Financial Econometrics - Homework 1

In [2]:

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

Question 1

In [11]:

```
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 [13]:

```
lll, mul, sig2l, skl, kul, corrsnp = [], [], [], [], [], []
start_date, end = '2001-01-01', '2020-01-01'
T = Ticker.shape[0]

SnP = data.DataReader('^GSPC', 'yahoo', start_date, end)
SnP['Log'] = np.log(SnP['Adj Close'])
Returns = np.diff(SnP['Log'])*100
Returns = np.append(0,Returns)
SnP['Returns'] = Returns

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'])*100
    Returns = np.append(0,Returns)
    extr['Returns'] = Returns
    analysis  =  stats.describe(extr['Returns'])
    if len(extr['Returns']) == len(SnP['Returns']):
        corrsnp.append(np.corrcoef(SnP['Returns'],extr['Returns'])[0][1])
    else:
        corrsnp.append(np.corrcoef(SnP['Returns'].iloc[len(SnP['Returns'])-len(extr|
    lll.append(round((extr['Adj Close'][-1] / extr['Adj Close'][0] - 1) * 100, 2))
    mu, sig2, sk, ku = analysis[2:]
    mul.append(mu)
    sig2l.append(sig2)
    skl.append(sk)
    kul.append(ku)

Ticker['Mean'] = mul
Ticker['Variance'] = sig2l
Ticker['Skewness'] = skl
Ticker['Kurtosis'] = kul
Ticker['Total Returns'] = lll
Ticker['SnPCorr'] = corrsnp
```

```
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```
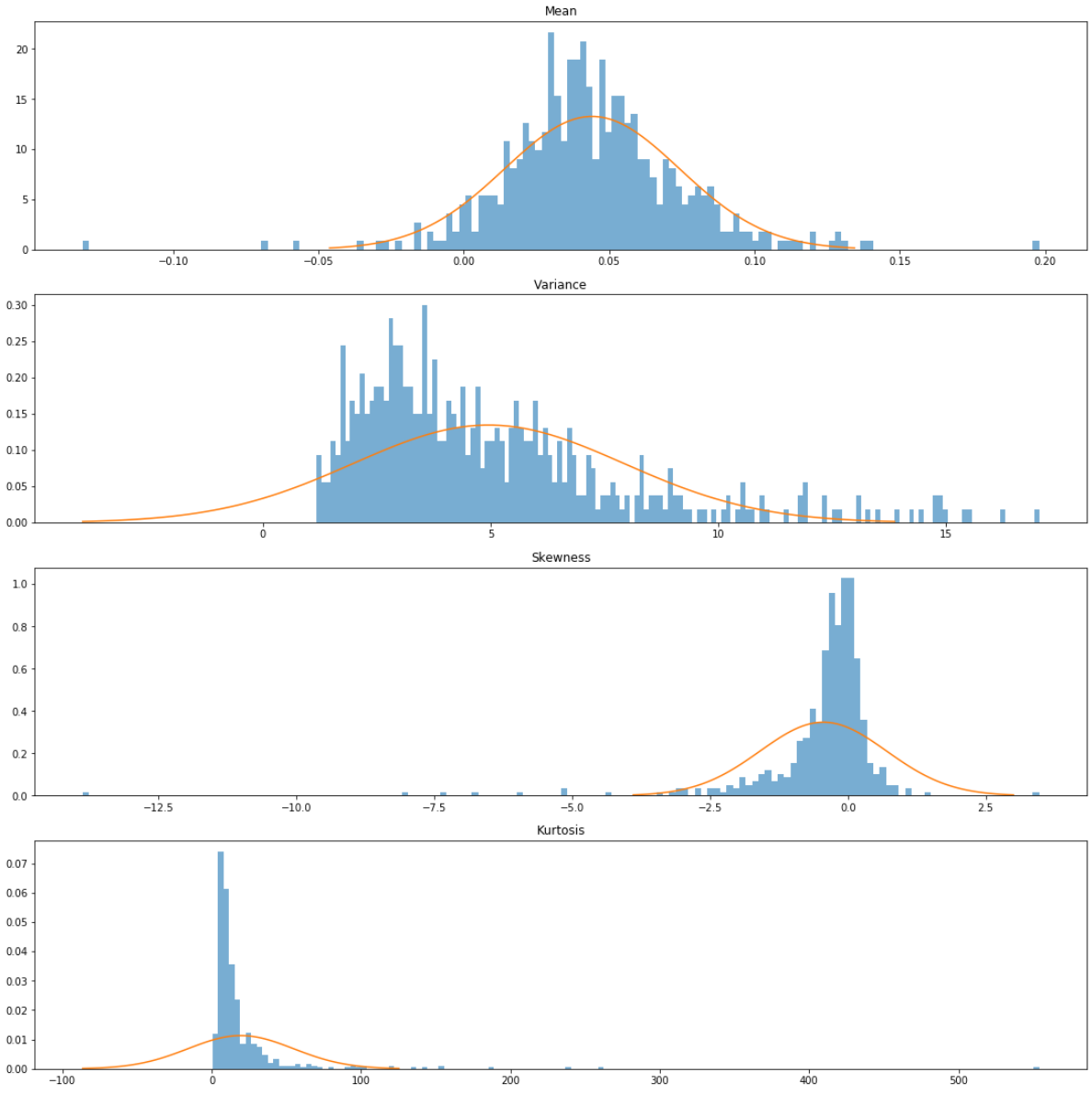

