Trade - Durable Goods              0.1402      0.147      0.951
0.342      -0.149       0.429
Wholesale Trade - Nondurable Goods          -0.2346      0.122     -1.919
0.055      -0.474       0.005
==============================================================================
Omnibus:                      949.191   Durbin-Watson:                   0.736
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             6796.824
```

```
Skew:                          1.880   Prob(JB):                         0.00
Kurtosis:                     10.742   Cond. No.                     4.64e+16
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The smallest eigenvalue is 7.9e-29. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

Testing for heteroskedasticity by a white-test:

[ ]:
```
from statsmodels.stats.diagnostic import het_white
from statsmodels.compat import lzip
```

[ ]:
```
keys = ['Lagrange Multiplier statistic:', 'LM test\'s p-value:', 'F-statistic:',␣
 ↪'F-test\'s p-value:']
results = het_white(model.resid, X)
lzip(keys, results)
```

[ ]:
```
[('Lagrange Multiplier statistic:', 632.3906912535831),
 ("LM test's p-value:", 0.009128581374301786),
 ('F-statistic:', 1.2064970051455968),
 ("F-test's p-value:", 0.002980874126806626)]
```

Column II: model 1 using White heteroskedastic-consistent standard errors.

[ ]:
```
model = sm.OLS(y, X).fit(cov_type='HC0')
predictions = model.predict(X) # make the predictions by the model

# Print out the statistics
print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                      Q   R-squared:                       0.300
Model:                            OLS   Adj. R-squared:                  0.280
Method:                 Least Squares   F-statistic:                     594.3
Date:                Fri, 23 Jul 2021   Prob (F-statistic):               0.00
Time:                        16:55:59   Log-Likelihood:                -2585.7
No. Observations:                2202   AIC:                             5295.
Df Residuals:                    2140   BIC:                             5649.
Df Model:                          61
Covariance Type:                  HC0
==============================================================================
============================
                                                 coef    std err          z
P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
----------------------------
```

constant			2.2521	0.179	12.572
0.000	1.901	2.603			
FamFirm			0.1152	0.045	2.569
0.010	0.027	0.203			
bs_volatility			-0.6628	0.199	-3.337
0.001	-1.052	-0.274			
assets			-0.0797	0.021	-3.739
0.000	-0.122	-0.038			
hightech			0.3164	0.039	8.036
0.000	0.239	0.394			
1992			0.2428	0.059	4.085
0.000	0.126	0.359			
1993			0.1611	0.042	3.847
0.000	0.079	0.243			
1994			0.0915	0.043	2.145
0.032	0.008	0.175			
1995			0.1747	0.044	4.004
0.000	0.089	0.260			
1996			0.2653	0.046	5.717
0.000	0.174	0.356			
1997			0.4115	0.047	8.777
0.000	0.320	0.503			
1998			0.4925	0.060	8.261
0.000	0.376	0.609			
1999			0.4128	0.064	6.436
0.000	0.287	0.538			
Amusement & Recreation Services			0.1029	0.204	0.504
0.614	-0.297	0.503			
Apparel & Accessory Stores			0.4249	0.220	1.930
0.054	-0.007	0.856			
Apparel & Other Textile Products			0.0358	0.105	0.342
0.732	-0.169	0.241			
Auto Repair, Services, & Parking			-0.5308	0.060	-8.880
0.000	-0.648	-0.414			
Automative Dealers & Service Stations			-0.3460	0.208	-1.661
0.097	-0.754	0.062			
Building Materials & Gardening Supplies			1.1857	0.286	4.143
0.000	0.625	1.747			
Business Services			0.3925	0.106	3.710
0.000	0.185	0.600			
Chemical & Allied Products			0.9321	0.080	11.588
0.000	0.774	1.090			
Communications			0.2696	0.069	3.920
0.000	0.135	0.404			
Depository Institutions			-0.2461	0.056	-4.393
0.000	-0.356	-0.136			
Eating & Drinking Places			0.4237	0.146	2.895
0.004	0.137	0.711			

```
Electric, Gas, & Sanitary Services          -0.2246      0.071     -3.184
0.001      -0.363      -0.086
Electronic & Other Electric Equipment        0.0021      0.072      0.029
0.977      -0.139       0.144
Engineering & Management Services            1.2255      0.251      4.884
0.000       0.734       1.717
Fabricated Metal Products                    0.2015      0.156      1.293
0.196      -0.104       0.507
Food & Kindred Products                      1.0349      0.101     10.258
0.000       0.837       1.233
Food Stores                                  0.0956      0.103      0.924
0.356      -0.107       0.298
Furniture & Fixtures                        -0.4054      0.047     -8.639
0.000      -0.497      -0.313
Furniture & Homefurnishings Stores           0.3327      0.224      1.485
0.138      -0.106       0.772
General Building Contractors                -0.6961      0.065    -10.723
0.000      -0.823      -0.569
General Merchandise Stores                  -0.1359      0.089     -1.519
0.129      -0.311       0.039
Health Services                             -0.4213      0.089     -4.747
0.000      -0.595      -0.247
Heavy Construction, Except Building         -0.1932      0.120     -1.614
0.106      -0.428       0.041
Hotels & Other Lodging Places               -0.0519      0.077     -0.670
0.503      -0.204       0.100
Industrial Machinery & Equipment            -0.2780      0.053     -5.231
0.000      -0.382      -0.174
Instruments & Related Products               0.1998      0.085      2.355
0.019       0.034       0.366
Insurance Agents, Brokers, & Service         0.3107      0.152      2.045
0.041       0.013       0.609
Insurance Carriers                          -0.4354      0.045     -9.650
0.000      -0.524      -0.347
Leather & Leather Products                  -0.2491      0.156     -1.600
0.110      -0.554       0.056
Lumber & Wood Products                      -0.2293      0.079     -2.898
0.004      -0.384      -0.074
Metal, Mining                                0.5470      0.185      2.951
0.003       0.184       0.910
Miscellaneous Manufacturing Industries       0.1557      0.129      1.203
0.229      -0.098       0.409
Miscellaneous Retail                         0.1241      0.136      0.910
0.363      -0.143       0.392
Motion Pictures                              0.3719      0.148      2.506
0.012       0.081       0.663
Nondepository Institutions                  -0.3408      0.058     -5.915
0.000      -0.454      -0.228
```

```
Oil & Gas Extraction                          -0.0767      0.059     -1.298
0.194      -0.192       0.039
Paper & Allied Products                       -0.0399      0.086     -0.466
0.641      -0.208       0.128
Personal Services                              0.2683      0.214      1.253
0.210      -0.151       0.688
Petroleum & Coal Products                     -0.1575      0.052     -3.044
0.002      -0.259      -0.056
Primary Metal Industries                       0.0234      0.099      0.236
0.814      -0.172       0.218
Printing & Publishing                          0.1954      0.070      2.805
0.005       0.059       0.332
Railroad Transportation                       -0.2709      0.052     -5.234
0.000      -0.372      -0.169
Rubber & Miscellaneous Plastics Products       0.2862      0.102      2.793
0.005       0.085       0.487
Security & Commodity Brokers                  -0.3192      0.088     -3.633
0.000      -0.491      -0.147
Stone, Clay, & Glass Products                 -0.0167      0.125     -0.133
0.894      -0.262       0.229
Textile Mill Products                         -0.7382      0.096     -7.684
0.000      -0.927      -0.550
Tobacco Products                               0.9422      0.284      3.320
0.001       0.386       1.499
Transportation Equipment                      -0.2424      0.032     -7.490
0.000      -0.306      -0.179
Transportation by Air                         -0.3483      0.038     -9.065
0.000      -0.424      -0.273
Trucking & Warehousing                        -0.7441      0.057    -13.087
0.000      -0.856      -0.633
Wholesale Trade - Durable Goods                0.1402      0.099      1.416
0.157      -0.054       0.334
Wholesale Trade - Nondurable Goods            -0.2346      0.088     -2.664
0.008      -0.407      -0.062
==============================================================================
Omnibus:                      949.191   Durbin-Watson:                   0.736
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             6796.824
Skew:                           1.880   Prob(JB):                         0.00
Kurtosis:                      10.742   Cond. No.                     4.64e+16
==============================================================================

Notes:
[1] Standard Errors are heteroscedasticity robust (HC0)
[2] The smallest eigenvalue is 7.9e-29. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.

/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:1834:
ValueWarning: covariance of constraints does not have full rank. The number of
```

```
constraints is 64, but rank is 62
  'rank is %d' % (J, J_), ValueWarning)
```

Column III: reestimaing column II after replaicing famfirm with FounderCEO.

[ ]:
```
(data['FamFirm'] == data['founderCEO']).sum()
```

[ ]:
```
1609
```

[ ]:
```
(data['FamFirm'] == data['founderCEO']).sum() / len(data['FamFirm'])
```

[ ]:
```
0.7306993642143506
```

[ ]:
```
X = pd.concat([pd.DataFrame(np.ones(len(data)), columns=['constant']),␣
 ↪data[['founderCEO', 'bs_volatility']], np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)

model = sm.OLS(y, X).fit(cov_type='HC1')
predictions = model.predict(X) # make the predictions by the model

# Print out the statistics
model.summary()
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:1834:
ValueWarning: covariance of constraints does not have full rank. The number of
constraints is 64, but rank is 62
  'rank is %d' % (J, J_), ValueWarning)
```

[ ]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                      Q   R-squared:                       0.302
Model:                            OLS   Adj. R-squared:                  0.282
Method:                 Least Squares   F-statistic:                     582.7
Date:                Fri, 23 Jul 2021   Prob (F-statistic):               0.00
Time:                        16:55:59   Log-Likelihood:                -2583.1
No. Observations:                2202   AIC:                             5290.
Df Residuals:                    2140   BIC:                             5643.
Df Model:                          61
Covariance Type:                  HC1
==============================================================================
============================
                                                 coef    std err          z
P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
----------------------------
constant                                    2.3361      0.177     13.181
0.000       1.989       2.683
```

```
founderCEO                                    0.2651      0.091      2.920
0.003       0.087       0.443
bs_volatility                                -0.7780      0.206     -3.778
0.000      -1.182      -0.374
assets                                       -0.0845      0.021     -3.952
0.000      -0.126      -0.043
hightech                                      0.2988      0.039      7.691
0.000       0.223       0.375
1992                                          0.2496      0.060      4.187
0.000       0.133       0.366
1993                                          0.1713      0.042      4.102
0.000       0.089       0.253
1994                                          0.1023      0.043      2.399
0.016       0.019       0.186
1995                                          0.1857      0.044      4.267
0.000       0.100       0.271
1996                                          0.2734      0.047      5.875
0.000       0.182       0.365
1997                                          0.4194      0.047      8.927
0.000       0.327       0.511
1998                                          0.5040      0.061      8.273
0.000       0.385       0.623
1999                                          0.4305      0.065      6.612
0.000       0.303       0.558
Amusement & Recreation Services               0.1018      0.207      0.493
0.622      -0.303       0.507
Apparel & Accessory Stores                    0.3980      0.232      1.714
0.087      -0.057       0.853
Apparel & Other Textile Products              0.0197      0.095      0.206
0.837      -0.167       0.207
Auto Repair, Services, & Parking             -0.5566      0.061     -9.145
0.000      -0.676      -0.437
Automative Dealers & Service Stations        -0.2544      0.209     -1.217
0.223      -0.664       0.155
Building Materials & Gardening Supplies       1.1134      0.275      4.053
0.000       0.575       1.652
Business Services                             0.3710      0.106      3.495
0.000       0.163       0.579
Chemical & Allied Products                    0.9377      0.081     11.510
0.000       0.778       1.097
Communications                                0.2554      0.073      3.507
0.000       0.113       0.398
Depository Institutions                      -0.1425      0.043     -3.340
0.001      -0.226      -0.059
Eating & Drinking Places                      0.4533      0.136      3.331
0.001       0.187       0.720
Electric, Gas, & Sanitary Services           -0.2829      0.067     -4.197
```

```
0.000      -0.415      -0.151
Electronic & Other Electric Equipment        0.0004      0.073      0.005
0.996      -0.143       0.144
Engineering & Management Services            1.1982      0.254      4.726
0.000       0.701       1.695
Fabricated Metal Products                    0.2122      0.155      1.366
0.172      -0.092       0.517
Food & Kindred Products                      1.0628      0.103     10.327
0.000       0.861       1.265
Food Stores                                  0.1551      0.101      1.531
0.126      -0.043       0.354
Furniture & Fixtures                        -0.4330      0.046     -9.433
0.000      -0.523      -0.343
Furniture & Homefurnishings Stores           0.3168      0.227      1.396
0.163      -0.128       0.762
General Building Contractors                -0.6742      0.055    -12.274
0.000      -0.782      -0.567
General Merchandise Stores                  -0.1383      0.095     -1.462
0.144      -0.324       0.047
Health Services                             -0.4380      0.093     -4.726
0.000      -0.620      -0.256
Heavy Construction, Except Building         -0.2146      0.121     -1.778
0.075      -0.451       0.022
Hotels & Other Lodging Places                0.0408      0.070      0.579
0.563      -0.097       0.179
Industrial Machinery & Equipment            -0.2534      0.053     -4.807
0.000      -0.357      -0.150
Instruments & Related Products               0.1808      0.086      2.108
0.035       0.013       0.349
Insurance Agents, Brokers, & Service         0.2807      0.153      1.832
0.067      -0.020       0.581
Insurance Carriers                          -0.4429      0.045     -9.795
0.000      -0.531      -0.354
Leather & Leather Products                  -0.2744      0.157     -1.749
0.080      -0.582       0.033
Lumber & Wood Products                      -0.1898      0.080     -2.378
0.017      -0.346      -0.033
Metal, Mining                                0.5276      0.187      2.828
0.005       0.162       0.893
Miscellaneous Manufacturing Industries       0.1726      0.127      1.358
0.175      -0.077       0.422
Miscellaneous Retail                         0.1353      0.138      0.977
0.328      -0.136       0.407
Motion Pictures                              0.3942      0.148      2.660
0.008       0.104       0.685
Nondepository Institutions                  -0.3531      0.059     -5.997
0.000      -0.469      -0.238
```

```
Oil & Gas Extraction                         -0.1007      0.059     -1.705
0.088      -0.216       0.015
Paper & Allied Products                      -0.0342      0.084     -0.406
0.685      -0.199       0.131
Personal Services                             0.2424      0.235      1.032
0.302      -0.218       0.703
Petroleum & Coal Products                    -0.1758      0.052     -3.355
0.001      -0.278      -0.073
Primary Metal Industries                      0.0148      0.103      0.143
0.886      -0.187       0.217
Printing & Publishing                         0.2430      0.066      3.674
0.000       0.113       0.373
Railroad Transportation                      -0.2914      0.053     -5.469
0.000      -0.396      -0.187
Rubber & Miscellaneous Plastics Products      0.2448      0.105      2.323
0.020       0.038       0.451
Security & Commodity Brokers                 -0.3192      0.089     -3.602
0.000      -0.493      -0.146
Stone, Clay, & Glass Products                -0.0315      0.130     -0.243
0.808      -0.286       0.223
Textile Mill Products                        -0.6519      0.094     -6.949
0.000      -0.836      -0.468
Tobacco Products                              0.9265      0.285      3.246
0.001       0.367       1.486
Transportation Equipment                     -0.2342      0.032     -7.263
0.000      -0.297      -0.171
Transportation by Air                        -0.3847      0.041     -9.437
0.000      -0.465      -0.305
Trucking & Warehousing                       -0.6843      0.066    -10.430
0.000      -0.813      -0.556
Wholesale Trade - Durable Goods               0.1437      0.103      1.394
0.163      -0.058       0.346
Wholesale Trade - Nondurable Goods           -0.2507      0.090     -2.784
0.005      -0.427      -0.074
==============================================================================
Omnibus:                      967.857   Durbin-Watson:                   0.738
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             7376.465
Skew:                           1.902   Prob(JB):                         0.00
Kurtosis:                      11.120   Cond. No.                     3.36e+16
==============================================================================

Notes:
[1] Standard Errors are heteroscedasticity robust (HC1)
[2] The smallest eigenvalue is 1.5e-28. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

Column IV: Reestimating comlumn II after replacing famfirm with nonfounderfam.

