Data Bootcamp Section 002 Final Project

Professor Zweig

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Data:

https://fred.stlouisfed.org/series/DTWEXAFEGS (https://fred.stlouisfed.org/series/DTWEXAFEGS)
https://fred.stlouisfed.org/series/DTWEXEMEGS (https://fred.stlouisfed.org/series/DTWEXEMEGS)
https://fred.stlouisfed.org/series/DEXCHUS (https://fred.stlouisfed.org/series/DEXCHUS)
https://www.kaggle.com/cristiangarrido/covid19geographicdistributionworldwide?select=Countries_ISO.csv
(https://www.kaggle.com/cristiangarrido/covid19geographicdistributionworldwide?select=Countries_ISO.csv)
https://www.kaggle.com/fireballbyedimyrnmom/us-counties-covid-19-dataset
(https://www.kaggle.com/fireballbyedimyrnmom/us-counties-covid-19-dataset)
https://www.kaggle.com/aayushmishra1512/faang-complete-stock-data
(https://www.kaggle.com/aayushmishra1512/faang-complete-stock-data)

In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import datetime as dt
import seaborn as sns
from numpy.polynomial.polynomial import polyfit
import matplotlib.gridspec as gridspec
import numpy as np
import matplotlib as mpl
mpl.rcParams.update(mpl.rcParamsDefault)
import math
import os
import requests, io
import zipfile as zf
import shutil
import statsmodels.formula.api as smf
import matplotlib.ticker as mtick
from sklearn.neighbors import KNeighborsRegressor as knn
from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_val_score
from sklearn.linear_model import LinearRegression as linreg
from scipy.stats import kde
import matplotlib.dates as mdates
from sklearn.preprocessing import MinMaxScaler
import plotly.graph_objects as go

