Financial Econometrics - Homework 3

In [1]:

```
import time
import datetime
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import statsmodels.api as sm
from datetime import datetime, timedelta
from scipy import stats
from scipy.stats import norm, ks_2samp
from pandas_datareader import data
from tqdm import tqdm
```

Question 1

In [2]:

```
Ticker = pd.read_html('https://en.wikipedia.org/wiki/List_of_S%26P_500_companies')[0
Ticker = Ticker.str.replace(".",'-')
Ticker = pd.DataFrame(Ticker)
```

In [3]:

```
final_list = []
start_date, end = '1984-01-01', '2019-12-30'
factors = pd.read_csv("F-F_Research_Data_5_Factors_2x3_daily.CSV",sep=',',header=2)
lenfact = factors.shape[0]
factors = factors[0:lenfact-1]
factors = factors.rename(columns={'Unnamed: 0':'X'})
factors['X'] = pd.to_datetime(factors['X'].astype(str))
factorsA = factors[factors['X'] > start_date]
factorsA = factorsA.reset_index()
factorsA = factorsA.drop(['index'], axis=1)
```

In [5]:

```
print(factorsA.tail())
```

```
              X  Mkt-RF   SMB   HML   RMW   CMA     RF
9069 2019-12-23    0.10  0.16 -0.28 -0.12  0.31  0.007
9070 2019-12-24    0.01  0.36 -0.07 -0.28  0.02  0.007
9071 2019-12-26    0.49 -0.56  0.00  0.23 -0.19  0.007
9072 2019-12-27   -0.09 -0.54 -0.07  0.24  0.16  0.007
9073 2019-12-30   -0.57  0.27  0.58  0.15  0.45  0.007
```

In [5]:

```
T = len(Ticker)
for i in tqdm(range(T)):
    extr = data.DataReader(Ticker.iloc[i][0], 'yahoo', start_date, end)
    extr['Log'] = np.log(extr['Adj Close'])
    Returns = np.diff(extr['Log'])
    extr['Returns'] = np.append(0,Returns)
    extr = extr.reset_index()

    factorsB = factorsA
    if len(extr) != len(factorsA):
        factorsB = factorsA[factorsA['X'] >= extr.Date[0]]

    factorsB = factorsB.reset_index()
    factorsB = factorsB.drop(['X', 'index'], axis=1)
    extr = pd.concat([extr, factorsB], axis=1)
    extr = extr.iloc[1:,:]
    Ri_Rf1 = extr['Returns'] - extr['RF']
    X = extr[['Mkt-RF', 'SMB', 'HML', 'RMW', 'CMA']]
    X, y = X.values, Ri_Rf1.values
    X = sm.add_constant(X)
    result = sm.OLS(y, X).fit()
    r2 = result.rsquared
    t_val = result.tvalues[0]
    final_list.append([Ticker.iloc[i][0], result.params[0], result.params[1], result
                result.params[3], result.params[4], result.params[5], t_val, r2])

df = pd.DataFrame(final_list, columns=['Ticker', 'Const', 'Mkt-RF', 'SMB', 'HML', 'F
df
```

```
 82%|████████████████████████████████████████████████████████████████
█               | 415/505 [21:11<03:09,  2.10s/it]C:\Users\William\Anac
onda3\lib\site-packages\pandas\core\series.py:853: RuntimeWarning: inv
alid value encountered in log
  result = getattr(ufunc, method)(*inputs, **kwargs)
100%|████████████████████████████████████████████████████████████████
████████████████| 505/505 [25:28<00:00,  3.03s/it]
```

Out[5]:

	Ticker	Const	Mkt-RF	SMB	HML	RMW	CMA	T_Val_Const	
0	MMM	-0.013404	0.009556	-0.001232	-0.000197	0.003969	0.005074	-83.087439	0.280
1	ABT	-0.013045	0.008424	-0.002579	-0.004522	0.006119	0.005433	-71.356049	0.210
2	ABBV	-0.002716	0.010319	-0.000704	-0.005302	-0.002590	0.002054	-7.421202	0.261
3	ABMD	-0.011664	0.010842	0.008926	-0.003576	-0.006554	0.001138	-25.396607	0.108
4	ACN	-0.004783	0.008998	-0.000694	-0.003413	-0.003988	-0.001043	-19.873786	0.310
...	...	...	...	...	...	...	...	...	
500	YUM	-0.007479	0.009041	0.001435	-0.000326	0.005312	0.002604	-30.981652	0.228
501	ZBRA	-0.009416	0.009654	0.006732	-0.002773	-0.001065	-0.002012	-32.419543	0.198
502	ZBH	-0.005107	0.007903	0.000884	-0.001506	0.001323	0.000437	-22.256971	0.248
503	ZION	-0.013543	0.011028	0.005040	0.018274	-0.002094	-0.007890	-59.522624	0.333
504	ZTS	-0.002498	0.008876	-0.001168	-0.005418	-0.001651	0.000530	-8.649385	0.312

505 rows × 9 columns

Question 2

In [6]:

```
df.describe()
```

Out[6]:

	Const	Mkt-RF	SMB	HML	RMW	CMA	T_Val_Const	
count	501.000000	501.000000	501.000000	501.000000	501.000000	501.000000	501.000000	50
mean	-0.009824	0.010257	0.002324	0.001218	0.000478	0.000101	-42.155362	
std	0.003946	0.002291	0.003200	0.005522	0.004895	0.004862	24.025818	
min	-0.013964	0.000596	-0.004344	-0.010514	-0.020753	-0.018711	-88.556002	
25%	-0.013335	0.008680	0.000029	-0.002130	-0.001420	-0.002275	-63.479099	
50%	-0.011626	0.010319	0.002130	0.000313	0.001826	0.000962	-42.821532	
75%	-0.006500	0.011886	0.004693	0.003740	0.003558	0.003550	-18.822432	
max	-0.001460	0.017119	0.011063	0.021700	0.013529	0.009794	-3.546225	