[ ]:
```
(data['FamFirm'] == data['nonfounderfam']).sum()
```

[ ]:
```
2060
```

[ ]:
```
(data['FamFirm'] == data['nonfounderfam']).sum() / len(data['FamFirm'])
```

[ ]:
```
0.935513169845595
```

[ ]:
```
X = pd.concat([pd.DataFrame(np.ones(len(data)), columns=['constant']),␣
 ↪data[['nonfounderfam', 'bs_volatility']], np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)

model = sm.OLS(y, X).fit(cov_type='HC1')
predictions = model.predict(X) # make the predictions by the model

# Print out the statistics
model.summary()
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:1834:
ValueWarning: covariance of constraints does not have full rank. The number of
constraints is 64, but rank is 62
  'rank is %d' % (J, J_), ValueWarning)
```

[ ]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                      Q   R-squared:                       0.298
Model:                            OLS   Adj. R-squared:                  0.278
Method:                 Least Squares   F-statistic:                     563.5
Date:                Fri, 23 Jul 2021   Prob (F-statistic):               0.00
Time:                        16:55:59   Log-Likelihood:                -2589.3
No. Observations:                2202   AIC:                             5303.
Df Residuals:                    2140   BIC:                             5656.
Df Model:                          61
Covariance Type:                  HC1
==============================================================================
============================
                                                 coef    std err          z
P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
----------------------------
constant                                       2.3212      0.180     12.916
0.000       1.969       2.673
nonfounderfam                                  0.0402      0.050      0.807
0.419      -0.057       0.138
bs_volatility                                 -0.6352      0.201     -3.158
0.002      -1.029      -0.241
```

```
assets                                          -0.0868      0.021     -4.066
0.000      -0.129      -0.045
hightech                                         0.3159      0.040      7.868
0.000       0.237       0.395
1992                                             0.2520      0.060      4.177
0.000       0.134       0.370
1993                                             0.1714      0.042      4.046
0.000       0.088       0.254
1994                                             0.1013      0.043      2.353
0.019       0.017       0.186
1995                                             0.1860      0.044      4.218
0.000       0.100       0.273
1996                                             0.2730      0.047      5.806
0.000       0.181       0.365
1997                                             0.4197      0.048      8.804
0.000       0.326       0.513
1998                                             0.4995      0.060      8.275
0.000       0.381       0.618
1999                                             0.4182      0.065      6.445
0.000       0.291       0.545
Amusement & Recreation Services                  0.0654      0.206      0.317
0.751      -0.339       0.470
Apparel & Accessory Stores                       0.4556      0.225      2.021
0.043       0.014       0.897
Apparel & Other Textile Products                 0.0418      0.101      0.412
0.680      -0.157       0.240
Auto Repair, Services, & Parking                -0.5544      0.060     -9.264
0.000      -0.672      -0.437
Automative Dealers & Service Stations           -0.3046      0.211     -1.441
0.150      -0.719       0.110
Building Materials & Gardening Supplies          1.1968      0.300      3.988
0.000       0.609       1.785
Business Services                                0.3991      0.108      3.707
0.000       0.188       0.610
Chemical & Allied Products                       0.9293      0.082     11.391
0.000       0.769       1.089
Communications                                   0.2921      0.069      4.252
0.000       0.157       0.427
Depository Institutions                         -0.1899      0.060     -3.145
0.002      -0.308      -0.072
Eating & Drinking Places                         0.4378      0.142      3.077
0.002       0.159       0.717
Electric, Gas, & Sanitary Services              -0.2014      0.084     -2.400
0.016      -0.366      -0.037
Electronic & Other Electric Equipment           -0.0005      0.074     -0.006
0.995      -0.145       0.144
Engineering & Management Services                1.1893      0.255      4.671
```

```
0.000       0.690       1.688
Fabricated Metal Products                    0.2010      0.157      1.284
0.199      -0.106       0.508
Food & Kindred Products                      1.0495      0.102     10.260
0.000       0.849       1.250
Food Stores                                  0.1250      0.105      1.193
0.233      -0.080       0.330
Furniture & Fixtures                        -0.4291      0.047     -9.109
0.000      -0.521      -0.337
Furniture & Homefurnishings Stores           0.3010      0.227      1.325
0.185      -0.144       0.746
General Building Contractors                -0.6989      0.058    -12.138
0.000      -0.812      -0.586
General Merchandise Stores                  -0.1246      0.092     -1.357
0.175      -0.305       0.055
Health Services                             -0.4491      0.090     -5.010
0.000      -0.625      -0.273
Heavy Construction, Except Building         -0.2220      0.121     -1.839
0.066      -0.459       0.015
Hotels & Other Lodging Places               -0.0024      0.080     -0.029
0.977      -0.160       0.155
Industrial Machinery & Equipment            -0.2732      0.054     -5.038
0.000      -0.379      -0.167
Instruments & Related Products               0.1904      0.087      2.196
0.028       0.020       0.360
Insurance Agents, Brokers, & Service         0.2866      0.155      1.850
0.064      -0.017       0.590
Insurance Carriers                          -0.4325      0.046     -9.334
0.000      -0.523      -0.342
Leather & Leather Products                  -0.2921      0.157     -1.863
0.063      -0.599       0.015
Lumber & Wood Products                      -0.2141      0.080     -2.667
0.008      -0.371      -0.057
Metal, Mining                                0.5131      0.187      2.741
0.006       0.146       0.880
Miscellaneous Manufacturing Industries       0.1523      0.129      1.183
0.237      -0.100       0.405
Miscellaneous Retail                         0.1462      0.138      1.059
0.290      -0.124       0.417
Motion Pictures                              0.3750      0.148      2.533
0.011       0.085       0.665
Nondepository Institutions                  -0.3498      0.059     -5.923
0.000      -0.466      -0.234
Oil & Gas Extraction                        -0.1001      0.060     -1.675
0.094      -0.217       0.017
Paper & Allied Products                     -0.0361      0.085     -0.424
0.672      -0.203       0.131
```

```
Personal Services                            0.3137      0.215      1.461
0.144      -0.107       0.735
Petroleum & Coal Products                   -0.1565      0.052     -3.026
0.002      -0.258      -0.055
Primary Metal Industries                     0.0217      0.103      0.211
0.833      -0.180       0.223
Printing & Publishing                        0.2198      0.070      3.132
0.002       0.082       0.357
Railroad Transportation                     -0.2874      0.052     -5.530
0.000      -0.389      -0.186
Rubber & Miscellaneous Plastics Products     0.3063      0.106      2.899
0.004       0.099       0.513
Security & Commodity Brokers                -0.3188      0.089     -3.587
0.000      -0.493      -0.145
Stone, Clay, & Glass Products               -0.0449      0.125     -0.360
0.719      -0.290       0.200
Textile Mill Products                       -0.6978      0.099     -7.029
0.000      -0.892      -0.503
Tobacco Products                             0.9320      0.286      3.263
0.001       0.372       1.492
Transportation Equipment                    -0.2365      0.033     -7.245
0.000      -0.300      -0.172
Transportation by Air                       -0.3518      0.041     -8.559
0.000      -0.432      -0.271
Trucking & Warehousing                      -0.7266      0.065    -11.154
0.000      -0.854      -0.599
Wholesale Trade - Durable Goods              0.1326      0.103      1.288
0.198      -0.069       0.334
Wholesale Trade - Nondurable Goods          -0.2573      0.090     -2.863
0.004      -0.433      -0.081
==============================================================================
Omnibus:                      959.465   Durbin-Watson:                   0.736
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             6937.988
Skew:                           1.901   Prob(JB):                         0.00
Kurtosis:                      10.821   Cond. No.                     6.88e+16
==============================================================================

Notes:
[1] Standard Errors are heteroscedasticity robust (HC1)
[2] The smallest eigenvalue is 3.59e-29. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

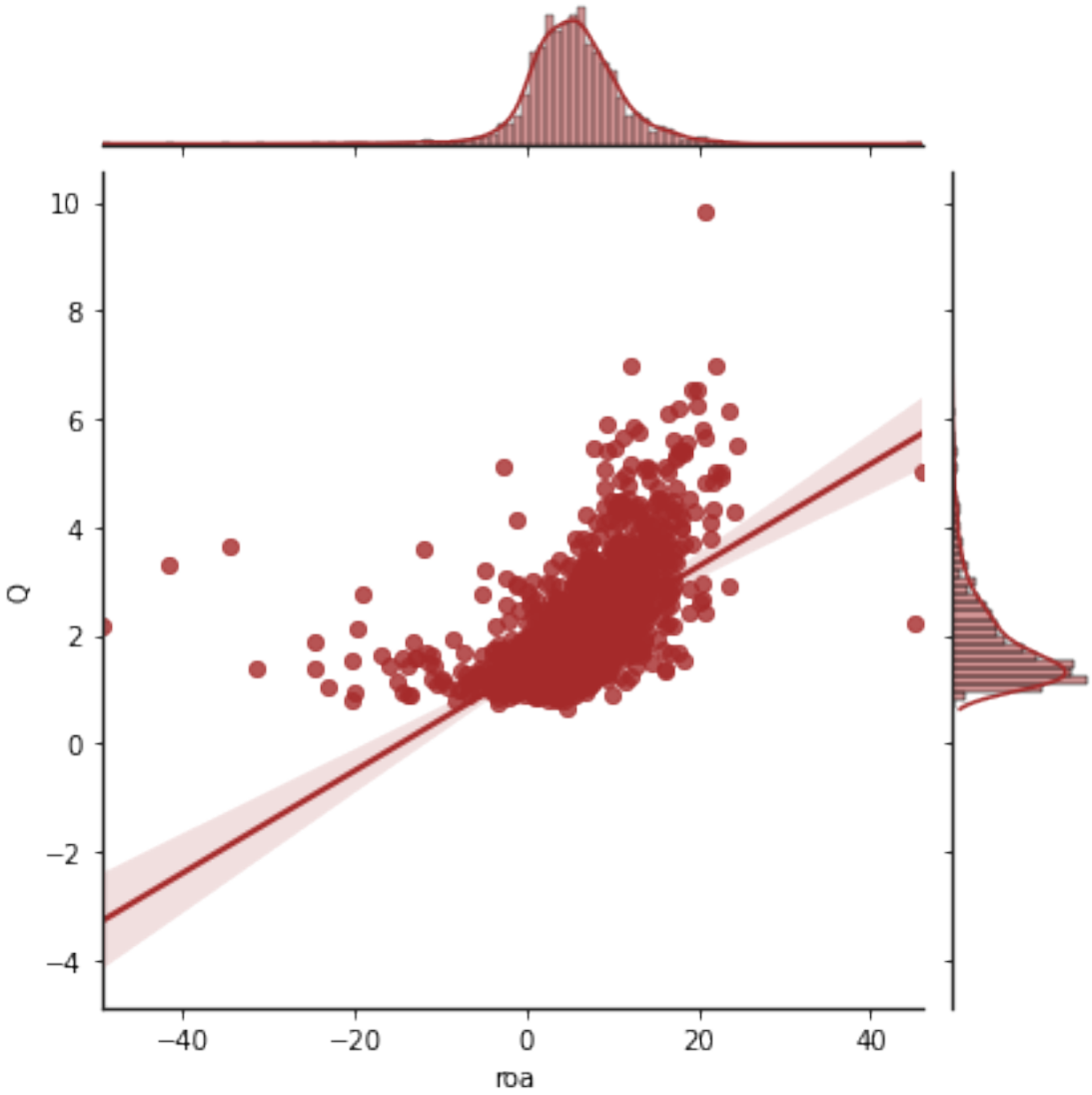
Column V: column II after replacing Q with ROA.

[ ]:
```
from scipy.stats import pearsonr
import seaborn as sns
plt.figure(figsize = (10, 10))
```

```
sns.jointplot(x='roa', y='Q', data=data,  kind="reg", color= 'brown')
```

[ ]: <seaborn.axisgrid.JointGrid at 0x7f8507e967d0>

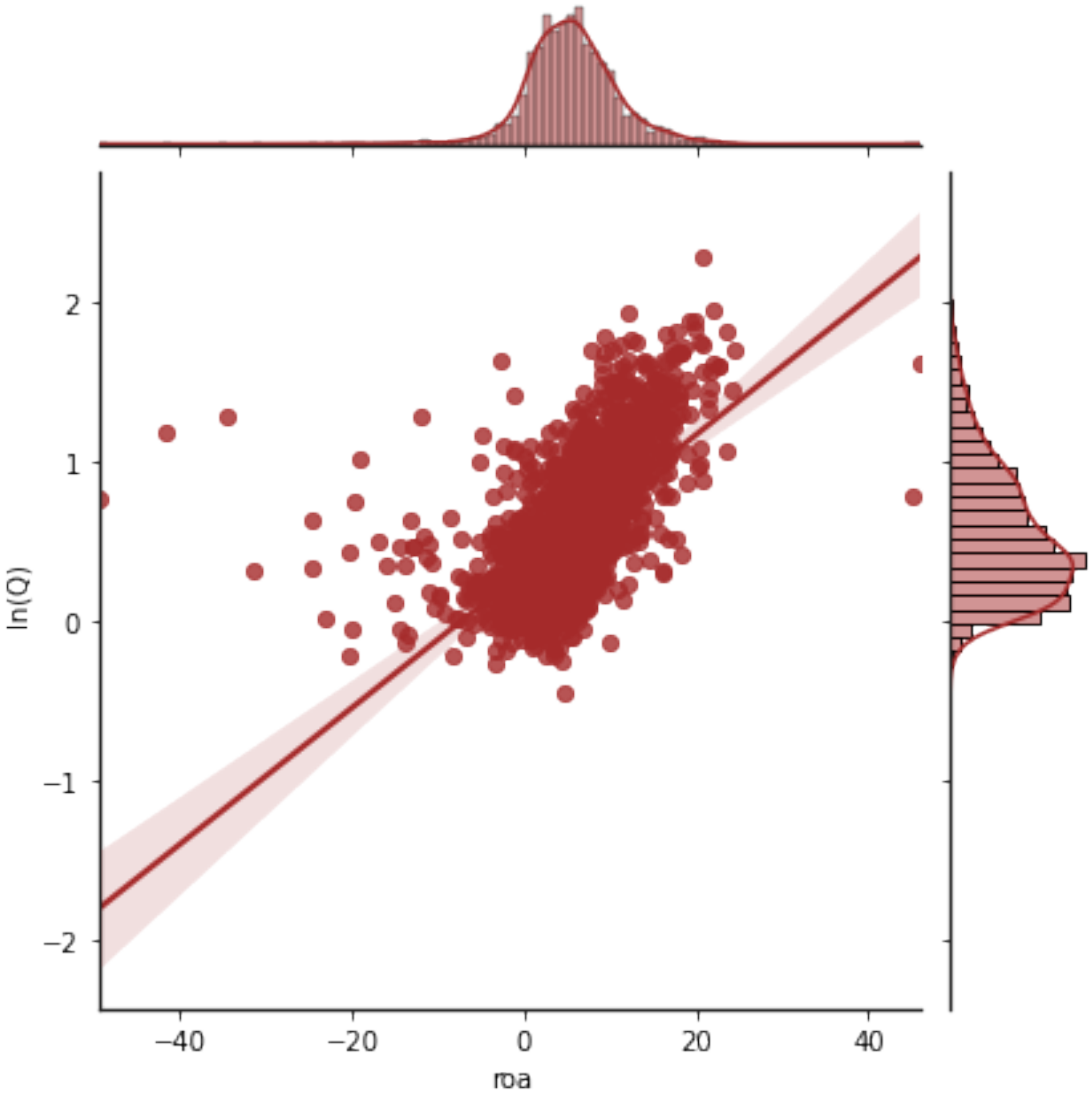
<Figure size 720x720 with 0 Axes>




```
from scipy.stats import pearsonr
import seaborn as sns
plt.figure(figsize = (10, 10))
data['ln(Q)'] = np.log(data['Q'])
sns.jointplot(x='roa', y='ln(Q)', data=data,  kind="reg", color= 'brown')
```

[ ]: <seaborn.axisgrid.JointGrid at 0x7f85084a9e90>

```
<Figure size 720x720 with 0 Axes>
```



[ ]:
```
y = data['roa']
X = pd.concat([pd.DataFrame(np.ones(len(data)), columns=['constant']),␣
 ↪data[['FamFirm', 'bs_volatility']], np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)
```

[ ]:
```
model = sm.OLS(y, X).fit(cov_type='HC1')
predictions = model.predict(X) # make the predictions by the model

# Print out the statistics
model.summary()
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:1834:
ValueWarning: covariance of constraints does not have full rank. The number of
constraints is 64, but rank is 62
  'rank is %d' % (J, J_), ValueWarning)
```

[ ]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                    roa   R-squared:                       0.206
Model:                            OLS   Adj. R-squared:                  0.184
Method:                 Least Squares   F-statistic:                     90.93
Date:                Fri, 23 Jul 2021   Prob (F-statistic):               0.00
Time:                        16:56:02   Log-Likelihood:                -6751.6
No. Observations:                2202   AIC:                         1.363e+04
Df Residuals:                    2140   BIC:                         1.398e+04
Df Model:                          61
Covariance Type:                  HC1
==============================================================================
============================
                                              coef    std err          z
P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
----------------------------
constant                                   13.1808      1.296     10.171
0.000      10.641      15.721
FamFirm                                     0.6119      0.290      2.110
0.035       0.044       1.180
bs_volatility                             -12.5904      1.708     -7.373
0.000     -15.937      -9.244
assets                                     -0.8129      0.153     -5.329
0.000      -1.112      -0.514
hightech                                    1.0977      0.293      3.752
0.000       0.524       1.671
1992                                        1.8879      0.337      5.600
0.000       1.227       2.549
1993                                        0.9557      0.309      3.089
0.002       0.349       1.562
1994                                        2.1470      0.270      7.946
0.000       1.617       2.677
1995                                        1.7484      0.312      5.598
0.000       1.136       2.361
1996                                        1.7092      0.285      6.002
0.000       1.151       2.267
1997                                        1.1337      0.403      2.815
0.005       0.344       1.923
1998                                        1.1899      0.413      2.879
```

```
0.004       0.380       2.000
1999                                    2.4090      0.395      6.106
0.000       1.636       3.182
Amusement & Recreation Services         0.6588      0.643      1.025
0.306      -0.601       1.919
Apparel & Accessory Stores              3.9150      1.494      2.620
0.009       0.986       6.844
Apparel & Other Textile Products        4.9149      0.873      5.632
0.000       3.204       6.625
Auto Repair, Services, & Parking       -2.6964      0.562     -4.795
0.000      -3.798      -1.594
Automative Dealers & Service Stations  -1.5549      0.800     -1.944
0.052      -3.123       0.013
Building Materials & Gardening Supplies 3.4488      0.401      8.611
0.000       2.664       4.234
Business Services                      -0.3325      0.808     -0.412
0.681      -1.915       1.250
Chemical & Allied Products              3.8953      0.420      9.276
0.000       3.072       4.718
Communications                          0.7330      0.614      1.193
0.233      -0.471       1.937
Depository Institutions                -0.7481      0.437     -1.714
0.087      -1.604       0.107
Eating & Drinking Places                3.0184      0.446      6.769
0.000       2.144       3.892
Electric, Gas, & Sanitary Services     -1.3513      0.400     -3.377
0.001      -2.136      -0.567
Electronic & Other Electric Equipment   0.9075      0.620      1.463
0.144      -0.309       2.124
Engineering & Management Services       1.7575      1.972      0.891
0.373      -2.107       5.622
Fabricated Metal Products              -0.1988      0.689     -0.289
0.773      -1.550       1.152
Food & Kindred Products                 3.4390      0.566      6.074
0.000       2.329       4.549
Food Stores                            -1.1138      1.006     -1.108
0.268      -3.085       0.857
Furniture & Fixtures                   -0.9351      0.271     -3.457
0.001      -1.465      -0.405
Furniture & Homefurnishings Stores      2.1005      1.004      2.092
0.036       0.133       4.068
General Building Contractors           -0.2490      0.495     -0.503
0.615      -1.219       0.721
General Merchandise Stores              0.7066      0.391      1.807
0.071      -0.060       1.473
Health Services                        -2.3795      1.303     -1.826
0.068      -4.934       0.175
```