%matplotlib inline
```

In [ ]:
```
```

In [2]:
```
path_world_covid = '/Users/jarrodhoran/Downloads/COVID-19-geographic-disbtribution-worldwide.csv'
world_covid = pd.read_csv(path_world_covid)
world_covid['dateRep'] = pd.to_datetime(world_covid['dateRep'])
world_covid
```

Out[2]:

	dateRep	day	month	year	cases	deaths	countriesAndTerritories	geoId	countryterritory
0	2020-10-27	27	10	2020	199	8	Afghanistan	AF	
1	2020-10-26	26	10	2020	65	3	Afghanistan	AF	
2	2020-10-25	25	10	2020	81	4	Afghanistan	AF	
3	2020-10-24	24	10	2020	61	2	Afghanistan	AF	
4	2020-10-23	23	10	2020	116	4	Afghanistan	AF	
...	...	...	...	...	...	...	...	...	
51678	2020-03-25	25	3	2020	0	0	Zimbabwe	ZW	
51679	2020-03-24	24	3	2020	0	1	Zimbabwe	ZW	
51680	2020-03-23	23	3	2020	0	0	Zimbabwe	ZW	
51681	2020-03-22	22	3	2020	1	0	Zimbabwe	ZW	
51682	2020-03-21	21	3	2020	1	0	Zimbabwe	ZW	

51683 rows × 12 columns

In [3]:
```
world_covid['geoId'].nunique()
world_covid['countriesAndTerritories'].nunique()
```

Out[3]: 212

In [4]:
```
#drop the countries that aren't in world COVID
path_country_coordinate = '/Users/jarrodhoran/Downloads/countries.csv'
country_coord = pd.read_csv(path_country_coordinate)
#country_coord
```

In [5]:
```
path_us_counties = '/Users/jarrodhoran/Downloads/us-counties.csv'
us_counties = pd.read_csv(path_us_counties)
us_counties['date'] = pd.to_datetime(us_counties['date'])
#us_counties
```

In [6]:
```
path_netflix = '/Users/jarrodhoran/Downloads/Netflix.csv'
netflix = pd.read_csv(path_netflix).tail(365)
netflix['Date'] = pd.to_datetime(netflix['Date'])
netflix = netflix[netflix['Date'].dt.year == 2020]
#pd.reset_option('display.max_rows', None)
#pd.set_option('display.max_rows', None)
#netflix
```

In [7]:
```
path_amazon = '/Users/jarrodhoran/Downloads/Amazon.csv'
amazon = pd.read_csv(path_amazon).tail(365)
amazon['Date'] = pd.to_datetime(amazon['Date'])
amazon = amazon[amazon['Date'].dt.year == 2020]
#pd.reset_option('display.max_rows', None)
#amazon
```

In [8]:
```
path_google = '/Users/jarrodhoran/Downloads/Google.csv'
google = pd.read_csv(path_google).tail(365)
google['Date'] = pd.to_datetime(google['Date'])
google = google[google['Date'].dt.year == 2020]
#pd.reset_option('display.max_rows', None)
#google
```

In [9]:
```
path_apple = '/Users/jarrodhoran/Downloads/Apple.csv'
apple = pd.read_csv(path_apple).tail(365)
apple['Date'] = pd.to_datetime(apple['Date'])
apple = apple[apple['Date'].dt.year == 2020]
#pd.reset_option('display.max_rows', None)
#apple
```

In [10]:
```
path_facebook = '/Users/jarrodhoran/Downloads/Facebook.csv'
facebook = pd.read_csv(path_facebook).tail(365)
facebook = facebook
facebook['Date'] = pd.to_datetime(facebook['Date'])
facebook = facebook[facebook['Date'].dt.year == 2020]
#pd.reset_option('display.max_rows', None)
#facebook
```

In [11]:
```
path_usd_adv_econ = '/Users/jarrodhoran/Downloads/DTWEXAFEGS.csv'
usd_adv_econ = pd.read_csv(path_usd_adv_econ)
usd_adv_econ['DATE'] = pd.to_datetime(usd_adv_econ['DATE'])
usd_adv_econ = usd_adv_econ[usd_adv_econ['DATE'].dt.year == 2020]
#pd.reset_option('display.max_rows', None)
#usd_adv_econ
```

In [12]:
```
path_usd_em_econ = '/Users/jarrodhoran/Downloads/DTWEXEMEGS.csv'
usd_em_econ = pd.read_csv(path_usd_em_econ)
usd_em_econ['DATE'] = pd.to_datetime(usd_em_econ['DATE'])
usd_em_econ = usd_em_econ[usd_em_econ['DATE'].dt.year == 2020]
#usd_em_econ
```

In [13]:
```
path_usd_rmb = '/Users/jarrodhoran/Downloads/DEXCHUS.csv'
usd_rmb = pd.read_csv(path_usd_rmb)
usd_rmb['DATE'] = pd.to_datetime(usd_rmb['DATE'])
usd_rmb = usd_rmb[usd_rmb['DATE'].dt.year == 2020]
#usd_rmb
```

How to does the FAANGs growth rate react to COVID from April - July?

In [14]:
```
# merge stocks
netflix2 = netflix.drop(columns = ['Open','High','Low','Adj Close','Volum
e'])
netflix2 = netflix2.rename(columns={"Close": "Close_Netflix"})
google2 = google.drop(columns = ['Open','High','Low','Adj Close','Volume'
])
google2 = google2.rename(columns={"Close": "Close_Google"})
amazon2 = amazon.drop(columns = ['Open','High','Low','Adj Close','Volume'
])
amazon2 = amazon2.rename(columns={"Close": "Close_Amazon"})
apple2 = apple.drop(columns = ['Open','High','Low','Adj Close','Volume'])
apple2 = apple2.rename(columns={"Close": "Close_Apple"})
facebook2 = facebook.drop(columns = ['Open','High','Low','Adj Close','Vol
ume'])
facebook2 = facebook2.rename(columns={"Close": "Close_FB"})

faangs = facebook2.merge(apple2, on = 'Date', how = 'left')
faangs = faangs.merge(amazon2, on = 'Date', how = 'left')
faangs = faangs.merge(google2, on = 'Date', how = 'left')
faangs = faangs.merge(netflix2, on = 'Date', how = 'left')
faangs['Date'] = faangs['Date'].dt.strftime('%Y-%m-%d')


faangs.drop([147,148,149,150,151,152,153,154,155,156,157,158], inplace =
True)
#faangs
```

In [15]:
```
faangs['Month'] = faangs.Date.str[6:7]