In [14]:

```
get_info = ['Mean', 'Variance', 'Skewness', 'Kurtosis']
fig, ax = plt.subplots(nrows=len(get_info),constrained_layout=True,figsize=(15,15))

for i in range(len(get_info)):
    ax[i].hist(Ticker[get_info[i]], bins=150, density=True, alpha=0.6)
    mu, sigma= Ticker[get_info[i]].mean(), Ticker[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()
print('Average return:',round(Ticker['Mean'].mean(), 4), 'Average variance:', round(
```



```
Average return: 0.0441 Average variance: 4.9572
```

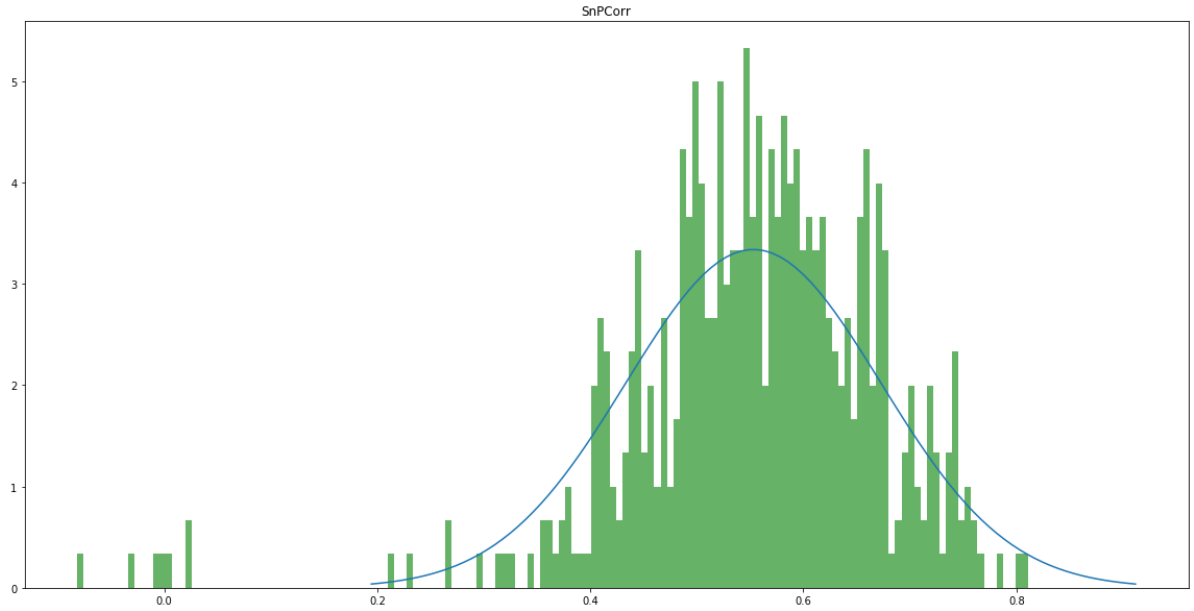
Comment

Returns' distribution is close to the normal gaussian, although observed tails are fatter than implied my normal distribution and skewness is different from zero. Variance and Kurtosis obviously have assymetrical distribution because their values cannot be negative.

Question 2

In [15]:

```
get_info = 'SnPCorr'
plt.figure(figsize=(20,10))
plt.hist(Ticker[get_info], bins=150, density=True, alpha=0.6, color='g')
mu = Ticker[get_info].mean()
sigma = Ticker[get_info].std()
x = np.linspace(mu - 3*sigma, mu + 3*sigma, 100)
plt.plot(x, stats.norm.pdf(x, mu, sigma))
plt.title(get_info)
plt.show()
print('Average correlation:', round(mu, 4))
```




```
Average correlation: 0.553
```

Comment

Nonparametric density estimates resemble normal distribution, however they're skewed to the left and have fat

tails.

Question 3

2001 to 2007

In [16]:

```
start_date_2007, end_2007 = '2001-01-01', '2008-01-01'
SnP_2007 = data.DataReader('^GSPC', 'yahoo', start_date_2007, end_2007)
SnP_2007['Log'] = np.log(SnP_2007['Adj Close'])
Returns_2007 = np.diff(SnP_2007['Log'])*100
Returns_2007 = np.append(0,Returns_2007)
SnP_2007['Returns'] = Returns_2007
```