```
Heavy Construction, Except Building         -1.2860      0.802     -1.604
0.109      -2.857       0.285
Hotels & Other Lodging Places               -0.4348      0.386     -1.125
0.260      -1.192       0.322
Industrial Machinery & Equipment            -0.6744      0.529     -1.275
0.202      -1.711       0.362
Instruments & Related Products               1.1972      0.542      2.208
0.027       0.135       2.260
Insurance Agents, Brokers, & Service         0.6135      1.281      0.479
0.632      -1.897       3.124
Insurance Carriers                          -1.6054      0.350     -4.580
0.000      -2.292      -0.918
Leather & Leather Products                  -1.4351      1.456     -0.986
0.324      -4.289       1.419
Lumber & Wood Products                      -1.0412      1.082     -0.963
0.336      -3.161       1.079
Metal, Mining                               -3.7091      1.553     -2.388
0.017      -6.753      -0.665
Miscellaneous Manufacturing Industries       1.7142      0.645      2.656
0.008       0.449       2.979
Miscellaneous Retail                        -0.2843      0.807     -0.352
0.725      -1.867       1.298
Motion Pictures                              2.4858      1.594      1.559
0.119      -0.639       5.610
Nondepository Institutions                  -1.3131      0.432     -3.038
0.002      -2.160      -0.466
Oil & Gas Extraction                        -1.9462      0.576     -3.378
0.001      -3.075      -0.817
Paper & Allied Products                     -0.7875      0.505     -1.560
0.119      -1.777       0.202
Personal Services                            1.1486      0.886      1.296
0.195      -0.588       2.885
Petroleum & Coal Products                   -0.5271      0.520     -1.014
0.310      -1.546       0.492
Primary Metal Industries                    -0.1739      0.563     -0.309
0.757      -1.277       0.929
Printing & Publishing                        0.0777      0.746      0.104
0.917      -1.384       1.539
Railroad Transportation                     -0.1184      0.444     -0.267
0.790      -0.989       0.752
Rubber & Miscellaneous Plastics Products     2.9611      0.634      4.668
0.000       1.718       4.204
Security & Commodity Brokers                -0.2389      0.636     -0.376
0.707      -1.485       1.007
Stone, Clay, & Glass Products               -3.8951      2.677     -1.455
0.146      -9.142       1.352
Textile Mill Products                       -1.8396      0.632     -2.909
```

```
0.004      -3.079      -0.600
Tobacco Products                            10.8922      3.482      3.128
0.002       4.067      17.717
Transportation Equipment                     0.2195      0.279      0.788
0.431      -0.327       0.766
Transportation by Air                       -0.5889      0.632     -0.931
0.352      -1.828       0.651
Trucking & Warehousing                      -4.0074      1.235     -3.246
0.001      -6.427      -1.588
Wholesale Trade - Durable Goods              1.5741      0.743      2.117
0.034       0.117       3.031
Wholesale Trade - Nondurable Goods          -1.7325      0.613     -2.828
0.005      -2.933      -0.532
==============================================================================
Omnibus:                      966.733   Durbin-Watson:                   1.249
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            22884.653
Skew:                          -1.525   Prob(JB):                         0.00
Kurtosis:                      18.496   Cond. No.                     4.64e+16
==============================================================================

Notes:
[1] Standard Errors are heteroscedasticity robust (HC1)
[2] The smallest eigenvalue is 7.9e-29. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

Column VI: column III after replacing Q with ROA.

[ ]:
```
X = pd.concat([pd.DataFrame(np.ones(len(data)), columns=['constant']),␣
 ↪data[['founderCEO', 'bs_volatility']], np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)

model = sm.OLS(y, X).fit(cov_type='HC1')
predictions = model.predict(X) # make the predictions by the model

# Print out the statistics
model.summary()
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:1834:
ValueWarning: covariance of constraints does not have full rank. The number of
constraints is 64, but rank is 62
  'rank is %d' % (J, J_), ValueWarning)
```

[ ]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
```

Dep. Variable:	roa	R-squared:	0.209
Model:	OLS	Adj. R-squared:	0.187
Method:	Least Squares	F-statistic:	97.92
Date:	Fri, 23 Jul 2021	Prob (F-statistic):	0.00
Time:	16:56:02	Log-Likelihood:	-6747.6
No. Observations:	2202	AIC:	1.362e+04
Df Residuals:	2140	BIC:	1.397e+04
Df Model:	61		
Covariance Type:	HC1		

	coef	std err	z	P>|z|	[0.025	0.975]
constant	13.6043	1.253	10.857	0.000	11.148	16.060
founderCEO	1.7496	0.711	2.459	0.014	0.355	3.144
bs_volatility	-13.3682	1.735	-7.706	0.000	-16.768	-9.968
assets	-0.8319	0.149	-5.576	0.000	-1.124	-0.540
hightech	0.9865	0.287	3.442	0.001	0.425	1.548
1992	1.9165	0.333	5.754	0.000	1.264	2.569
1993	1.0034	0.308	3.254	0.001	0.399	1.608
1994	2.2000	0.266	8.266	0.000	1.678	2.722
1995	1.8000	0.307	5.863	0.000	1.198	2.402
1996	1.7485	0.281	6.220	0.000	1.198	2.299
1997	1.1709	0.400	2.924	0.003	0.386	1.956
1998	1.2519	0.409	3.058	0.002	0.449	2.054
1999	2.5131	0.393	6.398	0.000	1.743	3.283
Amusement & Recreation Services	0.7132	0.630	1.133	0.257	-0.521	1.947
Apparel & Accessory Stores	3.6952	1.453	2.542	0.011	0.847	6.544
Apparel & Other Textile Products	4.7909	0.814	5.885	0.000	3.195	6.387

```
Auto Repair, Services, & Parking            -2.8219      0.562     -5.024
0.000      -3.923      -1.721
Automative Dealers & Service Stations       -1.0390      0.787     -1.321
0.187      -2.581       0.503
Building Materials & Gardening Supplies      2.9716      0.400      7.428
0.000       2.188       3.756
Business Services                           -0.4798      0.813     -0.590
0.555      -2.073       1.114
Chemical & Allied Products                   3.9358      0.417      9.427
0.000       3.118       4.754
Communications                               0.6067      0.642      0.944
0.345      -0.652       1.866
Depository Institutions                     -0.1793      0.374     -0.480
0.631      -0.912       0.553
Eating & Drinking Places                     3.1839      0.379      8.405
0.000       2.441       3.926
Electric, Gas, & Sanitary Services          -1.7585      0.397     -4.432
0.000      -2.536      -0.981
Electronic & Other Electric Equipment        0.9007      0.614      1.467
0.143      -0.303       2.105
Engineering & Management Services            1.6424      1.962      0.837
0.403      -2.203       5.488
Fabricated Metal Products                   -0.1300      0.673     -0.193
0.847      -1.450       1.190
Food & Kindred Products                      3.5935      0.560      6.418
0.000       2.496       4.691
Food Stores                                 -0.7826      0.999     -0.783
0.434      -2.741       1.176
Furniture & Fixtures                        -1.0720      0.255     -4.211
0.000      -1.571      -0.573
Furniture & Homefurnishings Stores           2.0505      1.000      2.051
0.040       0.091       4.010
General Building Contractors                -0.1047      0.472     -0.222
0.825      -1.030       0.821
General Merchandise Stores                   0.6736      0.405      1.664
0.096      -0.120       1.467
Health Services                             -2.4404      1.326     -1.840
0.066      -5.040       0.159
Heavy Construction, Except Building         -1.3751      0.795     -1.730
0.084      -2.933       0.183
Hotels & Other Lodging Places                0.0749      0.342      0.219
0.827      -0.596       0.746
Industrial Machinery & Equipment            -0.5257      0.527     -0.997
0.319      -1.559       0.508
Instruments & Related Products               1.0913      0.539      2.023
0.043       0.034       2.149
Insurance Agents, Brokers, & Service         0.4617      1.273      0.363
```

```
0.717      -2.033       2.956
Insurance Carriers                          -1.6572      0.347     -4.776
0.000      -2.337      -0.977
Leather & Leather Products                  -1.5266      1.451     -1.052
0.293      -4.371       1.318
Lumber & Wood Products                      -0.8140      1.081     -0.753
0.452      -2.933       1.305
Metal, Mining                               -3.7773      1.545     -2.444
0.015      -6.806      -0.749
Miscellaneous Manufacturing Industries       1.8278      0.643      2.842
0.004       0.567       3.088
Miscellaneous Retail                        -0.2521      0.809     -0.312
0.755      -1.838       1.334
Motion Pictures                              2.6229      1.651      1.589
0.112      -0.612       5.858
Nondepository Institutions                  -1.3765      0.438     -3.141
0.002      -2.235      -0.518
Oil & Gas Extraction                        -2.0606      0.572     -3.604
0.000      -3.181      -0.940
Paper & Allied Products                     -0.7598      0.498     -1.526
0.127      -1.736       0.216
Personal Services                            0.9112      1.012      0.900
0.368      -1.072       2.895
Petroleum & Coal Products                   -0.6443      0.522     -1.234
0.217      -1.667       0.379
Primary Metal Industries                    -0.2260      0.565     -0.400
0.689      -1.333       0.881
Printing & Publishing                        0.3417      0.736      0.464
0.643      -1.101       1.785
Railroad Transportation                     -0.2221      0.452     -0.491
0.623      -1.108       0.664
Rubber & Miscellaneous Plastics Products     2.6660      0.626      4.261
0.000       1.440       3.892
Security & Commodity Brokers                -0.2391      0.641     -0.373
0.709      -1.495       1.016
Stone, Clay, & Glass Products               -3.9436      2.691     -1.466
0.143      -9.217       1.330
Textile Mill Products                       -1.3557      0.620     -2.185
0.029      -2.572      -0.140
Tobacco Products                            10.8091      3.470      3.115
0.002       4.008      17.610
Transportation Equipment                     0.2626      0.279      0.941
0.347      -0.284       0.810
Transportation by Air                       -0.8144      0.640     -1.273
0.203      -2.069       0.440
Trucking & Warehousing                      -3.6551      1.176     -3.109
0.002      -5.960      -1.351
```

```
Wholesale Trade - Durable Goods              1.6091      0.752      2.139
0.032       0.135       3.084
Wholesale Trade - Nondurable Goods          -1.7985      0.610     -2.946
0.003      -2.995      -0.602
==============================================================================
Omnibus:                      997.276   Durbin-Watson:                   1.258
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            23287.738
Skew:                          -1.598   Prob(JB):                         0.00
Kurtosis:                      18.608   Cond. No.                     3.36e+16
==============================================================================

Notes:
[1] Standard Errors are heteroscedasticity robust (HC1)
[2] The smallest eigenvalue is 1.5e-28. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

Column VII: column IIV after replacing Q with ROA.

[ ]:
```
X = pd.concat([pd.DataFrame(np.ones(len(data)), columns=['constant']),␣
 ↪data[['nonfounderfam', 'bs_volatility']], np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)

model = sm.OLS(y, X).fit(cov_type='HC1')
predictions = model.predict(X) # make the predictions by the model

# Print out the statistics
model.summary()
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:1834:
ValueWarning: covariance of constraints does not have full rank. The number of
constraints is 64, but rank is 62
  'rank is %d' % (J, J_), ValueWarning)
```

[ ]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                    roa   R-squared:                       0.205
Model:                            OLS   Adj. R-squared:                  0.182
Method:                 Least Squares   F-statistic:                     91.75
Date:                Fri, 23 Jul 2021   Prob (F-statistic):               0.00
Time:                        16:56:02   Log-Likelihood:                -6754.2
No. Observations:                2202   AIC:                         1.363e+04
Df Residuals:                    2140   BIC:                         1.399e+04
Df Model:                          61
Covariance Type:                  HC1
```

```
==============================================================================
============================
                                              coef    std err          z
P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
----------------------------
constant                                   13.6552      1.287     10.607
0.000      11.132      16.179
nonfounderfam                               0.0814      0.281      0.290
0.772      -0.469       0.632
bs_volatility                             -12.4908      1.706     -7.323
0.000     -15.834      -9.148
assets                                     -0.8592      0.151     -5.683
0.000      -1.156      -0.563
hightech                                    1.0825      0.291      3.716
0.000       0.512       1.653
1992                                        1.9494      0.336      5.807
0.000       1.291       2.607
1993                                        1.0259      0.313      3.278
0.001       0.412       1.639
1994                                        2.2142      0.269      8.218
0.000       1.686       2.742
1995                                        1.8247      0.312      5.845
0.000       1.213       2.437
1996                                        1.7610      0.284      6.190
0.000       1.203       2.319
1997                                        1.1877      0.402      2.956
0.003       0.400       1.975
1998                                        1.2395      0.414      2.997
0.003       0.429       2.050
1999                                        2.4527      0.393      6.236
0.000       1.682       3.224
Amusement & Recreation Services             0.4277      0.638      0.671
0.502      -0.822       1.678
Apparel & Accessory Stores                  4.0855      1.512      2.701
0.007       1.121       7.050
Apparel & Other Textile Products            4.9713      0.828      6.003
0.000       3.348       6.594
Auto Repair, Services, & Parking           -2.8572      0.558     -5.120
0.000      -3.951      -1.764
Automative Dealers & Service Stations      -1.2456      0.795     -1.567
0.117      -2.803       0.312
Building Materials & Gardening Supplies     3.4709      0.453      7.659
0.000       2.583       4.359
Business Services                          -0.3059      0.806     -0.379
0.704      -1.886       1.275
Chemical & Allied Products                  3.8807      0.418      9.282
```

```
0.000       3.061       4.700
Communications                          0.8603      0.592      1.452
0.147      -0.301       2.022
Depository Institutions                -0.3407      0.441     -0.772
0.440      -1.205       0.524
Eating & Drinking Places                3.1218      0.399      7.820
0.000       2.339       3.904
Electric, Gas, & Sanitary Services     -1.2466      0.445     -2.800
0.005      -2.119      -0.374
Electronic & Other Electric Equipment   0.8905      0.626      1.423
0.155      -0.336       2.117
Engineering & Management Services       1.5186      1.976      0.769
0.442      -2.354       5.391
Fabricated Metal Products              -0.1962      0.676     -0.290
0.772      -1.520       1.128
Food & Kindred Products                 3.5451      0.570      6.215
0.000       2.427       4.663
Food Stores                            -0.8977      0.998     -0.899
0.369      -2.854       1.059
Furniture & Fixtures                   -1.0980      0.271     -4.051
0.000      -1.629      -0.567
Furniture & Homefurnishings Stores      1.8954      1.000      1.895
0.058      -0.065       3.856
General Building Contractors           -0.2533      0.477     -0.532
0.595      -1.187       0.681
General Merchandise Stores              0.7733      0.393      1.969
0.049       0.003       1.543
Health Services                        -2.5608      1.300     -1.969
0.049      -5.110      -0.012
Heavy Construction, Except Building    -1.4763      0.798     -1.849
0.064      -3.041       0.089
Hotels & Other Lodging Places          -0.0755      0.384     -0.196
0.844      -0.829       0.678
Industrial Machinery & Equipment       -0.6301      0.535     -1.177
0.239      -1.679       0.419
Instruments & Related Products          1.1280      0.547      2.063
0.039       0.056       2.200
Insurance Agents, Brokers, & Service    0.4468      1.285      0.348
0.728      -2.072       2.966
Insurance Carriers                     -1.5934      0.350     -4.557
0.000      -2.279      -0.908
Leather & Leather Products             -1.7143      1.451     -1.182
0.237      -4.558       1.129
Lumber & Wood Products                 -0.9248      1.089     -0.849
0.396      -3.059       1.210
Metal, Mining                          -3.9295      1.550     -2.535
0.011      -6.968      -0.891
```

```
Miscellaneous Manufacturing Industries       1.7029      0.640      2.660
0.008       0.448       2.958
Miscellaneous Retail                        -0.1343      0.811     -0.166
0.868      -1.723       1.455
Motion Pictures                              2.5173      1.630      1.545
0.122      -0.677       5.712
Nondepository Institutions                  -1.3769      0.436     -3.156
0.002      -2.232      -0.522
Oil & Gas Extraction                        -2.1052      0.575     -3.659
0.000      -3.233      -0.977
Paper & Allied Products                     -0.7552      0.495     -1.525
0.127      -1.726       0.215
Personal Services                            1.4093      0.862      1.635
0.102      -0.280       3.098
Petroleum & Coal Products                   -0.5327      0.513     -1.038
0.299      -1.539       0.473
Primary Metal Industries                    -0.1909      0.567     -0.337
0.736      -1.302       0.920
Printing & Publishing                        0.2556      0.733      0.349
0.727      -1.182       1.693
Railroad Transportation                     -0.2334      0.440     -0.530
0.596      -1.097       0.630
Rubber & Miscellaneous Plastics Products     3.0579      0.649      4.714
0.000       1.787       4.329
Security & Commodity Brokers                -0.2383      0.638     -0.373
0.709      -1.489       1.012
Stone, Clay, & Glass Products               -4.0781      2.670     -1.527
0.127      -9.311       1.155
Textile Mill Products                       -1.5397      0.632     -2.436
0.015      -2.779      -0.301
Tobacco Products                            10.8190      3.465      3.123
0.002       4.029      17.609
Transportation Equipment                     0.2598      0.281      0.924
0.356      -0.291       0.811
Transportation by Air                       -0.6337      0.641     -0.988
0.323      -1.891       0.623
Trucking & Warehousing                      -3.8643      1.180     -3.275
0.001      -6.177      -1.552
Wholesale Trade - Durable Goods              1.5290      0.757      2.021
0.043       0.046       3.012
Wholesale Trade - Nondurable Goods          -1.8827      0.615     -3.062
0.002      -3.088      -0.678
==============================================================================
Omnibus:                      964.543   Durbin-Watson:                   1.245
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            23029.564
Skew:                          -1.517   Prob(JB):                         0.00
Kurtosis:                      18.550   Cond. No.                     6.88e+16
```

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

Notes:
[1] Standard Errors are heteroscedasticity robust (HC1)
[2] The smallest eigenvalue is 3.59e-29. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

Column VIII: column II after replacing Q with $ln(Q)$.

[ ]:
```
y = np.log(data['Q'])
```

[ ]:
```
X = pd.concat([pd.DataFrame(np.ones(len(data)), columns=['constant']),␣
 ↪data[['FamFirm', 'bs_volatility']], np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)
```

[ ]:
```
model = sm.OLS(y, X).fit(cov_type='HC1')
predictions = model.predict(X) # make the predictions by the model