#April

faangs_april = faangs.loc[faangs['Month'] == '4']

faangs_april['Day_Close'] = (faangs_april['Close_FB'] + faangs_april['Clo
se_Apple'] +
                             faangs_april['Close_Amazon'] + faangs_april[
'Close_Google'] +
                             faangs_april['Close_Netflix'])

faangs_april['Date'] = pd.to_datetime(faangs_april['Date'])

f4_piv = faangs_april.pivot_table(index = 'Date',columns = 'Month',values
= 'Day_Close', aggfunc = 'sum')
f4_piv = f4_piv.pct_change()
f4_piv

#May

faangs_may = faangs.loc[faangs['Month'] == '5']
```

```
faangs_may['Day_Close'] = (faangs_may['Close_FB'] + faangs_may['Close_App
le'] +
                           faangs_may['Close_Amazon'] + faangs_may['Close
_Google'] +
                           faangs_may['Close_Netflix'])

faangs_may['Date'] = pd.to_datetime(faangs_may['Date'])

f5_piv = faangs_may.pivot_table(index = 'Date',columns = 'Month',values =
'Day_Close', aggfunc = 'sum')
f5_piv = f5_piv.pct_change()
#f5_piv

#June

faangs_june = faangs.loc[faangs['Month'] == '6']

faangs_june['Day_Close'] = (faangs_june['Close_FB'] + faangs_june['Close_
Apple'] +
                           faangs_june['Close_Amazon'] + faangs_june['Clo
se_Google'] +
                           faangs_june['Close_Netflix'])

faangs_june['Date'] = pd.to_datetime(faangs_june['Date'])

f6_piv = faangs_june.pivot_table(index = 'Date',columns = 'Month',values
= 'Day_Close', aggfunc = 'sum')
f6_piv = f6_piv.pct_change()
#f6_piv

#July

faangs_july = faangs.loc[faangs['Month'] == '7']

faangs_july['Day_Close'] = (faangs_july['Close_FB'] + faangs_july['Close_
Apple'] +
                           faangs_july['Close_Amazon'] + faangs_july['Clo
se_Google'] +
                           faangs_july['Close_Netflix'])

faangs_july['Date'] = pd.to_datetime(faangs_july['Date'])

f7_piv = faangs_july.pivot_table(index = 'Date',columns = 'Month',values
= 'Day_Close', aggfunc = 'sum')
f7_piv = f7_piv.pct_change()
#f7_piv
```

```
/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:9: Set
tingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead
```

```
See the caveats in the documentation: http://pandas.pydata.org/pandas-d
ocs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  if __name__ == '__main__':
/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:11: Se
ttingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-d
ocs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  # This is added back by InteractiveShellApp.init_path()
/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:23: Se
ttingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-d
ocs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:25: Se
ttingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-d
ocs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:37: Se
ttingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-d
ocs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:39: Se
ttingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-d
ocs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:51: Se
ttingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-d
ocs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:53: Se
ttingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-d
```

```
ocs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

In [16]:
```
#f6_piv = f6_piv.reset_index()
#f6_piv.dtypes
#f6_piv.ix[index.to_datetime()]
f6_piv.index
```

Out[16]:
```
DatetimeIndex(['2020-06-01', '2020-06-02', '2020-06-03', '2020-06-04',
               '2020-06-05', '2020-06-08', '2020-06-09', '2020-06-10',
               '2020-06-11', '2020-06-12', '2020-06-15', '2020-06-16',
               '2020-06-17', '2020-06-18', '2020-06-19', '2020-06-22',
               '2020-06-23', '2020-06-24', '2020-06-25', '2020-06-26',
               '2020-06-29', '2020-06-30'],
              dtype='datetime64[ns]', name='Date', freq=None)
```

In [17]:
```
#fig, ax = plt.subplots()
#ax.axhline(june_mean, color = 'red',linestyle = 'dashed')
#f6_piv.plot.line(ax = ax,x = 'Date', y = '6')
```

In [18]:
```
country_coord = country_coord.rename(columns={"country": "geoId"})
#country_coord
```