In [17]:

```
data_2007 = []

for i in tqdm(range(T)):
    try:
        extr_2007 = data.DataReader(Ticker.iloc[i][0], 'yahoo', start_date_2007, enc
    except Exception:
        pass
    else:
        data_row = []
        data_row.append(Ticker.iloc[i][0])
        extr_2007['Log'] = np.log(extr_2007['Adj Close'])
        Returns_2007 = np.diff(extr_2007['Log'])*100
        Returns_2007 = np.append(0,Returns_2007)
        extr_2007['Returns'] = Returns_2007
        analysis_2007  =  stats.describe(extr_2007['Returns'])
        mu, sig2, sk, ku = analysis_2007[2:]
        data_row.append(mu)
        data_row.append(sig2)
        data_row.append(sk)
        data_row.append(ku)
        data_row.append(round((extr_2007['Adj Close'][-1] / extr_2007['Adj Close'][(

        if len(extr_2007['Returns']) == len(SnP_2007['Returns']):
            data_row.append(np.corrcoef(SnP_2007['Returns'],extr_2007['Returns'])[0]
        else:
            data_row.append(np.corrcoef(SnP_2007['Returns'].iloc[len(SnP_2007['Retu
                                        extr_2007['Returns'])[0][1])

        data_2007.append(data_row)

Ticker_2007 = pd.DataFrame(data_2007,
                           columns=['Symbol','Mean','Variance','Skewness','Kurtosis
```

```
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```
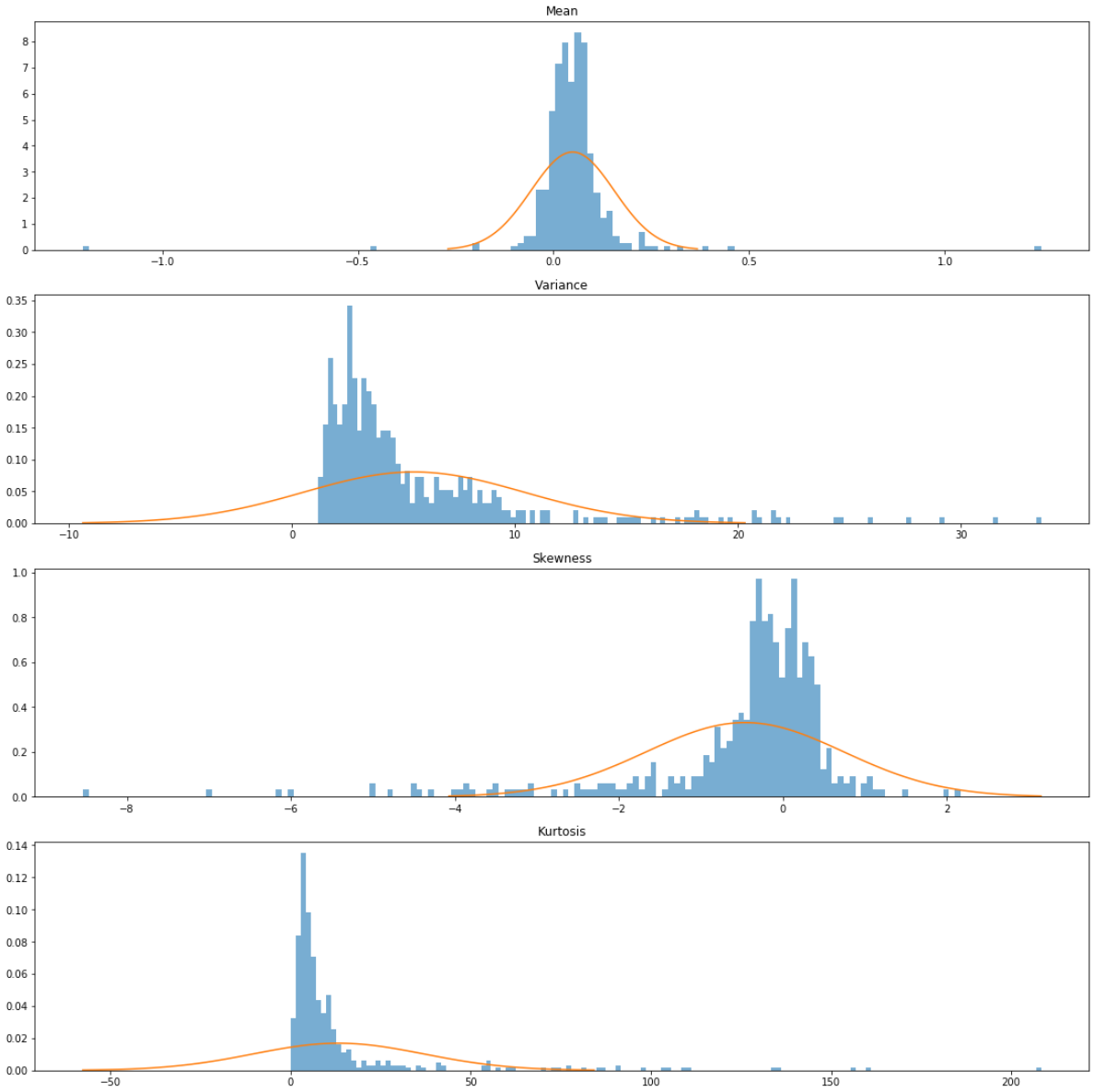

In [18]:

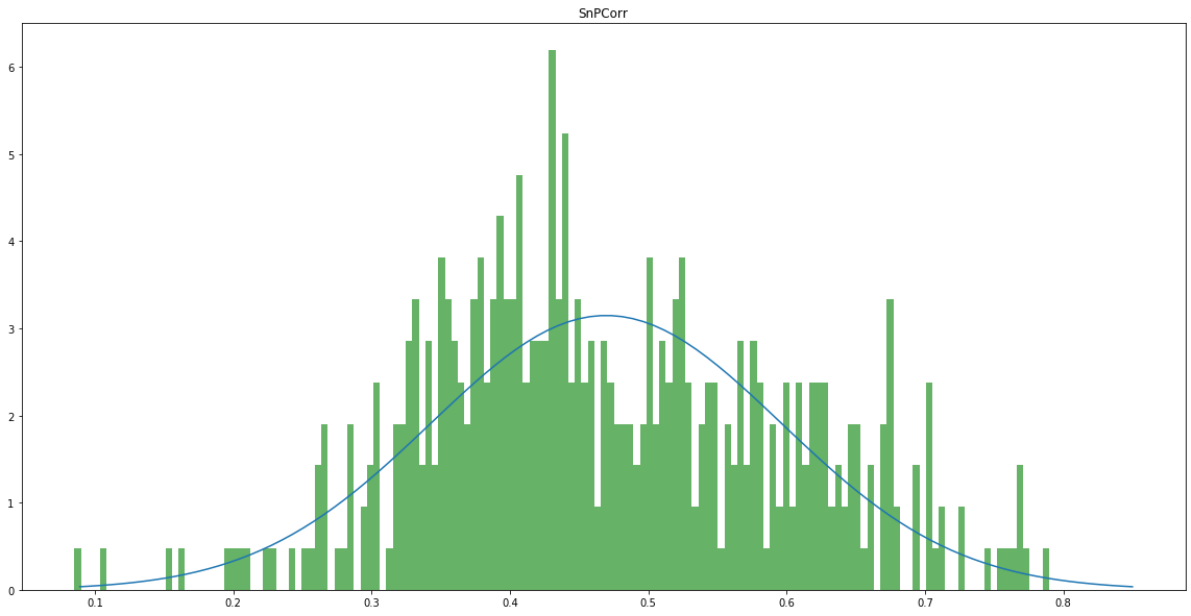
```
get_info = ['Mean', 'Variance', 'Skewness', 'Kurtosis']
fig, ax = plt.subplots(nrows=len(get_info),constrained_layout=True,figsize=(15,15))