# Print out the statistics
model.summary()
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:1834:
ValueWarning: covariance of constraints does not have full rank. The number of
constraints is 64, but rank is 62
  'rank is %d' % (J, J_), ValueWarning)
```

[ ]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                      Q   R-squared:                       0.369
Model:                            OLS   Adj. R-squared:                  0.351
Method:                 Least Squares   F-statistic:                     135.8
Date:                Fri, 23 Jul 2021   Prob (F-statistic):               0.00
Time:                        16:56:02   Log-Likelihood:                -656.85
No. Observations:                2202   AIC:                             1438.
Df Residuals:                    2140   BIC:                             1791.
Df Model:                          61
Covariance Type:                  HC1
==============================================================================
============================
                                                 coef    std err          z
P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
----------------------------
constant                                    0.8600      0.076     11.352
0.000       0.712       1.009
```

```
FamFirm                                    0.0358      0.019      1.912
0.056      -0.001       0.072
bs_volatility                             -0.4735      0.096     -4.939
0.000      -0.661      -0.286
assets                                    -0.0452      0.009     -5.138
0.000      -0.062      -0.028
hightech                                   0.1571      0.017      9.001
0.000       0.123       0.191
1992                                       0.0842      0.025      3.361
0.001       0.035       0.133
1993                                       0.0669      0.019      3.610
0.000       0.031       0.103
1994                                       0.0262      0.019      1.394
0.163      -0.011       0.063
1995                                       0.0663      0.019      3.579
0.000       0.030       0.103
1996                                       0.1065      0.019      5.600
0.000       0.069       0.144
1997                                       0.1804      0.020      9.132
0.000       0.142       0.219
1998                                       0.1839      0.024      7.623
0.000       0.137       0.231
1999                                       0.1457      0.027      5.340
0.000       0.092       0.199
Amusement & Recreation Services            0.0621      0.108      0.574
0.566      -0.150       0.274
Apparel & Accessory Stores                 0.1685      0.072      2.343
0.019       0.028       0.309
Apparel & Other Textile Products           0.0748      0.052      1.431
0.152      -0.028       0.177
Auto Repair, Services, & Parking          -0.3198      0.029    -10.947
0.000      -0.377      -0.263
Automative Dealers & Service Stations     -0.1592      0.132     -1.206
0.228      -0.418       0.100
Building Materials & Gardening Supplies    0.4993      0.088      5.650
0.000       0.326       0.673
Business Services                          0.1684      0.048      3.525
0.000       0.075       0.262
Chemical & Allied Products                 0.4061      0.030     13.728
0.000       0.348       0.464
Communications                             0.2018      0.034      5.924
0.000       0.135       0.269
Depository Institutions                   -0.0679      0.034     -2.006
0.045      -0.134      -0.002
Eating & Drinking Places                   0.2681      0.065      4.101
0.000       0.140       0.396
Electric, Gas, & Sanitary Services        -0.1017      0.048     -2.098
```

```
0.036      -0.197      -0.007
Electronic & Other Electric Equipment        0.0189      0.031      0.611
0.541      -0.042       0.079
Engineering & Management Services            0.5581      0.082      6.838
0.000       0.398       0.718
Fabricated Metal Products                    0.0663      0.062      1.070
0.285      -0.055       0.188
Food & Kindred Products                      0.4602      0.034     13.728
0.000       0.395       0.526
Food Stores                                  0.0675      0.057      1.191
0.234      -0.044       0.179
Furniture & Fixtures                        -0.2163      0.025     -8.787
0.000      -0.265      -0.168
Furniture & Homefurnishings Stores           0.1731      0.090      1.920
0.055      -0.004       0.350
General Building Contractors                -0.4182      0.036    -11.476
0.000      -0.490      -0.347
General Merchandise Stores                  -0.0918      0.046     -1.983
0.047      -0.182      -0.001
Health Services                             -0.2431      0.059     -4.098
0.000      -0.359      -0.127
Heavy Construction, Except Building         -0.0886      0.072     -1.224
0.221      -0.231       0.053
Hotels & Other Lodging Places                0.0499      0.040      1.235
0.217      -0.029       0.129
Industrial Machinery & Equipment            -0.1214      0.027     -4.571
0.000      -0.173      -0.069
Instruments & Related Products               0.0912      0.034      2.715
0.007       0.025       0.157
Insurance Agents, Brokers, & Service         0.1738      0.088      1.971
0.049       0.001       0.347
Insurance Carriers                          -0.2795      0.022    -12.595
0.000      -0.323      -0.236
Leather & Leather Products                  -0.1365      0.087     -1.563
0.118      -0.308       0.035
Lumber & Wood Products                      -0.0876      0.046     -1.910
0.056      -0.177       0.002
Metal, Mining                                0.2952      0.082      3.607
0.000       0.135       0.456
Miscellaneous Manufacturing Industries       0.1161      0.059      1.962
0.050       0.000       0.232
Miscellaneous Retail                         0.0635      0.065      0.982
0.326      -0.063       0.190
Motion Pictures                              0.2269      0.074      3.053
0.002       0.081       0.373
Nondepository Institutions                  -0.2206      0.029     -7.682
0.000      -0.277      -0.164
```

```
Oil & Gas Extraction                          -0.0211      0.034     -0.627
0.531      -0.087       0.045
Paper & Allied Products                       -0.0431      0.045     -0.961
0.337      -0.131       0.045
Personal Services                              0.1210      0.086      1.404
0.160      -0.048       0.290
Petroleum & Coal Products                     -0.0632      0.027     -2.357
0.018      -0.116      -0.011
Primary Metal Industries                      -0.0205      0.047     -0.439
0.660      -0.112       0.071
Printing & Publishing                          0.1340      0.032      4.144
0.000       0.071       0.197
Railroad Transportation                       -0.1372      0.029     -4.730
0.000      -0.194      -0.080
Rubber & Miscellaneous Plastics Products       0.1720      0.048      3.601
0.000       0.078       0.266
Security & Commodity Brokers                  -0.2356      0.037     -6.382
0.000      -0.308      -0.163
Stone, Clay, & Glass Products                  0.0505      0.070      0.724
0.469      -0.086       0.187
Textile Mill Products                         -0.4227      0.064     -6.626
0.000      -0.548      -0.298
Tobacco Products                               0.4708      0.089      5.310
0.000       0.297       0.645
Transportation Equipment                      -0.1083      0.017     -6.239
0.000      -0.142      -0.074
Transportation by Air                         -0.1870      0.022     -8.322
0.000      -0.231      -0.143
Trucking & Warehousing                        -0.4365      0.035    -12.501
0.000      -0.505      -0.368
Wholesale Trade - Durable Goods                0.0853      0.056      1.520
0.128      -0.025       0.195
Wholesale Trade - Nondurable Goods            -0.1564      0.053     -2.932
0.003      -0.261      -0.052
==============================================================================
Omnibus:                      151.808   Durbin-Watson:                   0.653
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              211.349
Skew:                           0.586   Prob(JB):                     1.28e-46
Kurtosis:                       3.964   Cond. No.                     4.64e+16
==============================================================================

Notes:
[1] Standard Errors are heteroscedasticity robust (HC1)
[2] The smallest eigenvalue is 7.9e-29. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

Column IX: column III after replacing Q with $ln(Q)$.

[ ]:
```
X = pd.concat([pd.DataFrame(np.ones(len(data)), columns=['constant']),␣
 ↪data[['founderCEO', 'bs_volatility']], np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)

model = sm.OLS(y, X).fit(cov_type='HC1')
predictions = model.predict(X) # make the predictions by the model

# Print out the statistics
model.summary()
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:1834:
ValueWarning: covariance of constraints does not have full rank. The number of
constraints is 64, but rank is 62
  'rank is %d' % (J, J_), ValueWarning)
```

[ ]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                      Q   R-squared:                       0.371
Model:                            OLS   Adj. R-squared:                  0.353
Method:                 Least Squares   F-statistic:                     137.7
Date:                Fri, 23 Jul 2021   Prob (F-statistic):               0.00
Time:                        16:56:03   Log-Likelihood:                -653.49
No. Observations:                2202   AIC:                             1431.
Df Residuals:                    2140   BIC:                             1784.
Df Model:                          61
Covariance Type:                  HC1
==============================================================================
============================
                                                 coef    std err          z
P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
----------------------------
constant                                       0.8848      0.074     11.880
0.000       0.739       1.031
founderCEO                                     0.1014      0.038      2.655
0.008       0.027       0.176
bs_volatility                                 -0.5185      0.098     -5.300
0.000      -0.710      -0.327
assets                                        -0.0463      0.009     -5.339
0.000      -0.063      -0.029
hightech                                       0.1506      0.017      8.843
0.000       0.117       0.184
1992                                           0.0859      0.025      3.464
0.001       0.037       0.134
```

1993			0.0697	0.018	3.796
0.000	0.034	0.106			
1994			0.0293	0.019	1.573
0.116	-0.007	0.066			
1995			0.0693	0.018	3.790
0.000	0.033	0.105			
1996			0.1089	0.019	5.773
0.000	0.072	0.146			
1997			0.1826	0.020	9.332
0.000	0.144	0.221			
1998			0.1875	0.024	7.757
0.000	0.140	0.235			
1999			0.1517	0.027	5.541
0.000	0.098	0.205			
Amusement & Recreation Services			0.0651	0.108	0.604
0.546	-0.146	0.276			
Apparel & Accessory Stores			0.1559	0.073	2.124
0.034	0.012	0.300			
Apparel & Other Textile Products			0.0676	0.049	1.371
0.171	-0.029	0.164			
Auto Repair, Services, & Parking			-0.3271	0.029	-11.141
0.000	-0.385	-0.270			
Automative Dealers & Service Stations			-0.1291	0.131	-0.982
0.326	-0.387	0.129			
Building Materials & Gardening Supplies			0.4717	0.083	5.672
0.000	0.309	0.635			
Business Services			0.1599	0.048	3.360
0.001	0.067	0.253			
Chemical & Allied Products			0.4084	0.030	13.813
0.000	0.350	0.466			
Communications			0.1945	0.035	5.584
0.000	0.126	0.263			
Depository Institutions			-0.0347	0.031	-1.126
0.260	-0.095	0.026			
Eating & Drinking Places			0.2778	0.061	4.529
0.000	0.158	0.398			
Electric, Gas, & Sanitary Services			-0.1252	0.045	-2.803
0.005	-0.213	-0.038			
Electronic & Other Electric Equipment			0.0185	0.031	0.596
0.551	-0.042	0.079			
Engineering & Management Services			0.5513	0.081	6.799
0.000	0.392	0.710			
Fabricated Metal Products			0.0703	0.061	1.153
0.249	-0.049	0.190			
Food & Kindred Products			0.4693	0.034	13.975
0.000	0.403	0.535			
Food Stores			0.0868	0.056	1.562

```
0.118      -0.022       0.196
Furniture & Fixtures                        -0.2243      0.024     -9.388
0.000      -0.271      -0.177
Furniture & Homefurnishings Stores           0.1701      0.090      1.890
0.059      -0.006       0.346
General Building Contractors                -0.4098      0.033    -12.413
0.000      -0.475      -0.345
General Merchandise Stores                  -0.0936      0.048     -1.971
0.049      -0.187      -0.001
Health Services                             -0.2467      0.060     -4.087
0.000      -0.365      -0.128
Heavy Construction, Except Building         -0.0939      0.072     -1.301
0.193      -0.235       0.048
Hotels & Other Lodging Places                0.0796      0.038      2.096
0.036       0.005       0.154
Industrial Machinery & Equipment            -0.1127      0.026     -4.306
0.000      -0.164      -0.061
Instruments & Related Products               0.0851      0.033      2.543
0.011       0.019       0.151
Insurance Agents, Brokers, & Service         0.1649      0.088      1.878
0.060      -0.007       0.337
Insurance Carriers                          -0.2825      0.022    -13.039
0.000      -0.325      -0.240
Leather & Leather Products                  -0.1419      0.087     -1.632
0.103      -0.312       0.029
Lumber & Wood Products                      -0.0743      0.046     -1.625
0.104      -0.164       0.015
Metal, Mining                                0.2911      0.081      3.584
0.000       0.132       0.450
Miscellaneous Manufacturing Industries       0.1227      0.058      2.114
0.034       0.009       0.236
Miscellaneous Retail                         0.0654      0.064      1.016
0.309      -0.061       0.192
Motion Pictures                              0.2349      0.074      3.187
0.001       0.090       0.379
Nondepository Institutions                  -0.2243      0.029     -7.799
0.000      -0.281      -0.168
Oil & Gas Extraction                        -0.0278      0.033     -0.833
0.405      -0.093       0.038
Paper & Allied Products                     -0.0414      0.044     -0.940
0.347      -0.128       0.045
Personal Services                            0.1073      0.093      1.151
0.250      -0.075       0.290
Petroleum & Coal Products                   -0.0700      0.027     -2.623
0.009      -0.122      -0.018
Primary Metal Industries                    -0.0235      0.047     -0.498
0.618      -0.116       0.069
```

```
Printing & Publishing                          0.1494      0.031      4.842
0.000       0.089       0.210
Railroad Transportation                       -0.1433      0.029     -4.868
0.000      -0.201      -0.086
Rubber & Miscellaneous Plastics Products       0.1550      0.048      3.223
0.001       0.061       0.249
Security & Commodity Brokers                  -0.2356      0.037     -6.392
0.000      -0.308      -0.163
Stone, Clay, & Glass Products                  0.0476      0.071      0.671
0.502      -0.091       0.186
Textile Mill Products                         -0.3944      0.063     -6.276
0.000      -0.518      -0.271
Tobacco Products                               0.4660      0.088      5.294
0.000       0.293       0.638
Transportation Equipment                      -0.1057      0.017     -6.165
0.000      -0.139      -0.072
Transportation by Air                         -0.2001      0.022     -9.014
0.000      -0.244      -0.157
Trucking & Warehousing                        -0.4160      0.036    -11.434
0.000      -0.487      -0.345
Wholesale Trade - Durable Goods                0.0873      0.057      1.533
0.125      -0.024       0.199
Wholesale Trade - Nondurable Goods            -0.1603      0.054     -2.994
0.003      -0.265      -0.055
==============================================================================
Omnibus:                      155.826   Durbin-Watson:                   0.654
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              228.205
Skew:                           0.578   Prob(JB):                     2.79e-50
Kurtosis:                       4.073   Cond. No.                     3.36e+16
==============================================================================

Notes:
[1] Standard Errors are heteroscedasticity robust (HC1)
[2] The smallest eigenvalue is 1.5e-28. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

Column X: column IV after replacing Q with $ln(Q)$.

[ ]:
```
X = pd.concat([pd.DataFrame(np.ones(len(data)), columns=['constant']),␣
 ↪data[['nonfounderfam', 'bs_volatility']], np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)

model = sm.OLS(y, X).fit(cov_type='HC1')
predictions = model.predict(X) # make the predictions by the model

# Print out the statistics
```

```
model.summary()
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:1834:
ValueWarning: covariance of constraints does not have full rank. The number of
constraints is 64, but rank is 62
  'rank is %d' % (J, J_), ValueWarning)
```

[ ]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                      Q   R-squared:                       0.367
Model:                            OLS   Adj. R-squared:                  0.349
Method:                 Least Squares   F-statistic:                     135.4
Date:                Fri, 23 Jul 2021   Prob (F-statistic):               0.00
Time:                        16:56:03   Log-Likelihood:                -659.07
No. Observations:                2202   AIC:                             1442.
Df Residuals:                    2140   BIC:                             1795.
Df Model:                          61
Covariance Type:                  HC1
==============================================================================
                                                 coef    std err          z
P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
------------------------------
constant                                       0.8875      0.076     11.711
0.000       0.739       1.036
nonfounderfam                                  0.0051      0.020      0.255
0.799      -0.034       0.044
bs_volatility                                 -0.4675      0.095     -4.914
0.000      -0.654      -0.281
assets                                        -0.0478      0.009     -5.460
0.000      -0.065      -0.031
hightech                                       0.1562      0.018      8.925
0.000       0.122       0.191
1992                                           0.0878      0.025      3.498
0.000       0.039       0.137
1993                                           0.0710      0.019      3.834
0.000       0.035       0.107
1994                                           0.0301      0.019      1.602
0.109      -0.007       0.067
1995                                           0.0707      0.019      3.811
0.000       0.034       0.107
1996                                           0.1096      0.019      5.752
0.000       0.072       0.147
1997                                           0.1835      0.020      9.275
```

```
0.000       0.145       0.222
1998                                        0.1867      0.024      7.739
0.000       0.139       0.234
1999                                        0.1482      0.027      5.443
0.000       0.095       0.202
Amusement & Recreation Services             0.0486      0.108      0.451
0.652      -0.163       0.260
Apparel & Accessory Stores                  0.1785      0.073      2.459
0.014       0.036       0.321
Apparel & Other Textile Products            0.0780      0.050      1.550
0.121      -0.021       0.177
Auto Repair, Services, & Parking           -0.3291      0.029    -11.384
0.000      -0.386      -0.272
Automative Dealers & Service Stations      -0.1413      0.132     -1.072
0.284      -0.400       0.117
Building Materials & Gardening Supplies     0.5007      0.092      5.471
0.000       0.321       0.680
Business Services                           0.1700      0.048      3.558
0.000       0.076       0.264
Chemical & Allied Products                  0.4052      0.030     13.697
0.000       0.347       0.463
Communications                              0.2092      0.034      6.164
0.000       0.143       0.276
Depository Institutions                    -0.0444      0.035     -1.261
0.207      -0.113       0.025
Eating & Drinking Places                    0.2741      0.063      4.371
0.000       0.151       0.397
Electric, Gas, & Sanitary Services         -0.0955      0.053     -1.814
0.070      -0.199       0.008
Electronic & Other Electric Equipment       0.0179      0.031      0.575
0.565      -0.043       0.079
Engineering & Management Services           0.5442      0.082      6.669
0.000       0.384       0.704
Fabricated Metal Products                   0.0664      0.061      1.086
0.277      -0.053       0.186
Food & Kindred Products                     0.4664      0.034     13.919
0.000       0.401       0.532
Food Stores                                 0.0800      0.056      1.420
0.155      -0.030       0.190
Furniture & Fixtures                       -0.2257      0.025     -9.183
0.000      -0.274      -0.178
Furniture & Homefurnishings Stores          0.1612      0.090      1.789
0.074      -0.015       0.338
General Building Contractors               -0.4184      0.033    -12.624
0.000      -0.483      -0.353
General Merchandise Stores                 -0.0879      0.047     -1.882
0.060      -0.179       0.004
```