In [19]:
```
covid_location = world_covid.merge(country_coord, on = 'geoId', how = 'le
ft', indicator = True)
covid_location = covid_location[covid_location['_merge']=='both']

covid_location = covid_location.drop(columns = ['day','year',
                                    'popData2019','name','Cumulative_number_fo
r_14_days_of_COVID-19_cases_per_100000'])

covid_location = covid_location.rename(columns={"dateRep": "Date","contin
entExp":"Continent",
                                                 "countriesAndTerritories"
:"Country","latitude":"Latitude",
                                                "longitude":"Longitude","c
ases":"New Cases",
                                                'deaths':"Deaths"})

covid_location['month'] = covid_location['month'].astype(str)
covid_location = covid_location.loc[(covid_location['month'].str.contains
('4|5|6|7|8') == True),:]

covid_location = covid_location.groupby(['month','Date','Country',
                                         'Continent','Latitude','Longitud
e','countryterritoryCode'], as_index = False)[['New Cases', 'Deaths']].su
m()
covid_location.loc[covid_location['Country'] == 'Afghanistan',:]
covid_location['month'] = covid_location['month'].astype(int)

covid_april = covid_location.loc[covid_location['month'] == 4]
covid_april = covid_april.groupby(['Country','Latitude','Longitude','Cont
inent','month','countryterritoryCode'], as_index = False)[['New Cases', '
Deaths']].sum()

covid_may = covid_location.loc[covid_location['month'] == 5]
covid_may = covid_may.groupby(['Country','Latitude','Longitude','Continen
t','month','countryterritoryCode'], as_index = False)[['New Cases', 'Deat
hs']].sum()

covid_june = covid_location.loc[covid_location['month'] == 6]
covid_june = covid_june.groupby(['Country','Latitude','Longitude','Contin
ent','month','countryterritoryCode'], as_index = False)[['New Cases', 'De
aths']].sum()

covid_july = covid_location.loc[covid_location['month'] == 7]
covid_july = covid_july.groupby(['Country','Latitude','Longitude','Contin
ent','month','countryterritoryCode'], as_index = False)[['New Cases', 'De
aths']].sum()
```

In [20]:
```
covid_july
```

Out[20]:

	Country	Latitude	Longitude	Continent	month	countryterritoryCode	New Cases	Deat
0	Afghanistan	33.939110	67.709953	Asia	7	AFG	5304	5
1	Albania	41.153332	20.168331	Europe	7	ALB	2731	
2	Algeria	28.033886	1.659626	Africa	7	DZA	16260	2
3	Andorra	42.546245	1.601554	Europe	7	AND	67	
4	Angola	-11.202692	17.873887	Africa	7	AGO	802	
...	...	...	...	...	...	...	...	
198	Vietnam	14.058324	108.277199	Asia	7	VNM	154	
199	Western_Sahara	24.215527	-12.885834	Africa	7	ESH	558	
200	Yemen	15.552727	48.516388	Asia	7	YEM	598	1
201	Zambia	-13.133897	27.849332	Africa	7	ZMB	3987	1
202	Zimbabwe	-19.015438	29.154857	Africa	7	ZWE	2518	