for i in range(len(get_info)):
    ax[i].hist(Ticker_2007[get_info[i]], bins=150, density=True, alpha=0.6)
    mu, sigma= Ticker_2007[get_info[i]].mean(), Ticker_2007[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()
print('Average return:',round(Ticker_2007['Mean'].mean(), 4), 'Average variance:', r
```




```
Average return: 0.0487 Average variance: 5.4742
```

In [19]:

```
get_info = 'SnPCorr'
plt.figure(figsize=(20,10))
plt.hist(Ticker_2007[get_info], bins=150, density=True, alpha=0.6, color='g')
mu = Ticker_2007[get_info].mean()
sigma = Ticker_2007[get_info].std()
x = np.linspace(mu - 3*sigma, mu + 3*sigma, 100)
plt.plot(x, stats.norm.pdf(x, mu, sigma))
plt.title(get_info)
plt.show()
print('Average correlation:', round(mu, 4))
```




```
Average correlation: 0.4695
```

Comment

Over the period 2001-2007 average daily return was 4.9% and the average correlation struck at 47%. Returns' distribution is still close to the normal gaussian, although observed tails are fatter than implied my normal distribution and skewness is different from zero. Variance and Kurtosis obviously have assymetrical distribution because their values cannot be negative.

2009 to 2020

In [20]:

```
start_date_2009, end_2009 = '2009-01-01', '2020-01-01'
SnP_2009 = data.DataReader('^GSPC', 'yahoo', start_date_2009, end_2009)
SnP_2009['Log'] = np.log(SnP_2009['Adj Close'])
Returns_2009 = np.diff(SnP_2009['Log'])*100
Returns_2009 = np.append(0,Returns_2009)
SnP_2009['Returns'] = Returns_2009
```

In [21]:

```
data_2009 = []


for i in tqdm(range(T)):
    try:
        extr_2009 = data.DataReader(Ticker.iloc[i][0], 'yahoo', start_date_2009, enc
    except Exception:
        pass
    else:
        data_row = []
        data_row.append(Ticker.iloc[i][0])
        extr_2009['Log'] = np.log(extr_2009['Adj Close'])
        Returns_2009 = np.diff(extr_2009['Log'])*100
        Returns_2009 = np.append(0,Returns_2009)
        extr_2009['Returns'] = Returns_2009
        analysis_2009  =  stats.describe(extr_2009['Returns'])

        mu, sig2, sk, ku = analysis_2009[2:]
        data_row.append(mu)
        data_row.append(sig2)
        data_row.append(sk)
        data_row.append(ku)
        data_row.append(round((extr_2009['Adj Close'][-1] / extr_2009['Adj Close'][(

        if len(extr_2009['Returns']) == len(SnP_2009['Returns']):
            data_row.append(np.corrcoef(SnP_2009['Returns'],extr_2009['Returns'])[0]
        else:
            data_row.append(np.corrcoef(SnP_2009['Returns'].iloc[len(SnP_2009['Retur
                                        extr_2009['Returns'])[0][1])

        data_2009.append(data_row)

Ticker_2009 = pd.DataFrame(data_2009,
                           columns=['Symbol','Mean','Variance','Skewness','Kurtosis
```

```
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```
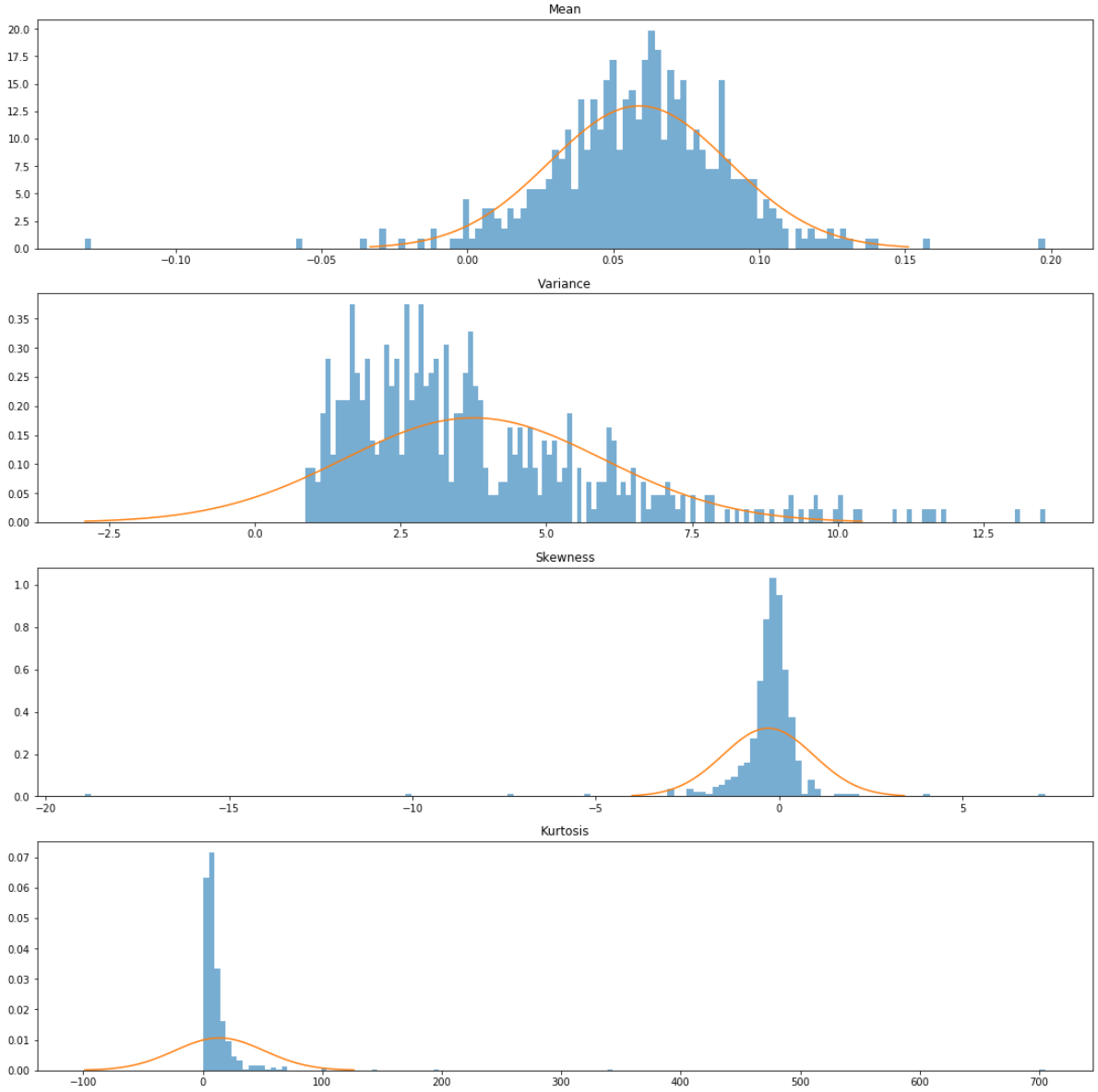