Health Services	-0.2536	0.059	-4.276	0.000	-0.370	-0.137
Heavy Construction, Except Building	-0.0997	0.072	-1.380	0.168	-0.241	0.042
Hotels & Other Lodging Places	0.0706	0.041	1.733	0.083	-0.009	0.151
Industrial Machinery & Equipment	-0.1188	0.027	-4.470	0.000	-0.171	-0.067
Instruments & Related Products	0.0872	0.034	2.575	0.010	0.021	0.154
Insurance Agents, Brokers, & Service	0.1642	0.089	1.855	0.064	-0.009	0.338
Insurance Carriers	-0.2788	0.023	-12.391	0.000	-0.323	-0.235
Leather & Leather Products	-0.1527	0.087	-1.755	0.079	-0.323	0.018
Lumber & Wood Products	-0.0809	0.046	-1.761	0.078	-0.171	0.009
Metal, Mining	0.2824	0.081	3.465	0.001	0.123	0.442
Miscellaneous Manufacturing Industries	0.1155	0.058	1.980	0.048	0.001	0.230
Miscellaneous Retail	0.0722	0.065	1.118	0.263	-0.054	0.199
Motion Pictures	0.2287	0.073	3.115	0.002	0.085	0.373
Nondepository Institutions	-0.2243	0.029	-7.748	0.000	-0.281	-0.168
Oil & Gas Extraction	-0.0303	0.034	-0.903	0.366	-0.096	0.035
Paper & Allied Products	-0.0412	0.044	-0.934	0.350	-0.128	0.045
Personal Services	0.1362	0.086	1.590	0.112	-0.032	0.304
Petroleum & Coal Products	-0.0635	0.026	-2.408	0.016	-0.115	-0.012
Primary Metal Industries	-0.0214	0.047	-0.453	0.650	-0.114	0.071
Printing & Publishing	0.1443	0.032	4.517	0.000	0.082	0.207
Railroad Transportation	-0.1439	0.029	-5.015	0.000	-0.200	-0.088
Rubber & Miscellaneous Plastics Products	0.1777	0.049	3.664	0.000	0.083	0.273
Security & Commodity Brokers	-0.2356	0.037	-6.391	0.000	-0.308	-0.163
Stone, Clay, & Glass Products	0.0398	0.069	0.577			

```
0.564      -0.095       0.175
Textile Mill Products                        -0.4053      0.064     -6.338
0.000      -0.531      -0.280
Tobacco Products                              0.4666      0.088      5.309
0.000       0.294       0.639
Transportation Equipment                     -0.1059      0.017     -6.115
0.000      -0.140      -0.072
Transportation by Air                        -0.1895      0.023     -8.140
0.000      -0.235      -0.144
Trucking & Warehousing                       -0.4282      0.037    -11.666
0.000      -0.500      -0.356
Wholesale Trade - Durable Goods               0.0827      0.057      1.444
0.149      -0.030       0.195
Wholesale Trade - Nondurable Goods           -0.1651      0.054     -3.081
0.002      -0.270      -0.060
==============================================================================
Omnibus:                      159.260   Durbin-Watson:                   0.654
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              223.277
Skew:                           0.605   Prob(JB):                     3.28e-49
Kurtosis:                       3.986   Cond. No.                     6.88e+16
==============================================================================

Notes:
[1] Standard Errors are heteroscedasticity robust (HC1)
[2] The smallest eigenvalue is 3.59e-29. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

Column XI: Reestimating the specification in Column II after eliminating observations with founderCEO == 1.

[ ]:
```
data = data[data['founderCEO'] == 0]

X = pd.concat([pd.DataFrame(np.ones(len(data)), columns=['constant'], index=data.
 ↪index), data[['FamFirm', 'bs_volatility']], np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)


y = data['Q']
```

[ ]:
```
model = sm.OLS(y, X).fit(cov_type='HC1')
model.summary()
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:1834:
ValueWarning: covariance of constraints does not have full rank. The number of
constraints is 64, but rank is 62
  'rank is %d' % (J, J_), ValueWarning)
```

[ ]: <class 'statsmodels.iolib.summary.Summary'>
"""
OLS Regression Results

Dep. Variable:	Q	R-squared:	0.314
Model:	OLS	Adj. R-squared:	0.292
Method:	Least Squares	F-statistic:	611.2
Date:	Fri, 23 Jul 2021	Prob (F-statistic):	0.00
Time:	16:56:03	Log-Likelihood:	-2347.0
No. Observations:	2052	AIC:	4818.
Df Residuals:	1990	BIC:	5167.
Df Model:	61		
Covariance Type:	HC1		

	coef	std err	z	P>|z|	[0.025	0.975]
constant	2.4203	0.183	13.223	0.000	2.062	2.779
FamFirm	0.0391	0.050	0.788	0.430	-0.058	0.136
bs_volatility	-0.6292	0.217	-2.896	0.004	-1.055	-0.203
assets	-0.1025	0.022	-4.710	0.000	-0.145	-0.060
hightech	0.2918	0.038	7.707	0.000	0.218	0.366
1992	0.2300	0.060	3.849	0.000	0.113	0.347
1993	0.1778	0.042	4.205	0.000	0.095	0.261
1994	0.1198	0.044	2.742	0.006	0.034	0.205
1995	0.2047	0.045	4.580	0.000	0.117	0.292
1996	0.2863	0.048	5.944	0.000	0.192	0.381
1997	0.4317	0.047	9.116	0.000	0.339	0.524
1998	0.5042	0.059	8.493	0.000	0.388	0.621
1999	0.4658	0.065	7.161	0.000	0.338	0.593
Amusement & Recreation Services	0.0738	0.207	0.357	0.721	-0.331	0.479

```
Apparel & Accessory Stores                    0.4529      0.320      1.414
0.157      -0.175       1.081
Apparel & Other Textile Products             -0.0077      0.083     -0.092
0.927      -0.170       0.155
Auto Repair, Services, & Parking             -0.5325      0.062     -8.616
0.000      -0.654      -0.411
Automative Dealers & Service Stations        -0.3052      0.212     -1.441
0.150      -0.720       0.110
Building Materials & Gardening Supplies       0.4351      0.143      3.052
0.002       0.156       0.715
Business Services                             0.4091      0.091      4.507
0.000       0.231       0.587
Chemical & Allied Products                    0.9519      0.082     11.632
0.000       0.791       1.112
Communications                                0.3460      0.078      4.423
0.000       0.193       0.499
Depository Institutions                      -0.1519      0.059     -2.559
0.010      -0.268      -0.036
Eating & Drinking Places                      0.4544      0.146      3.107
0.002       0.168       0.741
Electric, Gas, & Sanitary Services           -0.3289      0.054     -6.127
0.000      -0.434      -0.224
Electronic & Other Electric Equipment         0.0008      0.073      0.011
0.991      -0.143       0.145
Engineering & Management Services             1.1812      0.258      4.572
0.000       0.675       1.688
Fabricated Metal Products                     0.2154      0.157      1.369
0.171      -0.093       0.524
Food & Kindred Products                       1.0744      0.102     10.515
0.000       0.874       1.275
Food Stores                                   0.1385      0.105      1.314
0.189      -0.068       0.345
Furniture & Fixtures                         -0.4083      0.045     -9.174
0.000      -0.496      -0.321
Furniture & Homefurnishings Stores            0.3087      0.224      1.376
0.169      -0.131       0.748
General Building Contractors                 -0.6936      0.059    -11.677
0.000      -0.810      -0.577
General Merchandise Stores                   -0.0585      0.100     -0.584
0.559      -0.255       0.138
Health Services                              -0.4340      0.093     -4.656
0.000      -0.617      -0.251
Heavy Construction, Except Building          -0.2108      0.122     -1.726
0.084      -0.450       0.029
Hotels & Other Lodging Places                 0.0157      0.080      0.195
0.845      -0.142       0.173
Industrial Machinery & Equipment             -0.2544      0.053     -4.836
```

```
0.000      -0.358      -0.151
Instruments & Related Products              0.1363      0.089      1.530
0.126      -0.038       0.311
Insurance Agents, Brokers, & Service        0.3061      0.157      1.955
0.051      -0.001       0.613
Insurance Carriers                         -0.4091      0.045     -9.008
0.000      -0.498      -0.320
Leather & Leather Products                 -0.3051      0.159     -1.924
0.054      -0.616       0.006
Lumber & Wood Products                     -0.1910      0.081     -2.364
0.018      -0.349      -0.033
Metal, Mining                               0.5159      0.188      2.751
0.006       0.148       0.884
Miscellaneous Manufacturing Industries      0.1625      0.130      1.254
0.210      -0.091       0.416
Miscellaneous Retail                        0.1465      0.152      0.963
0.336      -0.152       0.445
Motion Pictures                             0.3992      0.148      2.702
0.007       0.110       0.689
Nondepository Institutions                 -0.2943      0.061     -4.861
0.000      -0.413      -0.176
Oil & Gas Extraction                       -0.0756      0.059     -1.281
0.200      -0.191       0.040
Paper & Allied Products                     0.0103      0.088      0.117
0.907      -0.162       0.183
Personal Services                           0.6225      0.290      2.143
0.032       0.053       1.192
Petroleum & Coal Products                  -0.0996      0.055     -1.821
0.069      -0.207       0.008
Primary Metal Industries                    0.0187      0.109      0.172
0.863      -0.194       0.232
Printing & Publishing                       0.2334      0.070      3.343
0.001       0.097       0.370
Railroad Transportation                    -0.2497      0.053     -4.739
0.000      -0.353      -0.146
Rubber & Miscellaneous Plastics Products    0.2131      0.114      1.875
0.061      -0.010       0.436
Security & Commodity Brokers               -0.2402      0.090     -2.677
0.007      -0.416      -0.064
Stone, Clay, & Glass Products              -0.0326      0.126     -0.259
0.795      -0.279       0.214
Textile Mill Products                      -0.7026      0.100     -7.054
0.000      -0.898      -0.507
Tobacco Products                            0.9796      0.278      3.519
0.000       0.434       1.525
Transportation Equipment                   -0.2093      0.035     -6.044
0.000      -0.277      -0.141
```

```
Transportation by Air                          -0.3578      0.042     -8.549
0.000      -0.440      -0.276
Trucking & Warehousing                         -0.7320      0.067    -10.951
0.000      -0.863      -0.601
Wholesale Trade - Durable Goods                 0.1444      0.103      1.403
0.161      -0.057       0.346
Wholesale Trade - Nondurable Goods             -0.2412      0.090     -2.671
0.008      -0.418      -0.064
==============================================================================
Omnibus:                      970.033   Durbin-Watson:                   0.738
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             8521.754
Skew:                           2.025   Prob(JB):                         0.00
Kurtosis:                      12.126   Cond. No.                     1.90e+16
==============================================================================

Notes:
[1] Standard Errors are heteroscedasticity robust (HC1)
[2] The smallest eigenvalue is 4.43e-28. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

Column XII: Reestimating the specification in Column III after eliminating observations with nonfounderfam == 1.

[ ]:
```
data = pd.read_excel(path, sheet_name='Sheet2')

data = data[data.columns[:14]]
data = data[data['nonfounderfam'] == 0]

X = pd.concat([pd.DataFrame(np.ones(len(data)), columns=['constant'], index=data.
 ↪index), data[['founderCEO', 'bs_volatility']], np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)
y = data['Q']

model = sm.OLS(y, X).fit(cov_type='HC1')
model.summary()
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:1834:
ValueWarning: covariance of constraints does not have full rank. The number of
constraints is 60, but rank is 58
  'rank is %d' % (J, J_), ValueWarning)
```

[ ]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:                      Q   R-squared:                       0.347
Model:                            OLS   Adj. R-squared:                  0.323
```

Method:	Least Squares	F-statistic:	591.6
Date:	Fri, 23 Jul 2021	Prob (F-statistic):	0.00
Time:	16:56:04	Log-Likelihood:	-1788.5
No. Observations:	1617	AIC:	3693.
Df Residuals:	1559	BIC:	4006.
Df Model:	57		
Covariance Type:	HC1		

	coef	std err	z	P>|z|	[0.025	0.975]
constant	2.2074	0.216	10.202	0.000	1.783	2.631
founderCEO	0.4047	0.092	4.414	0.000	0.225	0.584
bs_volatility	-0.8646	0.220	-3.932	0.000	-1.296	-0.434
assets	-0.0639	0.026	-2.474	0.013	-0.115	-0.013
hightech	0.2607	0.041	6.426	0.000	0.181	0.340
1992	0.2359	0.068	3.494	0.000	0.104	0.368
1993	0.1723	0.050	3.463	0.001	0.075	0.270
1994	0.0964	0.048	1.999	0.046	0.002	0.191
1995	0.1866	0.050	3.742	0.000	0.089	0.284
1996	0.2763	0.052	5.274	0.000	0.174	0.379
1997	0.4028	0.053	7.571	0.000	0.298	0.507
1998	0.4582	0.064	7.140	0.000	0.332	0.584
1999	0.3788	0.070	5.436	0.000	0.242	0.515
Amusement & Recreation Services	0.1275	0.207	0.617	0.537	-0.277	0.532
Apparel & Accessory Stores	0.0310	0.155	0.200	0.841	-0.273	0.335
Apparel & Other Textile Products	0.1212	0.170	0.713	0.476	-0.212	0.454
Auto Repair, Services, & Parking	-0.5674	0.057	-9.942	0.000	-0.679	-0.456

Building Materials & Gardening Supplies	1.0623	0.265	4.010	0.000	0.543	1.581
Business Services	0.3369	0.113	2.985	0.003	0.116	0.558
Chemical & Allied Products	0.9701	0.100	9.708	0.000	0.774	1.166
Communications	0.1447	0.084	1.714	0.086	-0.021	0.310
Eating & Drinking Places	0.8352	0.137	6.092	0.000	0.566	1.104
Electric, Gas, & Sanitary Services	-0.3864	0.059	-6.588	0.000	-0.501	-0.271
Electronic & Other Electric Equipment	-0.0377	0.074	-0.507	0.612	-0.183	0.108
Engineering & Management Services	1.2249	0.255	4.808	0.000	0.726	1.724
Fabricated Metal Products	0.5133	0.213	2.408	0.016	0.095	0.931
Food & Kindred Products	0.9318	0.118	7.928	0.000	0.701	1.162
Food Stores	0.3376	0.175	1.926	0.054	-0.006	0.681
Furniture & Fixtures	-0.4435	0.045	-9.883	0.000	-0.531	-0.356
Furniture & Homefurnishings Stores	0.3307	0.232	1.423	0.155	-0.125	0.786
General Building Contractors	-0.5731	0.051	-11.318	0.000	-0.672	-0.474
General Merchandise Stores	-0.3308	0.065	-5.097	0.000	-0.458	-0.204
Health Services	-0.4388	0.089	-4.930	0.000	-0.613	-0.264
Heavy Construction, Except Building	-0.2095	0.119	-1.765	0.077	-0.442	0.023
Industrial Machinery & Equipment	-0.2533	0.059	-4.313	0.000	-0.368	-0.138
Instruments & Related Products	0.2147	0.090	2.385	0.017	0.038	0.391
Insurance Agents, Brokers, & Service	0.2656	0.154	1.725	0.085	-0.036	0.567
Insurance Carriers	-0.5141	0.048	-10.695	0.000	-0.608	-0.420
Leather & Leather Products	-0.2314	0.160	-1.442	0.149	-0.546	0.083
Lumber & Wood Products	-0.2209	0.138	-1.602	0.109	-0.491	0.049
Metal, Mining	0.5464	0.186	2.938			

```
0.003       0.182       0.911
Miscellaneous Manufacturing Industries       0.3152      0.179      1.765
0.078      -0.035       0.665
Miscellaneous Retail                         0.0175      0.181      0.096
0.923      -0.338       0.373
Motion Pictures                              0.4430      0.193      2.299
0.022       0.065       0.821
Nondepository Institutions                  -0.4096      0.065     -6.323
0.000      -0.537      -0.283
Oil & Gas Extraction                        -0.1159      0.060     -1.926
0.054      -0.234       0.002
Paper & Allied Products                      0.1533      0.113      1.353
0.176      -0.069       0.375
Personal Services                           -0.4978      0.123     -4.031
0.000      -0.740      -0.256
Petroleum & Coal Products                   -0.1911      0.058     -3.287
0.001      -0.305      -0.077
Primary Metal Industries                    -0.2593      0.071     -3.673
0.000      -0.398      -0.121
Printing & Publishing                        0.5518      0.103      5.375
0.000       0.351       0.753
Railroad Transportation                     -0.3237      0.055     -5.928
0.000      -0.431      -0.217
Rubber & Miscellaneous Plastics Products     0.0812      0.115      0.709
0.479      -0.143       0.306
Security & Commodity Brokers                -0.3989      0.102     -3.928
0.000      -0.598      -0.200
Stone, Clay, & Glass Products               -0.0274      0.129     -0.213
0.831      -0.279       0.225
Tobacco Products                             0.8820      0.302      2.921
0.003       0.290       1.474
Transportation Equipment                    -0.2679      0.036     -7.539
0.000      -0.338      -0.198
Transportation by Air                       -0.4221      0.043     -9.705
0.000      -0.507      -0.337
Trucking & Warehousing                      -0.7851      0.063    -12.389
0.000      -0.909      -0.661
Wholesale Trade - Durable Goods             -0.0233      0.118     -0.198
0.843      -0.254       0.207
Wholesale Trade - Nondurable Goods          -0.3015      0.089     -3.390
0.001      -0.476      -0.127
==============================================================================
Omnibus:                      501.026   Durbin-Watson:                   0.719
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             1936.313
Skew:                           1.466   Prob(JB):                         0.00
Kurtosis:                       7.488   Cond. No.                     1.48e+16
==============================================================================
```