203 rows × 8 columns

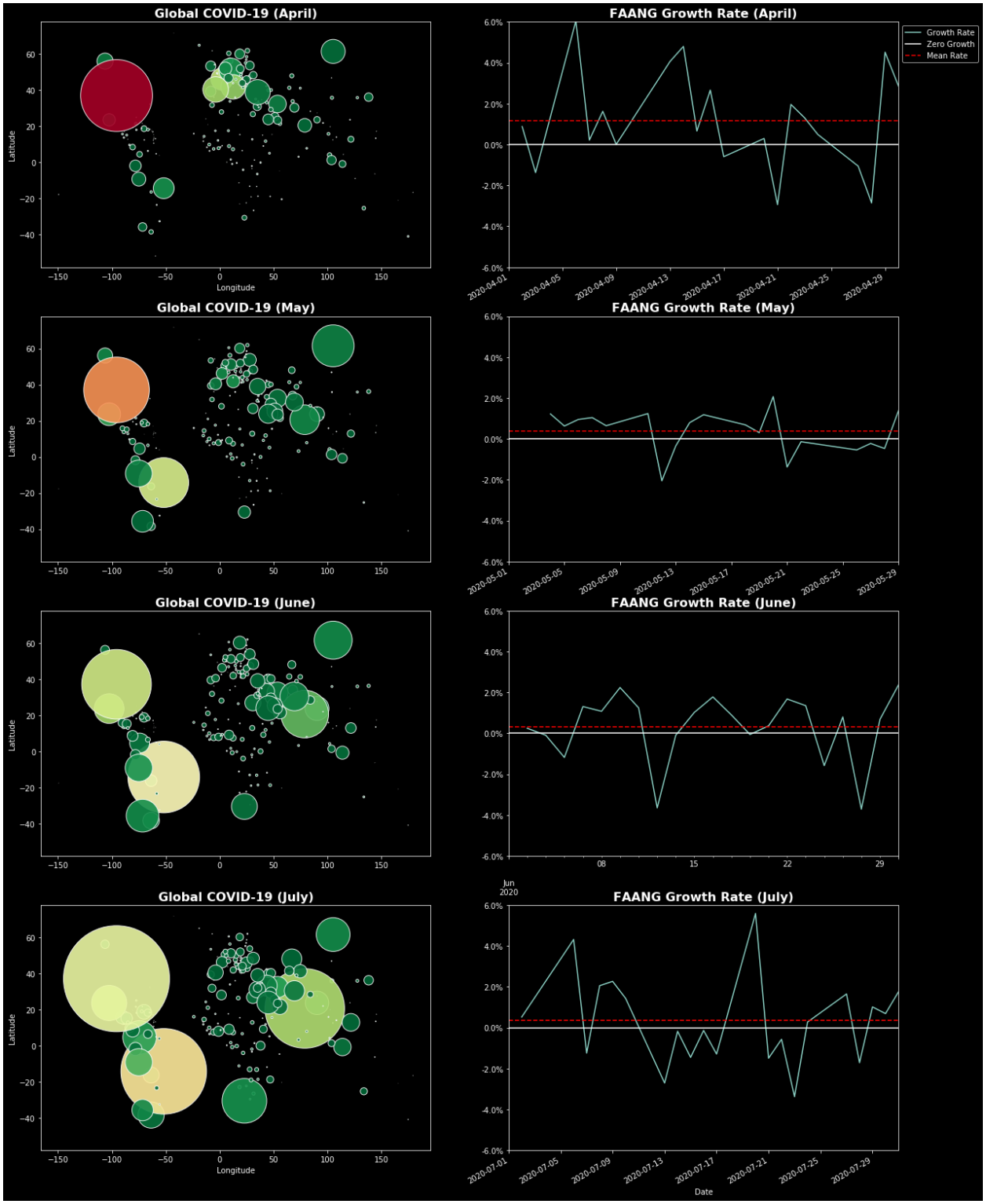
In [21]:
```
world_covid = world_covid.rename(columns={"dateRep": "Date"})
```

In [22]:
```
cmap = mpl.cm.RdYlGn
reversed_cmap = cmap.reversed()
n = mpl.colors.Normalize()
plt.style.use('dark_background')
```

In [23]:
```
fig, ax = plt.subplots(ncols = 2,nrows = 4)
plt.subplots_adjust(bottom = .7)

#APRIL

covid_april.plot.scatter(ax = ax[0,0],figsize=(20,30), y='Latitude',x='Lo
ngitude',s=covid_april['New Cases'] * .01,
                         color=reversed_cmap(n(covid_april['Deaths'].valu
es * 2500)),
                        edgecolors = 'white',alpha = .9)
ax[0,0].set_title("Global COVID-19 (April)", fontsize = 16, fontweight =
'bold')

f4_piv.plot.line(ax = ax[0,1])

ax[0,1].axhline(0, color = 'white')
april_mean = f4_piv['4'].mean()
ax[0,1].axhline(april_mean, color = 'red',linestyle = 'dashed')
```

```
ax[0,1].legend(bbox_to_anchor = (1, 1), labels = ['Growth Rate','Zero Gro
wth','Mean Rate'])
ax[0,1].set_title("FAANG Growth Rate (April)", fontsize = 16, fontweight
= 'bold')
ax[0,1].set_ylim(-.06, .06)
ax[0,1].set_xlabel(xlabel = '')
ax[0,1].yaxis.set_major_formatter(mtick.PercentFormatter(1.0))


#MAY

covid_may.plot.scatter(ax = ax[1,0], y='Latitude',x='Longitude',s=covid_m
ay['New Cases'] * .01,
                           color=reversed_cmap(n(covid_may['Deaths'].values
* 2500)),
                          edgecolors = 'white',alpha = .9)
ax[1,0].set_title("Global COVID-19 (May)", fontsize = 16, fontweight = 'b
old')
ax[1,0].set_xlabel(xlabel = '')

f5_piv.plot.line(ax = ax[1,1])

ax[1,1].axhline(0, color = 'white')
may_mean = f5_piv['5'].mean()
ax[1,1].axhline(may_mean, color = 'red',linestyle = 'dashed')
ax[1,1].legend().remove()
ax[1,1].set_title("FAANG Growth Rate (May)", fontsize = 16, fontweight =
'bold')
ax[1,1].set_ylim(-.06, .06)
ax[1,1].set_xlabel(xlabel = '')
ax[1,1].yaxis.set_major_formatter(mtick.PercentFormatter(1.0))

#JUNE

covid_june.plot.scatter(ax = ax[2,0], y='Latitude',x='Longitude',s=covid_
june['New Cases'] * .01,
                           color=reversed_cmap(n(covid_june['Deaths'].value
s * 2500)),
                          edgecolors = 'white',alpha = .9)
ax[2,0].set_title("Global COVID-19 (June)", fontsize = 16, fontweight = '
bold')
ax[2,0].set_xlabel(xlabel = '')

f6_piv.plot.line(ax = ax[2,1])
ax[2,1].set_title("FAANG Growth Rate (June)", fontsize = 16, fontweight =
'bold')
ax[2,1].axhline(0, color = 'white')
june_mean = f6_piv['6'].mean()
ax[2,1].axhline(june_mean, color = 'red',linestyle = 'dashed')

ax[2,1].legend().remove()
```