In [22]:

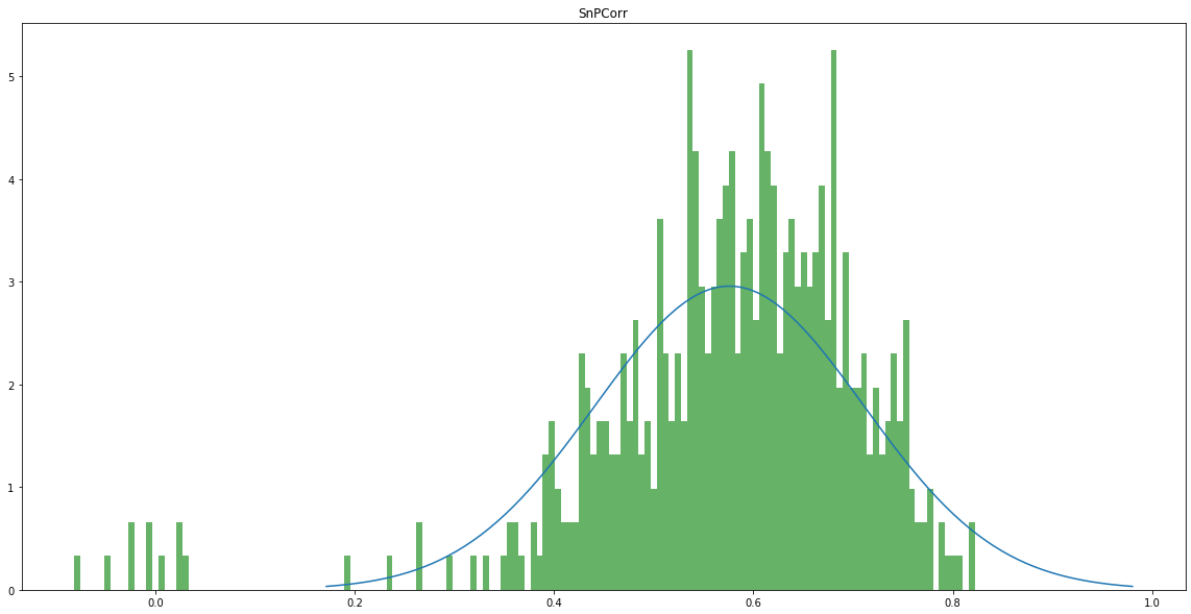
```
get_info = ['Mean', 'Variance', 'Skewness', 'Kurtosis']
fig, ax = plt.subplots(nrows=len(get_info),constrained_layout=True,figsize=(15,15))

for i in range(len(get_info)):
    ax[i].hist(Ticker_2009[get_info[i]], bins=150, density=True, alpha=0.6)
    mu, sigma= Ticker_2009[get_info[i]].mean(), Ticker_2009[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()
print('Average return:', round(Ticker_2009['Mean'].mean(), 4), 'Average variance:',
```



```
Average return: 0.0589 Average variance: 3.7515
```