```
Notes:
[1] Standard Errors are heteroscedasticity robust (HC1)
[2] The smallest eigenvalue is 5.83e-28. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

column XIII:

[ ]:
```
data = pd.read_excel(path, sheet_name='Sheet2')

data = data[data.columns[:14]]
X = pd.concat([pd.DataFrame(np.ones(len(data)), columns=['constant']),␣
 ↪data[['FamFirm', 'bs_volatility']], np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               #pd.get_dummies(data['industry name']),
               pd.get_dummies(data['Ticker'])], axis=1)



y = data['Q']
X
```

[ ]:

	constant	FamFirm	bs_volatility	assets	...	XOM	XRX	YELL	Z
0	1.0	0	0.190	8.579492	...	0	0	0	0
1	1.0	0	0.221	8.261449	...	0	0	0	0
2	1.0	0	0.246	9.307748	...	0	0	0	0
3	1.0	0	0.228	9.358493	...	0	0	0	0
4	1.0	0	0.222	9.421670	...	0	0	0	0
...	...	...	...	...	...	...	...	...	..
2197	1.0	0	0.252	8.432289	...	0	0	0	1
2198	1.0	0	0.300	8.336390	...	0	0	0	1
2199	1.0	0	0.315	8.162231	...	0	0	0	1
2200	1.0	0	0.365	8.153637	...	0	0	0	1
2201	1.0	0	0.396	8.065265	...	0	0	0	1

[2202 rows x 333 columns]

[ ]:
```
model = sm.OLS(y, X).fit(cov_type='HC1')
model.summary()
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:1834:
ValueWarning: covariance of constraints does not have full rank. The number of
constraints is 332, but rank is 327
  'rank is %d' % (J, J_), ValueWarning)
```

[ ]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
```

Dep. Variable:	Q	R-squared:	0.766
Model:	OLS	Adj. R-squared:	0.725
Method:	Least Squares	F-statistic:	1041.
Date:	Fri, 23 Jul 2021	Prob (F-statistic):	0.00
Time:	16:56:06	Log-Likelihood:	-1379.7
No. Observations:	2202	AIC:	3421.
Df Residuals:	1871	BIC:	5307.
Df Model:	330		
Covariance Type:	HC1		

	coef	std err	z	P>|z|	[0.025	0.975]
constant	4.3494	0.485	8.976	0.000	3.400	5.299
FamFirm	0.0357	0.086	0.416	0.677	-0.132	0.204
bs_volatility	-0.6045	0.229	-2.639	0.008	-1.053	-0.156
assets	-0.3264	0.060	-5.410	0.000	-0.445	-0.208
hightech	-0.1550	0.099	-1.562	0.118	-0.349	0.039
1992	0.3600	0.066	5.418	0.000	0.230	0.490
1993	0.3880	0.058	6.656	0.000	0.274	0.502
1994	0.3167	0.059	5.360	0.000	0.201	0.432
1995	0.4381	0.061	7.226	0.000	0.319	0.557
1996	0.5301	0.063	8.401	0.000	0.406	0.654
1997	0.7294	0.068	10.749	0.000	0.596	0.862
1998	0.8194	0.072	11.336	0.000	0.678	0.961
1999	0.7677	0.091	8.445	0.000	0.590	0.946
9441B	-0.2926	0.063	-4.676	0.000	-0.415	-0.170
AA	-0.1371	0.136	-1.008	0.314	-0.404	0.130
AAL	-0.7966	0.064	-12.417	0.000	-0.922	-0.671

AAPL	-0.2697	0.143	-1.886	0.059	-0.550
0.011					
ABS	0.4665	0.166	2.802	0.005	0.140
0.793					
ABT	2.5834	0.260	9.926	0.000	2.073
3.094					
ACK	-0.5795	0.126	-4.606	0.000	-0.826
-0.333					
ACY.	-0.2661	0.048	-5.587	0.000	-0.359
-0.173					
ADM	-0.4450	0.095	-4.689	0.000	-0.631
-0.259					
ADSK	0.7630	0.221	3.449	0.001	0.329
1.197					
AET	0.0173	0.185	0.094	0.925	-0.346
0.380					
AGC	-0.0807	0.151	-0.535	0.593	-0.376
0.215					
AHC	-0.6560	0.092	-7.135	0.000	-0.836
-0.476					
AIG	0.3083	0.198	1.559	0.119	-0.079
0.696					
AM	-0.9436	0.207	-4.565	0.000	-1.349
-0.538					
AMD	-0.5341	0.131	-4.065	0.000	-0.792
-0.277					
AMGN	2.6112	0.283	9.236	0.000	2.057
3.165					
AMH.	-0.6220	0.142	-4.391	0.000	-0.900
-0.344					
AMP	0.5310	0.114	4.653	0.000	0.307
0.755					
AMR	-0.3549	0.097	-3.658	0.000	-0.545
-0.165					
AN.	0.2347	0.113	2.085	0.037	0.014
0.455					
ANDW	0.4939	0.545	0.906	0.365	-0.574
1.562					
APD	-0.3255	0.073	-4.487	0.000	-0.468
-0.183					
AR	-1.1724	0.097	-12.034	0.000	-1.363
-0.981					
ARC	0.0520	0.101	0.517	0.605	-0.145
0.249					
AS	-0.7257	0.144	-5.051	0.000	-1.007
-0.444					
ASC.1	-0.4730	0.048	-9.857	0.000	-0.567

-0.379					
ASH	-0.7568	0.082	-9.275	0.000	-0.917
-0.597					
AVP	1.6357	0.312	5.237	0.000	1.023
2.248					
AVY	0.1565	0.281	0.558	0.577	-0.393
0.707					
AXP	0.2650	0.190	1.393	0.164	-0.108
0.638					
AZA	0.7905	0.403	1.962	0.050	0.001
1.580					
BA	0.1759	0.128	1.372	0.170	-0.075
0.427					
BAX	0.3421	0.146	2.338	0.019	0.055
0.629					
BC	-0.7164	0.097	-7.404	0.000	-0.906
-0.527					
BCC	-0.9162	0.064	-14.315	0.000	-1.042
-0.791					
BCR	-0.0499	0.166	-0.300	0.764	-0.376
0.276					
BDK	-0.3268	0.117	-2.785	0.005	-0.557
-0.097					
BDX	0.1229	0.191	0.643	0.520	-0.252
0.498					
BEV	-1.0984	0.156	-7.038	0.000	-1.404
-0.792					
BF.B	0.1907	0.151	1.260	0.208	-0.106
0.487					
BFO	0.6080	0.158	3.858	0.000	0.299
0.917					
BGG	-0.6274	0.148	-4.248	0.000	-0.917
-0.338					
BHI	-0.2634	0.109	-2.418	0.016	-0.477
-0.050					
BLL	-1.1283	0.107	-10.523	0.000	-1.338
-0.918					
BLY	-0.8449	0.082	-10.318	0.000	-1.005
-0.684					
BMET	1.0772	0.237	4.543	0.000	0.612
1.542					
BMY	1.9277	0.238	8.105	0.000	1.462
2.394					
BNI	-0.2345	0.098	-2.405	0.016	-0.426
-0.043					
BNL.1	-0.4764	0.081	-5.866	0.000	-0.636
-0.317					

BOL	-0.5611	0.094	-5.998	0.000	-0.744 -0.378
BRNO20	-0.9258	0.163	-5.688	0.000	-1.245 -0.607
BS	-0.8507	0.125	-6.797	0.000	-1.096 -0.605
BUD	0.6453	0.163	3.965	0.000	0.326 0.964
BV.	0.8429	0.125	6.731	0.000	0.597 1.088
BWS	-1.3819	0.181	-7.645	0.000	-1.736 -1.028
CA	1.5685	0.372	4.211	0.000	0.839 2.299
CAG	0.0453	0.089	0.508	0.612	-0.129 0.220
CAT	0.1007	0.143	0.705	0.481	-0.179 0.381
CB	-0.3548	0.096	-3.699	0.000	-0.543 -0.167
CBE	-0.3119	0.103	-3.032	0.002	-0.514 -0.110
CC	-0.2422	0.158	-1.531	0.126	-0.552 0.068
CCK	-0.5720	0.110	-5.204	0.000	-0.787 -0.357
CEN	0.5560	0.297	1.874	0.061	-0.025 1.137
CHRS	-1.3466	0.202	-6.652	0.000	-1.743 -0.950
CI	0.0161	0.176	0.091	0.927	-0.330 0.362
CKL	-0.5351	0.106	-5.064	0.000	-0.742 -0.328
CL	1.2481	0.444	2.808	0.005	0.377 2.119
CLX	0.4251	0.252	1.687	0.092	-0.069 0.919
CMCSK	0.1410	0.124	1.134	0.257	-0.103 0.385
CNF	-0.8998	0.073	-12.323	0.000	-1.043 -0.757
CPB	1.4340	0.330	4.345	0.000	0.787 2.081
CPQ	0.8757	0.280	3.123	0.002	0.326 1.425
CSC	0.0672	0.182	0.368	0.713	-0.290

```
0.425
CSX             -0.3717      0.122     -3.057      0.002      -0.610
-0.133
CTB             -0.2542      0.354     -0.718      0.473      -0.948
0.440
CTX             -0.9921      0.070    -14.079      0.000      -1.130
-0.854
CUM             -0.7314      0.114     -6.439      0.000      -0.954
-0.509
CVS              0.1512      0.270      0.561      0.575      -0.377
0.680
CYM             -0.6722      0.048    -14.058      0.000      -0.766
-0.578
CYR.            -1.1912      0.107    -11.093      0.000      -1.402
-0.981
DAL             -0.4676      0.070     -6.663      0.000      -0.605
-0.330
DCN             -0.5271      0.055     -9.646      0.000      -0.634
-0.420
DD               0.6017      0.141      4.277      0.000       0.326
0.877
DDS             -0.8365      0.119     -7.004      0.000      -1.071
-0.602
DE              -0.1062      0.141     -0.754      0.451      -0.382
0.170
DEC             -0.2435      0.136     -1.796      0.073      -0.509
0.022
DI.             -0.2658      0.070     -3.791      0.000      -0.403
-0.128
DIGI.            0.7948      0.507      1.567      0.117      -0.199
1.789
DIS              0.5554      0.136      4.088      0.000       0.289
0.822
DJ               0.0839      0.271      0.309      0.757      -0.448
0.616
DLX              0.2894      0.197      1.471      0.141      -0.096
0.675
DNB              1.2784      0.157      8.160      0.000       0.971
1.585
DNY             -0.2929      0.109     -2.679      0.007      -0.507
-0.079
DOV              0.3796      0.127      2.989      0.003       0.131
0.628
DOW              0.0053      0.098      0.055      0.957      -0.187
0.198
ECH             -0.6586      0.124     -5.325      0.000      -0.901
-0.416
```