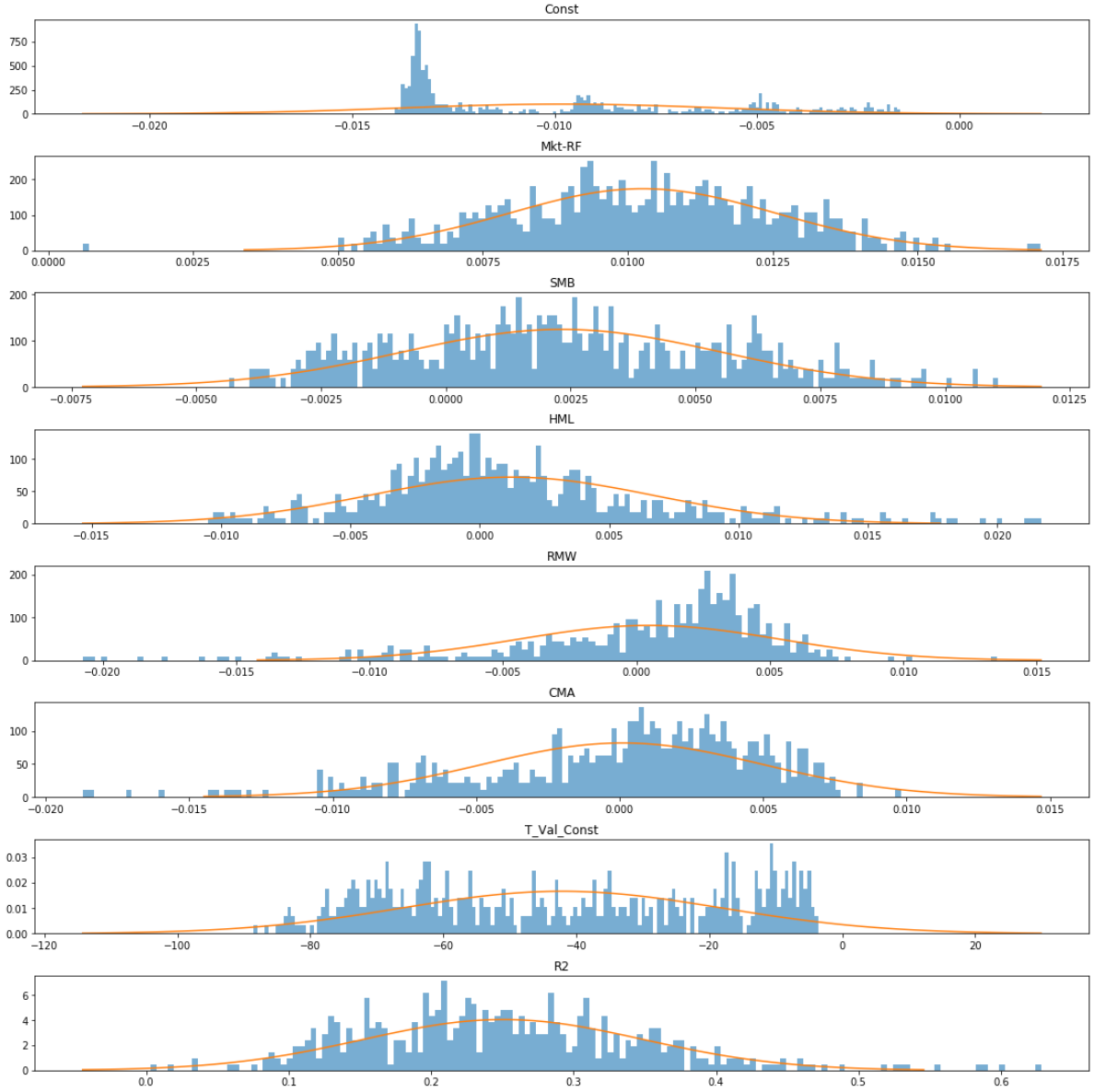
Question 3

In [7]:

```
get_info = list(df.columns)[1:]
fig, ax = plt.subplots(nrows=len(get_info),constrained_layout=True,figsize=(15,15))

for i in range(len(get_info)):
    ax[i].hist(df[get_info[i]], bins=150, density=True, alpha=0.6)
    mu, sigma= df[get_info[i]].mean(), df[get_info[i]].std()
    x = np.linspace(mu - 3*sigma, mu + 3*sigma, 100)
    ax[i].plot(x, stats.norm.pdf(x, mu, sigma))
    ax[i].set_title(get_info[i])
plt.show()
```

```
C:\Users\William\Anaconda3\lib\site-packages\numpy\lib\histograms.py:8
24: RuntimeWarning: invalid value encountered in greater_equal
  keep = (tmp_a >= first_edge)
C:\Users\William\Anaconda3\lib\site-packages\numpy\lib\histograms.py:8
25: RuntimeWarning: invalid value encountered in less_equal
  keep &= (tmp_a <= last_edge)
```



Question 4

Five companies with the highest constant

In [8]:

```
df.sort_values(by='Const', ascending=False).head(5)
```

Out[8]:

	Ticker	Const	Mkt-RF	SMB	HML	RMW	CMA	T_Val_Const	
79	AVGO	-0.001460	0.012040	0.001859	-0.002971	-0.000755	-0.005981	-4.200659	0.328
102	CHTR	-0.001462	0.008321	-0.001556	-0.001991	-0.000994	0.000301	-4.742724	0.205
475	V	-0.001581	0.009379	-0.001943	-0.000103	-0.003010	-0.006423	-6.161144	0.441
201	FTNT	-0.001619	0.010507	0.004369	-0.006967	-0.005035	-0.007041	-3.830970	0.263
196	FLT	-0.001624	0.009317	0.002040	-0.001113	-0.002343	-0.002190	-5.248454	0.299

Five companies with the lowest constant

In [9]:

```
df.sort_values(by='Const').head(5)
```

Out[9]:

	Ticker	Const	Mkt-RF	SMB	HML	RMW	CMA	T_Val_Const	I
33	AIG	-0.013964	0.013420	-0.003737	0.014633	-0.003994	-0.005306	-49.469166	0.2804
52	ARNC	-0.013941	0.014084	0.002592	0.004112	0.001731	0.004496	-62.895179	0.3197
491	WY	-0.013900	0.012142	0.000037	0.003513	0.002727	0.004364	-61.830513	0.2507
240	HST	-0.013831	0.014304	0.006685	0.010809	0.004532	-0.002330	-60.743845	0.3429
255	IP	-0.013804	0.012752	0.001241	0.005276	0.002617	0.003470	-68.674856	0.3205

Question 5

We will consider momentum as the 6th factor. For this one, we will do the difference between the average percentage return of the portfolio of the 5 highest momentum stocks and the average percentage return of the portfolio of the 5 lowest momentum stocks. Momentum will be calculated on a 5-day basis using the following formula:

M = ln(Price Today) - ln(Price Five Days Ago)

In [27]:

```
final_list = []
T = len(Ticker)

for i in tqdm(range(T)):
    extr = data.DataReader(Ticker.iloc[i][0], 'yahoo', start_date, end)
    extr['Log'] = np.log(extr['Adj Close'])
    Returns = np.diff(extr['Log'])
    extr['Returns'] = np.append(0,Returns)

    momentum = np.diff(extr['Log'], n=2)
    extr['Momentum'] = np.append([0, 0],momentum)
    extr = extr.iloc[6:]

    extr = extr.reset_index()

    factorsB = factorsA
    if len(extr) != len(factorsA):
        factorsB = factorsA[factorsA['X'] >= extr.Date[0]]

    factorsB = factorsB.reset_index()
    factorsB = factorsB.drop(['X', 'index'], axis=1)
    extr = pd.concat([extr, factorsB], axis=1)
    extr = extr.iloc[1:,:]
    Ri_Rf1 = extr['Returns'] - extr['RF']
    X = extr[['Mkt-RF', 'SMB', 'HML', 'RMW', 'CMA','Momentum']]
    X, y = X.values, Ri_Rf1.values
    X = sm.add_constant(X)
    result = sm.OLS(y, X, missing='drop').fit()
    r2 = result.rsquared
    t_val = result.tvalues[0]
    final_list.append([Ticker.iloc[i][0], result.params[0], result.params[1], result
                result.params[3], result.params[4], result.params[5], result.params

new_df = pd.DataFrame(final_list, columns=['Ticker', 'Const', 'Mkt-RF', 'SMB', 'HML
new_df
```

```
 82%|████████▏   | 415/505 [08:31<02:02,  1.36s/it]/Users/semen/anaconda
3/lib/python3.6/site-packages/pandas/core/series.py:853: RuntimeWarnin
g: invalid value encountered in log
  result = getattr(ufunc, method)(*inputs, **kwargs)
100%|██████████| 505/505 [11:36<00:00,  2.14s/it]
```

Out[27]:

	Ticker	Const	Mkt-RF	SMB	HML	RMW	CMA	Momentum	T_Val_(
0	MMM	-0.013198	0.005887	-0.000124	-0.000086	0.002001	0.002483	0.367546	-91.1
1	ABT	-0.012851	0.004965	-0.000685	-0.002697	0.003863	0.002156	0.416335	-82.3
2	ABBV	-0.002436	0.006055	-0.000666	-0.003015	-0.002708	0.002684	0.421000	-8.4
3	ABMD	-0.011523	0.005508	0.006600	-0.001929	-0.004677	0.000779	0.474100	-35.7
4	ACN	-0.004641	0.005103	-0.000591	-0.001840	-0.003219	-0.002187	0.399290	-24.0
...	...	...	...	...	...	...	...	...	...
500	YUM	-0.007287	0.004946	0.001202	0.000224	0.002809	0.000516	0.422868	-37.1