In [23]:

```
get_info = 'SnPCorr'
plt.figure(figsize=(20,10))
plt.hist(Ticker_2009[get_info], bins=150, density=True, alpha=0.6, color='g')
mu = Ticker_2009[get_info].mean()
sigma = Ticker_2009[get_info].std()
x = np.linspace(mu - 3*sigma, mu + 3*sigma, 100)
plt.plot(x, stats.norm.pdf(x, mu, sigma))
plt.title(get_info)
plt.show()
print('Average correlation:', round(mu, 4))
```




```
Average correlation: 0.5759
```

Comment

Over the period 2009-2020 average daily return was 5.9% and the average correlation soared to 57 mainly due to the rise in ETFs. Returns' distribution now is even closer to the normal gaussian, although observed tails are fatter than implied my normal distribution and skewness is different from zero. Variance and Kurtosis obviously have assymetrical distribution because their values cannot be negative.

Question 4

In [24]:

```
col_to_compare = ['Mean','Variance','Skewness','Kurtosis','Annual Returns','SnPCorr
kolmogorov_list = []

for colname in col_to_compare:
    ks_row = []
    ks_row.append(ks_2samp(Ticker_2009[colname], Ticker_2007[colname])[0])
    ks_row.append(ks_2samp(Ticker_2009[colname], Ticker_2007[colname])[1])
    kolmogorov_list.append(ks_row)
```

In [25]:

```
pd.DataFrame(kolmogorov_list, index = col_to_compare, columns = ['KS-statistics', 'K
```

Out[25]:

	KS-statistics	KS p-value
Mean	0.240415	1.574074e-12
Variance	0.157308	1.339932e-05
Skewness	0.084781	6.130726e-02
Kurtosis	0.164002	4.770155e-06
Annual Returns	0.419324	0.000000e+00
SnPCorr	0.414304	0.000000e+00

Comment

Considering that p-values are all less than 1%, we can safely reject the null hypothesis and assume that the distributions of the returns, moments and SnP correlations have been affected by the financial crysis.

Question 5

In [26]:

```
lll, mul, sig2l, skl, kul, corrsnp = [], [], [], [], [], []
start_date, end = '2019-01-01', '2020-01-01'
T = Ticker.shape[0]

SnP = data.DataReader('^GSPC', 'yahoo', start_date, end)
SnP['Log'] = np.log(SnP['Adj Close'])
Returns = np.diff(SnP['Log'])*100
Returns = np.append(0,Returns)
SnP['Returns'] = Returns

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'])*100
    Returns = np.append(0,Returns)
    extr['Returns'] = Returns
    analysis  =  stats.describe(extr['Returns'])
    if len(extr['Returns']) == len(SnP['Returns']):
        corrsnp.append(np.corrcoef(SnP['Returns'],extr['Returns'])[0][1])
    else:
        corrsnp.append(np.corrcoef(SnP['Returns'].iloc[len(SnP['Returns'])-len(extr|
    lll.append(round((extr['Adj Close'][-1] / extr['Adj Close'][0] - 1) * 100, 2))
    mu, sig2, sk, ku = analysis[2:]
    mul.append(mu)
    sig2l.append(sig2)
    skl.append(sk)
    kul.append(ku)

Ticker['Mean'] = mul
Ticker['Variance'] = sig2l
Ticker['Skewness'] = skl
Ticker['Kurtosis'] = kul
Ticker['Annual Returns'] = lll
Ticker['SnPCorr'] = corrsnp

print('\n S&P 500 Return: ')
print(round((SnP['Adj Close'][-1] / SnP['Adj Close'][0] - 1) * 100, 2))
print('Top 10 Companies:')
print(Ticker.sort_values(by=['Annual Returns'], ascending=False).head(10)[['Symbol'/
print('\nBottom 10 Stocks:')
print(Ticker.sort_values(by=['Annual Returns'], ascending=False).tail(10)[['Symbol'/
```

```
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```

```
 S&P 500 Return:
28.71
Top 10 Companies:
```