```
ECL              0.3033      0.250      1.211      0.226      -0.187
0.794
EK               0.6016      0.158      3.804      0.000       0.292
0.912
EMR              0.7533      0.115      6.578      0.000       0.529
0.978
ESY.            -0.5664      0.099     -5.725      0.000      -0.760
-0.373
ETN             -0.4224      0.076     -5.566      0.000      -0.571
-0.274
EY              -0.6598      0.251     -2.628      0.009      -1.152
-0.168
F                0.3448      0.231      1.492      0.136      -0.108
0.798
FBO             -0.9297      0.109     -8.536      0.000      -1.143
-0.716
FDX             -0.3612      0.105     -3.427      0.001      -0.568
-0.155
FG              -0.3884      0.096     -4.046      0.000      -0.576
-0.200
FJ              -0.4241      0.122     -3.481      0.000      -0.663
-0.185
FLE             -0.8972      0.165     -5.446      0.000      -1.220
-0.574
FLM             -1.1175      0.085    -13.145      0.000      -1.284
-0.951
FLR             -0.3006      0.176     -1.712      0.087      -0.645
0.044
FMC             -0.6949      0.110     -6.342      0.000      -0.910
-0.480
FO              -0.4470      0.111     -4.036      0.000      -0.664
-0.230
FON              0.2610      0.186      1.404      0.160      -0.103
0.625
FWC             -0.9191      0.122     -7.507      0.000      -1.159
-0.679
G                2.5364      0.276      9.175      0.000       1.995
3.078
GAP             -1.1166      0.109    -10.276      0.000      -1.330
-0.904
GCI              0.6826      0.111      6.151      0.000       0.465
0.900
GD              -0.3127      0.083     -3.774      0.000      -0.475
-0.150
GIS              1.3407      0.142      9.415      0.000       1.062
1.620
GLK             -0.0970      0.311     -0.312      0.755      -0.707
```

0.513
GLW 0.7480 0.413 1.813 0.070 -0.061
1.557
GM 0.3737 0.233 1.606 0.108 -0.082
0.830
GP -0.4038 0.107 -3.766 0.000 -0.614
-0.194
GPC 0.0985 0.178 0.553 0.580 -0.251
0.448
GPS 2.5297 1.044 2.422 0.015 0.483
4.577
GR -0.8306 0.063 -13.170 0.000 -0.954
-0.707
GRA -0.3317 0.140 -2.374 0.018 -0.605
-0.058
GRN -0.1242 0.110 -1.126 0.260 -0.340
0.092
GT -0.3406 0.099 -3.447 0.001 -0.534
-0.147
GWW 0.0458 0.135 0.339 0.735 -0.219
0.311
H -0.5731 0.115 -4.978 0.000 -0.799
-0.347
HAL 0.0369 0.171 0.215 0.829 -0.299
0.372
HAS -0.5115 0.108 -4.716 0.000 -0.724
-0.299
HD 2.6755 0.524 5.108 0.000 1.649
3.702
HET -0.1416 0.287 -0.494 0.621 -0.704
0.420
HI -0.1339 0.124 -1.077 0.282 -0.378
0.110
HLT -0.3818 0.103 -3.709 0.000 -0.584
-0.180
HM -0.2077 0.274 -0.757 0.449 -0.745
0.330
HNZ 0.5148 0.145 3.539 0.000 0.230
0.800
HON 0.1324 0.071 1.861 0.063 -0.007
0.272
HON.Z 0.6166 0.086 7.173 0.000 0.448
0.785
HPC -0.0495 0.219 -0.226 0.821 -0.478
0.379
HRB 0.9119 0.408 2.236 0.025 0.113
1.711

HRS	-0.6584	0.085	-7.736	0.000	-0.825
-0.492					
HSY	0.2852	0.159	1.791	0.073	-0.027
0.597					
HUM	-0.4461	0.234	-1.903	0.057	-0.906
0.013					
HWP	0.9164	0.200	4.586	0.000	0.525
1.308					
IBM	0.9053	0.299	3.023	0.003	0.318
1.492					
IFF	1.2645	0.175	7.219	0.000	0.921
1.608					
IKN	-0.5395	0.131	-4.134	0.000	-0.795
-0.284					
INGR	-1.3606	0.155	-8.801	0.000	-1.664
-1.058					
INTC	2.3787	0.585	4.066	0.000	1.232
3.525					
IP	-0.3082	0.098	-3.154	0.002	-0.500
-0.117					
IPG	0.0964	0.188	0.512	0.608	-0.272
0.465					
IR	-0.1974	0.098	-2.008	0.045	-0.390
-0.005					
ITW	0.6269	0.154	4.078	0.000	0.326
0.928					
JCI	-0.6799	0.049	-13.812	0.000	-0.776
-0.583					
JCP	-0.2779	0.122	-2.269	0.023	-0.518
-0.038					
JNJ	2.2740	0.271	8.398	0.000	1.743
2.805					
JP	-0.5625	0.065	-8.601	0.000	-0.691
-0.434					
JWN	-0.2999	0.136	-2.200	0.028	-0.567
-0.033					
K	1.8880	0.231	8.161	0.000	1.435
2.341					
KM	-0.4851	0.117	-4.134	0.000	-0.715
-0.255					
KMB	0.8570	0.194	4.424	0.000	0.477
1.237					
KMG	-0.6951	0.105	-6.607	0.000	-0.901
-0.489					
KO	3.9532	0.077	51.483	0.000	3.803
4.104					
KR	0.4170	0.155	2.686	0.007	0.113

0.721
KRB -0.1847 0.099 -1.874 0.061 -0.378
0.008
KRI -0.4738 0.084 -5.665 0.000 -0.638
-0.310
KWP -0.4935 0.289 -1.705 0.088 -1.061
0.074
LDG -1.2256 0.163 -7.506 0.000 -1.546
-0.906
LIT -0.7021 0.072 -9.768 0.000 -0.843
-0.561
LIZ -0.3404 0.210 -1.624 0.104 -0.751
0.070
LLY 1.5591 0.589 2.648 0.008 0.405
2.713
LMT -0.2007 0.128 -1.571 0.116 -0.451
0.050
LNC -0.1159 0.157 -0.736 0.462 -0.425
0.193
LOR.2 -0.3111 0.106 -2.929 0.003 -0.519
-0.103
LOTS. 0.8776 0.216 4.061 0.000 0.454
1.301
LOW 0.4673 0.231 2.020 0.043 0.014
0.921
LPX -0.6477 0.191 -3.395 0.001 -1.022
-0.274
LTD 0.0430 0.186 0.231 0.817 -0.321
0.407
MAR -0.1604 0.112 -1.433 0.152 -0.380
0.059
MAS -0.1768 0.143 -1.233 0.217 -0.458
0.104
MAT 0.4385 0.215 2.039 0.041 0.017
0.860
MAY -0.0968 0.072 -1.350 0.177 -0.237
0.044
MCD 0.9003 0.153 5.888 0.000 0.601
1.200
MCIC 0.1513 0.122 1.243 0.214 -0.087
0.390
MCK -0.2155 0.186 -1.159 0.246 -0.580
0.149
MD. -0.1902 0.155 -1.224 0.221 -0.495
0.114
MDT 2.6793 0.714 3.751 0.000 1.279
4.079

MER	0.3180	0.223	1.429	0.153	-0.118
0.754					
MHP	0.1799	0.215	0.837	0.403	-0.241
0.601					
MIL	0.4115	0.274	1.503	0.133	-0.125
0.948					
MKG	-0.4729	0.125	-3.773	0.000	-0.719
-0.227					
MMC	0.3413	0.116	2.931	0.003	0.113
0.570					
MMM	0.9902	0.135	7.319	0.000	0.725
1.255					
MO	0.9908	0.200	4.963	0.000	0.600
1.382					
MOB	0.3113	0.137	2.269	0.023	0.042
0.580					
MOT	0.8694	0.229	3.794	0.000	0.420
1.319					
MRK	2.9311	0.412	7.116	0.000	2.124
3.738					
MRO	-0.3985	0.066	-6.029	0.000	-0.528
-0.269					
MST	-1.1010	0.100	-11.009	0.000	-1.297
-0.905					
MXS	-0.7653	0.067	-11.368	0.000	-0.897
-0.633					
MYG	-0.1367	0.183	-0.747	0.455	-0.495
0.222					
NAV	-0.7176	0.087	-8.221	0.000	-0.889
-0.547					
NC	-1.1191	0.164	-6.821	0.000	-1.441
-0.798					
NEM	0.2972	0.280	1.060	0.289	-0.253
0.847					
NKE	0.7080	0.324	2.185	0.029	0.073
1.343					
NLC	-0.1320	0.185	-0.715	0.475	-0.494
0.230					
NOC	-0.4529	0.116	-3.920	0.000	-0.679
-0.226					
NOVL	1.0320	0.485	2.126	0.033	0.081
1.983					
NSC	-0.3109	0.094	-3.301	0.001	-0.496
-0.126					
NSI	-0.7957	0.136	-5.838	0.000	-1.063
-0.529					
NSM	-0.2830	0.143	-1.981	0.048	-0.563

-0.003
NUE 0.1080 0.254 0.426 0.670 -0.389
0.605
NWL -0.0470 0.104 -0.453 0.651 -0.250
0.156
NYT -0.3076 0.184 -1.668 0.095 -0.669
0.054
OAT 0.7530 0.307 2.456 0.014 0.152
1.354
ORCL 3.5201 0.115 30.558 0.000 3.294
3.746
ORX -0.2647 0.123 -2.154 0.031 -0.505
-0.024
OWC -0.3629 0.132 -2.746 0.006 -0.622
-0.104
OXY -0.3595 0.094 -3.843 0.000 -0.543
-0.176
P -0.2004 0.079 -2.528 0.011 -0.356
-0.045
PBI 0.3096 0.171 1.810 0.070 -0.026
0.645
PBY -0.8348 0.243 -3.429 0.001 -1.312
-0.358
PCAR -0.7613 0.077 -9.932 0.000 -0.912
-0.611
PCH -1.1846 0.126 -9.424 0.000 -1.431
-0.938
PD -0.6618 0.108 -6.154 0.000 -0.873
-0.451
PEP 1.0475 0.169 6.210 0.000 0.717
1.378
PFE 1.7679 0.249 7.098 0.000 1.280
2.256
PG 1.5970 0.345 4.628 0.000 0.921
2.273
PH -0.5466 0.088 -6.204 0.000 -0.719
-0.374
PHA 0.3629 0.166 2.183 0.029 0.037
0.689
PHM -1.3743 0.102 -13.527 0.000 -1.573
-1.175
PLL 0.3511 0.156 2.256 0.024 0.046
0.656
PMI -0.9484 0.139 -6.824 0.000 -1.221
-0.676
PPG 0.0852 0.069 1.229 0.219 -0.051
0.221

PX	-0.3592	0.084	-4.279	0.000	-0.524 -0.195
R	-0.7883	0.082	-9.593	0.000	-0.949 -0.627
RAD	-0.5227	0.101	-5.187	0.000	-0.720 -0.325
RAL	0.2172	0.097	2.241	0.025	0.027 0.407
RBD	0.5568	0.334	1.666	0.096	-0.098 1.212
RBK	-0.4365	0.284	-1.539	0.124	-0.992 0.119
RLM	-0.6397	0.065	-9.899	0.000	-0.766 -0.513
RML	-1.1784	0.194	-6.067	0.000	-1.559 -0.798
ROH	-0.2678	0.078	-3.453	0.001	-0.420 -0.116
ROK	0.0897	0.135	0.666	0.505	-0.174 0.354
RSH	-0.0055	0.403	-0.014	0.989	-0.796 0.785
RT	-0.8332	0.130	-6.432	0.000	-1.087 -0.579
RYC	-0.2134	0.162	-1.317	0.188	-0.531 0.104
S	0.0470	0.161	0.291	0.771	-0.269 0.363
SAFC	-0.5011	0.092	-5.468	0.000	-0.681 -0.321
SFA	0.1594	0.161	0.991	0.322	-0.156 0.475
SFX.1	-0.2071	0.078	-2.648	0.008	-0.360 -0.054
SGP	2.4750	0.307	8.072	0.000	1.874 3.076
SHW	-0.2764	0.118	-2.349	0.019	-0.507 -0.046
SLE	0.4442	0.151	2.942	0.003	0.148 0.740
SMI	-1.4078	0.160	-8.824	0.000	-1.721 -1.095
SNA	-0.6631	0.127	-5.221	0.000	-0.912 -0.414
SPC	-0.4543	0.092	-4.935	0.000	-0.635 -0.274
SPP.1	-0.3638	0.150	-2.429	0.015	-0.657

-0.070
SRR -0.7362 0.305 -2.417 0.016 -1.333
-0.139
SRV -0.4874 0.092 -5.291 0.000 -0.668
-0.307
STJ 0.4537 0.296 1.535 0.125 -0.126
1.033
STO. -0.5654 0.116 -4.884 0.000 -0.792
-0.338
SUN -0.7329 0.073 -10.062 0.000 -0.876
-0.590
SUNW 0.4216 0.354 1.190 0.234 -0.273
1.116
SVU -0.7922 0.073 -10.797 0.000 -0.936
-0.648
SWK -0.3340 0.157 -2.125 0.034 -0.642
-0.026
SYY 0.3579 0.099 3.633 0.000 0.165
0.551
T 0.9196 0.181 5.094 0.000 0.566
1.273
TA.1 -0.1777 0.135 -1.318 0.188 -0.442
0.087
TCOMA 0.1063 0.128 0.832 0.405 -0.144
0.357
TDM -0.6399 0.169 -3.782 0.000 -0.971
-0.308
TEK -0.6458 0.141 -4.576 0.000 -0.922
-0.369
TEN -0.3648 0.152 -2.392 0.017 -0.664
-0.066
TGT -0.0221 0.179 -0.124 0.901 -0.372
0.328
THC -0.3577 0.084 -4.256 0.000 -0.522
-0.193
TIN -0.5995 0.096 -6.240 0.000 -0.788
-0.411
TJX 0.0574 0.320 0.179 0.858 -0.571
0.685
TKR -0.9284 0.121 -7.661 0.000 -1.166
-0.691
TMC -0.2623 0.128 -2.045 0.041 -0.514
-0.011
TMK -0.5164 0.074 -7.005 0.000 -0.661
-0.372
TNB -0.6081 0.113 -5.359 0.000 -0.830
-0.386

TOY	-0.2628	0.246	-1.068	0.285	-0.745
0.219					
TRB	-0.1015	0.074	-1.372	0.170	-0.247
0.044					
TRW	-0.3627	0.050	-7.250	0.000	-0.461
-0.265					
TWX	0.4478	0.198	2.260	0.024	0.059
0.836					
TX	-0.0067	0.100	-0.067	0.947	-0.202
0.188					
TXN	0.8194	0.490	1.673	0.094	-0.141
1.780					
U	-0.4038	0.108	-3.737	0.000	-0.616
-0.192					
UAL	-0.3768	0.109	-3.447	0.001	-0.591
-0.163					
UCC	-0.6695	0.082	-8.163	0.000	-0.830
-0.509					
UCL	-0.2065	0.083	-2.499	0.012	-0.368
-0.045					
UIS	0.0125	0.191	0.065	0.948	-0.362
0.387					
UK	-0.3374	0.080	-4.194	0.000	-0.495
-0.180					
UNP	-0.2290	0.126	-1.822	0.068	-0.475
0.017					
USH	-0.7538	0.061	-12.439	0.000	-0.873
-0.635					
USS	-0.0899	0.383	-0.235	0.814	-0.840
0.660					
UST	2.3336	0.138	16.860	0.000	2.062
2.605					
UTX	0.0027	0.104	0.025	0.980	-0.202
0.207					
VAT	-0.5976	0.130	-4.612	0.000	-0.852
-0.344					
VFC	-0.4854	0.109	-4.435	0.000	-0.700
-0.271					
WAG	0.8233	0.346	2.381	0.017	0.146
1.501					
WEN	-0.5560	0.136	-4.087	0.000	-0.823
-0.289					
WHR	-0.3700	0.119	-3.109	0.002	-0.603
-0.137					
WIN	0.1795	0.118	1.517	0.129	-0.052
0.411					
WLA	1.3430	0.326	4.125	0.000	0.705

```
1.981
WMB             -0.4848      0.066     -7.382      0.000      -0.613
-0.356
WMT              1.5105      0.378      3.998      0.000       0.770
2.251
WMX              0.1844      0.134      1.379      0.168      -0.078
0.446
WOR             -0.3877      0.279     -1.391      0.164      -0.934
0.158
WWY              3.5145      0.202     17.381      0.000       3.118
3.911
WY              -0.2930      0.089     -3.277      0.001      -0.468
-0.118
X               -0.6371      0.118     -5.393      0.000      -0.869
-0.406
XOM              0.7987      0.195      4.093      0.000       0.416
1.181
XRX              0.2310      0.174      1.324      0.185      -0.111
0.573
YELL            -1.3233      0.128    -10.373      0.000      -1.573
-1.073
Z               -0.5843      0.082     -7.132      0.000      -0.745
-0.424
==============================================================================
Omnibus:                      985.493   Durbin-Watson:                   1.314
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            16362.449
Skew:                           1.678   Prob(JB):                         0.00
Kurtosis:                      15.926   Cond. No.                     3.97e+17
==============================================================================

Notes:
[1] Standard Errors are heteroscedasticity robust (HC1)
[2] The smallest eigenvalue is 1.08e-30. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

3 Part 5: Instrumental Variable estimation

3.1 5.1 Assessing the quality of an instrument

removing firms with missing *meanagef*

[ ]:
```
data = data[data['meanagef'] != 0].dropna()
```

[ ]:
```
##Plotting the relationship between X and Y
plt.style.use('seaborn')

#sns.set_style("white")
```

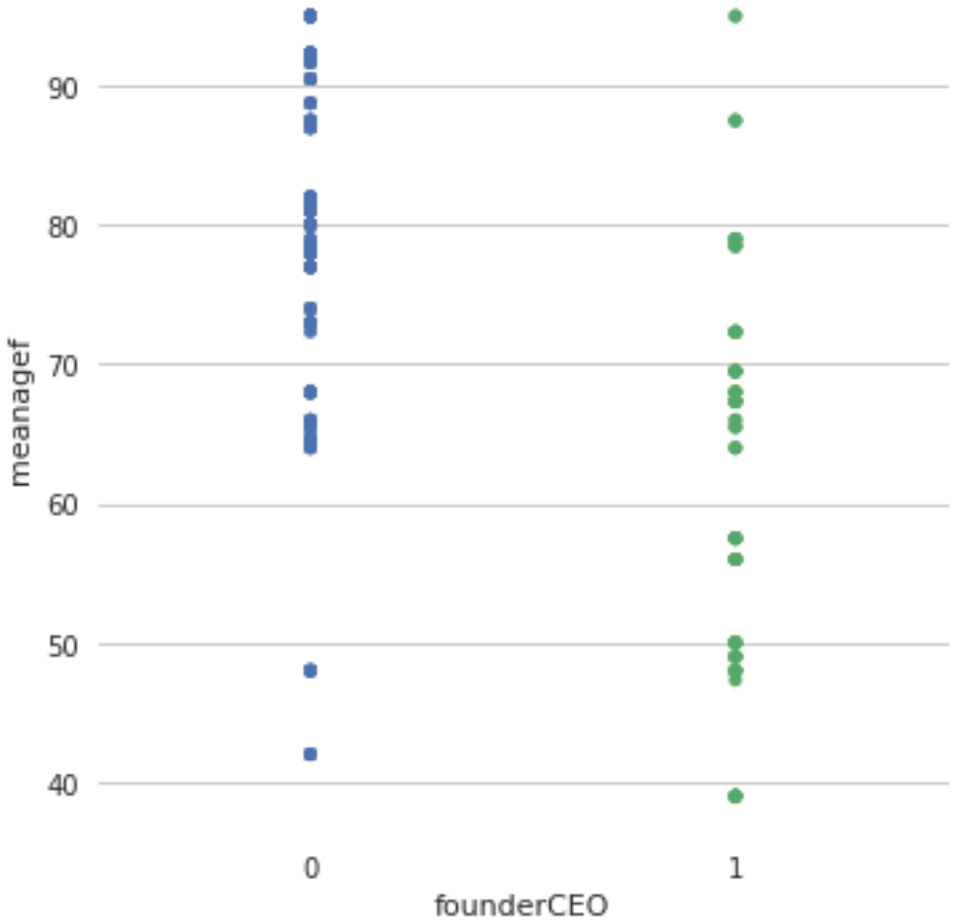
```
sns.set_style("whitegrid")
sns.despine(bottom = True, left = True)

sns.catplot(x = 'founderCEO', y = 'meanagef', data = data,  jitter=False)
#sns.despine(fig=None, ax=None, top=True, right=True, left=False, bottom=False,␣
 ↪offset=None, trim=False)

np.corrcoef(data['founderCEO'], data['meanagef'])
```

[ ]:
```
array([[ 1.       , -0.700844],
       [-0.700844,  1.      ]])
```

```
<Figure size 576x396 with 0 Axes>
```



[ ]:
```
scipy.stats.ttest_ind(data['meanagef'][data['founderCEO'] == 0],␣
 ↪data['meanagef'][data['founderCEO'] == 1])
```

[ ]:
```
Ttest_indResult(statistic=36.867321076344126, pvalue=7.969197778425855e-209)
```

[ ]:
```
np.corrcoef(data['Q'], data['meanagef'])
```

[ ]:
```
array([[ 1.        , -0.13603332],
       [-0.13603332,  1.        ]])
```

[ ]:
```
data['const'] = 1

X = pd.concat([data[['const', 'FamFirm', 'bs_volatility']], np.
 ↪log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)



y = data['Q']


model = sm.OLS(y, X).fit()

np.corrcoef(model.resid, data['meanagef'])
```

[ ]:
```
array([[ 1.        , -0.17687666],
       [-0.17687666,  1.        ]])
```

[ ]:
```
scipy.stats.ttest_ind(model.resid, data['meanagef'])
```

[ ]:
```
Ttest_indResult(statistic=-305.5647284554123, pvalue=0.0)
```

[ ]:
```
# First stage: regressing X (data['founderCEO']) on Z (data['meanagef'])
data['const'] = 1
model = sm.OLS(data['founderCEO'], data[['const', 'meanagef']]).fit()
print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:             founderCEO   R-squared:                       0.491
Model:                            OLS   Adj. R-squared:                  0.491
Method:                 Least Squares   F-statistic:                     1359.
Date:                Fri, 23 Jul 2021   Prob (F-statistic):          7.97e-209
Time:                        16:56:07   Log-Likelihood:                 440.46
No. Observations:                1410   AIC:                            -876.9
Df Residuals:                    1408   BIC:                            -866.4
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          1.4855      0.039     38.294      0.000       1.409       1.562
meanagef      -0.0156      0.000    -36.867      0.000      -0.016      -0.015
```

```
==============================================================================
Omnibus:                      350.505   Durbin-Watson:                   0.505
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             5759.509
Skew:                           0.701   Prob(JB):                         0.00
Kurtosis:                      12.801   Cond. No.                         752.
==============================================================================

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

[ ]:
```
X_hat = pd.DataFrame(model.predict(data[['const', 'meanagef']]), columns=['IV'])

X = pd.concat([pd.DataFrame(X_hat),
               data[['bs_volatility', 'const']],
               np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)


y = data['Q']
X

model = sm.OLS(y, X).fit()
print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                      Q   R-squared:                       0.333
Model:                            OLS   Adj. R-squared:                  0.309
Method:                 Least Squares   F-statistic:                     13.85
Date:                Fri, 23 Jul 2021   Prob (F-statistic):           8.02e-88
Time:                        16:56:07   Log-Likelihood:                -1616.7
No. Observations:                1410   AIC:                             3333.
Df Residuals:                    1360   BIC:                             3596.
Df Model:                          49
Covariance Type:            nonrobust
==============================================================================
                                                 coef    std err          t
P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
IV                                             1.2086      0.138      8.739
0.000       0.937       1.480
bs_volatility                                 -1.1879      0.287     -4.143
0.000      -1.750      -0.625
```