	Ticker	Const	Mkt-RF	SMB	HML	RMW	CMA	Momentum	T_Val_(
501	ZBRA	-0.009231	0.005023	0.004271	-0.001563	-0.002265	-0.001509	0.442925	-41.4
502	ZBH	-0.004944	0.004344	0.000323	-0.000308	0.000371	-0.000957	0.414934	-26.4
503	ZION	-0.013330	0.006528	0.003266	0.011260	-0.001975	-0.005282	0.383816	-70.8
504	ZTS	-0.002317	0.005263	-0.000664	-0.003301	-0.001332	0.001366	0.409650	-10.5

505 rows × 10 columns

In [28]:

```
new_df.describe()
```

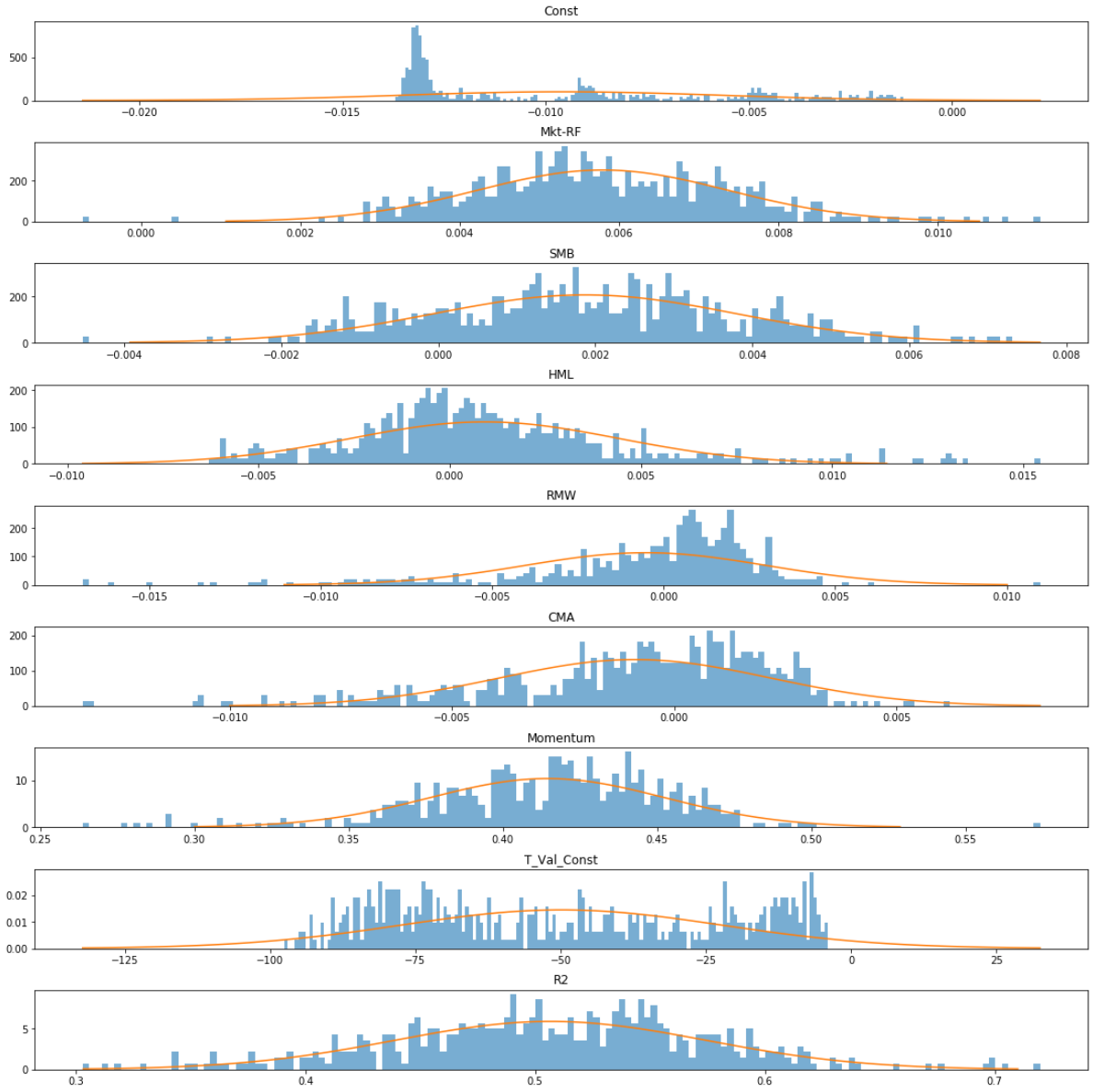
Out[28]:

	Const	Mkt-RF	SMB	HML	RMW	CMA	Momentum	T_V
count	505.000000	505.000000	505.000000	505.000000	505.000000	505.000000	505.000000	50
mean	-0.009616	0.005796	0.001871	0.000917	-0.000529	-0.000886	0.414418	-4
std	0.003927	0.001576	0.001933	0.003505	0.003514	0.003038	0.038129	2
min	-0.013714	-0.000730	-0.004530	-0.006292	-0.016948	-0.013312	0.263708	-9
25%	-0.013118	0.004690	0.000518	-0.001195	-0.001704	-0.002278	0.390510	-7
50%	-0.011422	0.005658	0.001826	0.000442	0.000486	-0.000403	0.418737	-5
75%	-0.006449	0.006867	0.003145	0.002560	0.001708	0.001296	0.440822	-2
max	-0.001203	0.011284	0.007313	0.015442	0.010973	0.006183	0.574216	-

In [29]:

```
get_info = list(new_df.columns)[1:]
fig, ax = plt.subplots(nrows=len(get_info),constrained_layout=True,figsize=(15,15))

for i in range(len(get_info)):
    ax[i].hist(new_df[get_info[i]], bins=150, density=True, alpha=0.6)
    mu, sigma= new_df[get_info[i]].mean(), new_df[get_info[i]].std()
    x = np.linspace(mu - 3*sigma, mu + 3*sigma, 100)
    ax[i].plot(x, stats.norm.pdf(x, mu, sigma))
    ax[i].set_title(get_info[i])
plt.show()
```



Five companies with the highest constant

In [30]:

```
new_df.sort_values(by='Const', ascending=False).head(5)
```

Out[30]:

	Ticker	Const	Mkt-RF	SMB	HML	RMW	CMA	Momentum	T_Val_(
79	AVGO	-0.001203	0.007301	0.000955	-0.002259	-0.000419	-0.002356	0.400729	-4.4
102	CHTR	-0.001239	0.004540	-0.000692	-0.001430	-0.000548	0.000721	0.439960	-5.2
201	FTNT	-0.001393	0.006195	0.002979	-0.004105	-0.002299	-0.003737	0.423757	-4.3
475	V	-0.001414	0.005465	-0.001570	0.000033	-0.003356	-0.005132	0.360546	-7.0
196	FLT	-0.001464	0.005299	0.001130	-0.000785	-0.001289	-0.001130	0.406607	-6.0

Five companies with the lowest constant

In [31]:

```
new_df.sort_values(by='Const').head(5)
```

Out[31]:

	Ticker	Const	Mkt-RF	SMB	HML	RMW	CMA	Momentum	T_Val_C
33	AIG	-0.013714	0.007732	-0.002011	0.008709	-0.003500	-0.004379	0.389400	-56.62
52	ARNC	-0.013654	0.008407	0.002576	0.002986	-0.000179	0.001330	0.377742	-71.82
491	WY	-0.013628	0.007079	0.001298	0.002094	0.000807	0.001250	0.413284	-73.31
112	C	-0.013598	0.010078	-0.000707	0.013046	-0.003849	-0.010687	0.308457	-68.72
240	HST	-0.013552	0.008794	0.004991	0.006585	0.002493	-0.002340	0.382068	-72.10