```
const                                    1.8321      0.235      7.802
0.000       1.371       2.293
assets                                  -0.0100      0.028     -0.357
0.721      -0.065       0.045
hightech                                 0.1887      0.052      3.630
0.000       0.087       0.291
1992                                     0.1287      0.069      1.854
0.064      -0.007       0.265
1993                                     0.0725      0.059      1.230
0.219      -0.043       0.188
1994                                    -0.0073      0.059     -0.123
0.902      -0.124       0.109
1995                                     0.0934      0.059      1.573
0.116      -0.023       0.210
1996                                     0.1799      0.060      2.988
0.003       0.062       0.298
1997                                     0.3948      0.062      6.400
0.000       0.274       0.516
1998                                     0.5487      0.064      8.633
0.000       0.424       0.673
1999                                     0.4215      0.069      6.084
0.000       0.286       0.557
Apparel & Accessory Stores               0.4942      0.135      3.650
0.000       0.229       0.760
Apparel & Other Textile Products        -0.0459      0.269     -0.171
0.865      -0.574       0.482
Auto Repair, Services, & Parking        -0.8118      0.270     -3.009
0.003      -1.341      -0.283
Building Materials & Gardening Supplies  1.0225      0.165      6.204
0.000       0.699       1.346
Business Services                        0.2651      0.109      2.427
0.015       0.051       0.479
Chemical & Allied Products               1.0420      0.073     14.236
0.000       0.898       1.186
Communications                           0.1751      0.148      1.186
0.236      -0.115       0.465
Eating & Drinking Places                 0.7303      0.289      2.528
0.012       0.164       1.297
Electric, Gas, & Sanitary Services      -0.4303      0.269     -1.597
0.110      -0.959       0.098
Electronic & Other Electric Equipment    0.1704      0.084      2.041
0.041       0.007       0.334
Fabricated Metal Products                0.3046      0.127      2.398
0.017       0.055       0.554
Food & Kindred Products                  0.9995      0.087     11.522
0.000       0.829       1.170
Food Stores                              0.4076      0.149      2.734
0.006       0.115       0.700
```

```
Furniture & Fixtures                          -0.4046      0.269     -1.504
0.133      -0.932       0.123
Furniture & Homefurnishings Stores             0.4417      0.201      2.203
0.028       0.048       0.835
General Merchandise Stores                    -0.2128      0.114     -1.861
0.063      -0.437       0.012
Health Services                               -0.7587      0.316     -2.404
0.016      -1.378      -0.139
Heavy Construction, Except Building           -0.1272      0.199     -0.640
0.522      -0.517       0.262
Hotels & Other Lodging Places                  0.0513      0.198      0.260
0.795      -0.336       0.439
Industrial Machinery & Equipment              -0.1948      0.075     -2.582
0.010      -0.343      -0.047
Instruments & Related Products                -0.0521      0.123     -0.423
0.673      -0.294       0.190
Insurance Carriers                            -0.2274      0.313     -0.725
0.468      -0.842       0.388
Lumber & Wood Products                        -0.1622      0.231     -0.703
0.482      -0.615       0.290
Miscellaneous Manufacturing Industries         0.1492      0.162      0.923
0.356      -0.168       0.466
Miscellaneous Retail                           0.0324      0.131      0.246
0.806      -0.226       0.290
Motion Pictures                                0.2043      0.273      0.749
0.454      -0.331       0.739
Oil & Gas Extraction                          -0.0998      0.158     -0.630
0.529      -0.410       0.211
Paper & Allied Products                        0.0511      0.110      0.466
0.641      -0.164       0.266
Petroleum & Coal Products                     -0.2739      0.115     -2.378
0.018      -0.500      -0.048
Primary Metal Industries                      -0.0352      0.115     -0.307
0.759      -0.260       0.190
Printing & Publishing                          0.2430      0.102      2.371
0.018       0.042       0.444
Railroad Transportation                       -0.3832      0.143     -2.685
0.007      -0.663      -0.103
Rubber & Miscellaneous Plastics Products       0.0652      0.142      0.459
0.646      -0.214       0.344
Stone, Clay, & Glass Products                  0.0520      0.288      0.180
0.857      -0.514       0.618
Tobacco Products                               0.5228      0.276      1.892
0.059      -0.019       1.065
Transportation Equipment                      -0.2938      0.080     -3.668
0.000      -0.451      -0.137
Transportation by Air                         -0.4573      0.124     -3.690
0.000      -0.700      -0.214
```

```
Trucking & Warehousing                        -0.5203      0.291     -1.790
0.074      -1.091       0.050
Wholesale Trade - Durable Goods                0.1515      0.145      1.045
0.296      -0.133       0.436
Wholesale Trade - Nondurable Goods            -0.2525      0.120     -2.108
0.035      -0.487      -0.018
==============================================================================
Omnibus:                      579.296   Durbin-Watson:                   0.746
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             4224.613
Skew:                           1.740   Prob(JB):                         0.00
Kurtosis:                      10.733   Cond. No.                     1.06e+17
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The smallest eigenvalue is 1.03e-29. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
```

3.2 5.2 Hausman test

[ ]:
```
X = pd.concat([data[['const', 'founderCEO', 'bs_volatility', 'meanagef']], np.
 ↪log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)
X
```

[ ]:
```
      const  ...  Wholesale Trade - Nondurable Goods
2         1  ...                                   0
3         1  ...                                   0
4         1  ...                                   0
5         1  ...                                   0
6         1  ...                                   0
...     ...  ...                                 ...
2197      1  ...                                   0
2198      1  ...                                   0
2199      1  ...                                   0
2200      1  ...                                   0
2201      1  ...                                   0

[1410 rows x 54 columns]
```

[ ]:
```
# First step: Run OLS regression of endogenous variable xk on all exogenous␣
 ↪variables and the instrument using OLS

reg_fs = sm.OLS(data['founderCEO'],
                    X.drop(columns = ['founderCEO'])).fit()
print(reg_fs.summary())
```

OLS Regression Results

Dep. Variable:	founderCEO	R-squared:	0.587
Model:	OLS	Adj. R-squared:	0.572
Method:	Least Squares	F-statistic:	39.43
Date:	Fri, 23 Jul 2021	Prob (F-statistic):	1.46e-223
Time:	16:56:07	Log-Likelihood:	587.31
No. Observations:	1410	AIC:	-1075.
Df Residuals:	1360	BIC:	-812.1
Df Model:	49		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	1.4140	0.060	23.548	0.000	1.296	1.532
bs_volatility	-0.0478	0.060	-0.795	0.427	-0.166	0.070
meanagef	-0.0156	0.000	-34.416	0.000	-0.016	-0.015
assets	-0.0156	0.006	-2.657	0.008	-0.027	-0.004
hightech	0.0363	0.011	3.332	0.001	0.015	0.058
1992	0.1833	0.015	12.111	0.000	0.154	0.213
1993	0.1949	0.013	14.834	0.000	0.169	0.221
1994	0.1916	0.013	14.475	0.000	0.166	0.218
1995	0.1815	0.013	13.844	0.000	0.156	0.207
1996	0.1717	0.013	13.007	0.000	0.146	0.198
1997	0.1725	0.014	12.776	0.000	0.146	0.199
1998	0.1573	0.014	11.292	0.000	0.130	0.185
1999	0.1612	0.015	10.490	0.000	0.131	0.191
Apparel & Accessory Stores	0.0840	0.028	2.974	0.003	0.029	0.139
Apparel & Other Textile Products	0.0295	0.056	0.523	0.601	-0.081	0.140
Auto Repair, Services, & Parking	-0.1970	0.056	-3.491			

```
0.000      -0.308      -0.086
Building Materials & Gardening Supplies      0.1662      0.034      4.824
0.000       0.099       0.234
Business Services                            0.0771      0.023      3.370
0.001       0.032       0.122
Chemical & Allied Products                   0.0441      0.015      2.856
0.004       0.014       0.074
Communications                               0.1950      0.031      6.311
0.000       0.134       0.256
Eating & Drinking Places                     0.0019      0.061      0.032
0.975      -0.117       0.121
Electric, Gas, & Sanitary Services           0.0469      0.056      0.831
0.406      -0.064       0.158
Electronic & Other Electric Equipment        0.0534      0.018      3.052
0.002       0.019       0.088
Fabricated Metal Products                    0.0362      0.027      1.356
0.175      -0.016       0.089
Food & Kindred Products                      0.0372      0.018      2.034
0.042       0.001       0.073
Food Stores                                 -0.0181      0.031     -0.578
0.563      -0.079       0.043
Furniture & Fixtures                         0.0352      0.056      0.624
0.533      -0.075       0.146
Furniture & Homefurnishings Stores           0.0319      0.042      0.757
0.449      -0.051       0.114
General Merchandise Stores                   0.0763      0.024      3.187
0.001       0.029       0.123
Health Services                             -0.4241      0.066     -6.429
0.000      -0.554      -0.295
Heavy Construction, Except Building          0.0324      0.042      0.776
0.438      -0.049       0.114
Hotels & Other Lodging Places                0.0040      0.041      0.096
0.923      -0.077       0.085
Industrial Machinery & Equipment            -0.1014      0.016     -6.428
0.000      -0.132      -0.070
Instruments & Related Products               0.0072      0.026      0.278
0.781      -0.043       0.058
Insurance Carriers                           0.4535      0.066      6.909
0.000       0.325       0.582
Lumber & Wood Products                       0.0440      0.048      0.910
0.363      -0.051       0.139
Miscellaneous Manufacturing Industries      -0.0682      0.034     -2.012
0.044      -0.135      -0.002
Miscellaneous Retail                        -0.0111      0.027     -0.405
0.686      -0.065       0.043
Motion Pictures                              0.0641      0.057      1.121
0.262      -0.048       0.176
Oil & Gas Extraction                         0.0463      0.033      1.392
```

```
0.164      -0.019       0.111
Paper & Allied Products                      0.0367      0.023      1.597
0.110      -0.008       0.082
Petroleum & Coal Products                    0.0934      0.024      3.870
0.000       0.046       0.141
Primary Metal Industries                    -0.0320      0.024     -1.329
0.184      -0.079       0.015
Printing & Publishing                        0.0309      0.022      1.432
0.152      -0.011       0.073
Railroad Transportation                      0.0534      0.030      1.782
0.075      -0.005       0.112
Rubber & Miscellaneous Plastics Products     0.2470      0.030      8.339
0.000       0.189       0.305
Stone, Clay, & Glass Products                0.0392      0.060      0.648
0.517      -0.079       0.158
Tobacco Products                             0.0743      0.058      1.283
0.200      -0.039       0.188
Transportation Equipment                     0.0546      0.017      3.237
0.001       0.021       0.088
Transportation by Air                        0.0973      0.026      3.749
0.000       0.046       0.148
Trucking & Warehousing                       0.0199      0.061      0.327
0.744      -0.100       0.140
Wholesale Trade - Durable Goods             -0.0341      0.030     -1.122
0.262      -0.094       0.026
Wholesale Trade - Nondurable Goods          -0.0131      0.025     -0.519
0.604      -0.062       0.036
==============================================================================
Omnibus:                      325.206   Durbin-Watson:                   0.542
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             5492.275
Skew:                           0.601   Prob(JB):                         0.00
Kurtosis:                      12.594   Cond. No.                     4.55e+17
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The smallest eigenvalue is 5.75e-29. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
```

[ ]:
```
###SECOND STAGE regression model
X = pd.concat([data[['const', 'founderCEO', 'bs_volatility']], np.
 ↪log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)
#we first need to retrive the residuals:
data['residual'] = reg_fs.resid
```

```
reg_ss = sm.OLS(data['Q'],
                pd.concat([data['residual'], X], axis = 1) ).fit()
print(reg_ss.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                      Q   R-squared:                       0.333
Model:                            OLS   Adj. R-squared:                  0.308
Method:                 Least Squares   F-statistic:                     13.57
Date:                Fri, 23 Jul 2021   Prob (F-statistic):           2.83e-87
Time:                        16:56:07   Log-Likelihood:                -1616.6
No. Observations:                1410   AIC:                             3335.
Df Residuals:                    1359   BIC:                             3603.
Df Model:                          50
Covariance Type:            nonrobust
==============================================================================
                                                 coef    std err          t
P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
residual                                      -1.1651      0.190     -6.139
0.000      -1.537      -0.793
const                                          1.6765      0.237      7.087
0.000       1.212       2.141
founderCEO                                     1.2121      0.139      8.736
0.000       0.940       1.484
bs_volatility                                 -1.1300      0.285     -3.959
0.000      -1.690      -0.570
assets                                         0.0089      0.028      0.315
0.753      -0.047       0.065
hightech                                       0.1786      0.052      3.431
0.001       0.076       0.281
1992                                           0.1013      0.070      1.456
0.146      -0.035       0.238
1993                                           0.0310      0.059      0.524
0.600      -0.085       0.147
1994                                          -0.0448      0.060     -0.751
0.453      -0.162       0.072
1995                                           0.0682      0.060      1.145
0.252      -0.049       0.185
1996                                           0.1665      0.060      2.760
0.006       0.048       0.285
1997                                           0.3805      0.062      6.156
0.000       0.259       0.502
1998                                           0.5529      0.064      8.698
```

```
0.000       0.428       0.678
1999                                        0.4208      0.069      6.073
0.000       0.285       0.557
Apparel & Accessory Stores                  0.4348      0.137      3.183
0.001       0.167       0.703
Apparel & Other Textile Products           -0.0394      0.269     -0.146
0.884      -0.568       0.489
Auto Repair, Services, & Parking           -0.5306      0.269     -1.973
0.049      -1.058      -0.003
Building Materials & Gardening Supplies     0.8634      0.168      5.153
0.000       0.535       1.192
Business Services                           0.1801      0.110      1.633
0.103      -0.036       0.396
Chemical & Allied Products                  1.0308      0.073     14.098
0.000       0.887       1.174
Communications                             -0.0189      0.151     -0.126
0.900      -0.314       0.276
Eating & Drinking Places                    0.7703      0.289      2.666
0.008       0.203       1.337
Electric, Gas, & Sanitary Services         -0.4449      0.269     -1.651
0.099      -0.973       0.084
Electronic & Other Electric Equipment       0.1141      0.083      1.370
0.171      -0.049       0.278
Fabricated Metal Products                   0.3030      0.127      2.386
0.017       0.054       0.552
Food & Kindred Products                     0.9968      0.087     11.490
0.000       0.827       1.167
Food Stores                                 0.4718      0.149      3.159
0.002       0.179       0.765
Furniture & Fixtures                       -0.4049      0.269     -1.505
0.133      -0.933       0.123
Furniture & Homefurnishings Stores          0.4455      0.201      2.220
0.027       0.052       0.839
General Merchandise Stores                 -0.2630      0.115     -2.293
0.022      -0.488      -0.038
Health Services                            -0.2023      0.312     -0.649
0.517      -0.814       0.410
Heavy Construction, Except Building        -0.1240      0.199     -0.624
0.533      -0.514       0.266
Hotels & Other Lodging Places               0.0888      0.198      0.449
0.653      -0.299       0.477
Industrial Machinery & Equipment           -0.0634      0.075     -0.849
0.396      -0.210       0.083
Instruments & Related Products             -0.0523      0.123     -0.424
0.671      -0.294       0.189
Insurance Carriers                         -0.7347      0.322     -2.285
0.022      -1.366      -0.104
Lumber & Wood Products                     -0.1732      0.231     -0.751
```

```
0.453      -0.626       0.279
Miscellaneous Manufacturing Industries       0.2742      0.162      1.689
0.091      -0.044       0.593
Miscellaneous Retail                         0.0882      0.131      0.673
0.501      -0.169       0.345
Motion Pictures                              0.1689      0.273      0.619
0.536      -0.366       0.704
Oil & Gas Extraction                        -0.1135      0.158     -0.717
0.474      -0.424       0.197
Paper & Allied Products                      0.0490      0.110      0.446
0.656      -0.166       0.264
Petroleum & Coal Products                   -0.3448      0.116     -2.984
0.003      -0.571      -0.118
Primary Metal Industries                     0.0459      0.115      0.399
0.690      -0.180       0.272
Printing & Publishing                        0.2479      0.103      2.417
0.016       0.047       0.449
Railroad Transportation                     -0.4056      0.143     -2.842
0.005      -0.686      -0.126
Rubber & Miscellaneous Plastics Products    -0.1918      0.150     -1.280
0.201      -0.486       0.102
Stone, Clay, & Glass Products                0.0469      0.289      0.162
0.871      -0.519       0.613
Tobacco Products                             0.4751      0.276      1.718
0.086      -0.067       1.017
Transportation Equipment                    -0.3176      0.080     -3.967
0.000      -0.475      -0.161
Transportation by Air                       -0.5330      0.124     -4.282
0.000      -0.777      -0.289
Trucking & Warehousing                      -0.5021      0.291     -1.726
0.085      -1.073       0.069
Wholesale Trade - Durable Goods              0.2352      0.146      1.616
0.106      -0.050       0.521
Wholesale Trade - Nondurable Goods          -0.1943      0.120     -1.615
0.106      -0.430       0.042
==============================================================================
Omnibus:                      581.387   Durbin-Watson:                   0.746
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             4283.046
Skew:                           1.744   Prob(JB):                         0.00
Kurtosis:                      10.794   Cond. No.                     1.55e+17
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The smallest eigenvalue is 4.78e-30. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
```

3.3 5.3 IV coefficient estimates

[ ]:
```
X = pd.concat([data[['const','founderCEO', 'bs_volatility']], np.
 ↪log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)

Z =  pd.concat([data[['const', 'meanagef', 'bs_volatility']], np.
 ↪log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)


exog = pd.concat([data[['const', 'bs_volatility']], np.log(data['assets']),
               data['hightech'], pd.get_dummies(data['Year']),
               pd.get_dummies(data['industry name'])], axis=1)

endog = data['founderCEO']

instruments = data['meanagef']
y = data['Q']

model = IV2SLS(y, exog[['const', 'bs_volatility', 'assets', 'hightech']], endog,␣
 ↪instruments).fit()
print(model)
```

```
                          IV-2SLS Estimation Summary
==============================================================================
Dep. Variable:                      Q   R-squared:                      0.0238
Estimator:                    IV-2SLS   Adj. R-squared:                 0.0210
No. Observations:                1410   F-statistic:                    79.173
Date:                Fri, Jul 23 2021   P-value (F-stat)                0.0000
Time:                        16:56:07   Distribution:                  chi2(4)
Cov. Estimator:                robust

                             Parameter Estimates
==============================================================================
=
               Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper
CI
------------------------------------------------------------------------------
-
const             2.6545     0.2351     11.291     0.0000      2.1937
3.1153
bs_volatility    -2.0406     0.2544    -8.0208     0.0000     -2.5393
-1.5420
assets           -0.0302     0.0246    -1.2278     0.2195     -0.0784
0.0180
```

```
hightech          0.0794     0.0540     1.4707     0.1414     -0.0264
0.1852
founderCEO        1.0159     0.1968     5.1615     0.0000      0.6301
1.4017
==============================================================================
=

Endogenous: founderCEO
Instruments: meanagef
Robust Covariance (Heteroskedastic)
Debiased: False
```