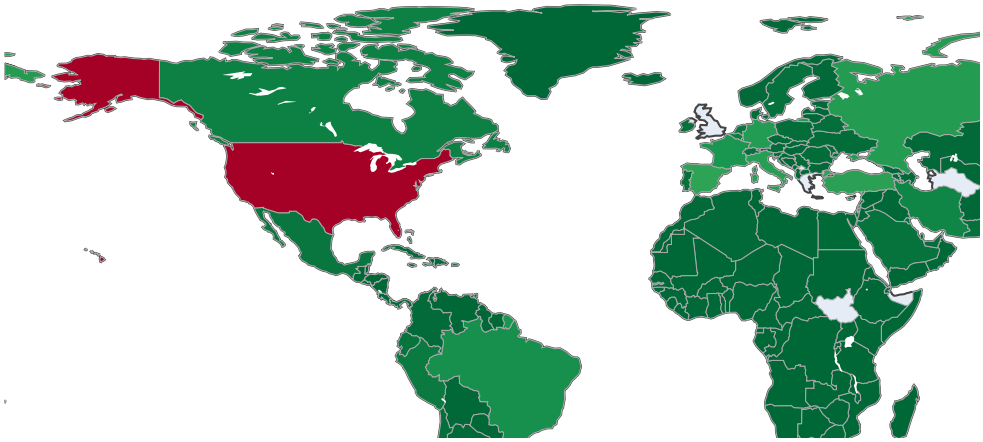
```
ax[2,1].legend().remove()
ax[2,1].set_ylim(-.06, .06)
ax[2,1].set_xlabel(xlabel = '')
ax[2,1].yaxis.set_major_formatter(mtick.PercentFormatter(1.0))



#JULY

covid_july.plot.scatter(ax = ax[3,0], y='Latitude',x='Longitude',s=covid_
july['New Cases'] * .01,
                        color=reversed_cmap(n(covid_july['Deaths'].value
s * 2500)),
                       edgecolors = 'white',alpha = .9)
ax[3,0].set_title("Global COVID-19 (July)", fontsize = 16, fontweight = '
bold')

f7_piv.plot.line(ax = ax[3,1])
ax[3,1].axhline(0, color = 'white')
july_mean = f7_piv['7'].mean()
ax[3,1].axhline(july_mean, color = 'red',linestyle = 'dashed')
ax[3,1].legend().remove()
ax[3,1].set_title("FAANG Growth Rate (July)", fontsize = 16, fontweight =
'bold')
ax[3,1].set_ylim(-.06, .06)
ax[3,1].yaxis.set_major_formatter(mtick.PercentFormatter(1.0))
plt.savefig('Covid_stocks.png')
```



Graphs are interactive charts visualizing new cases per country, similar to the scatter plots above.

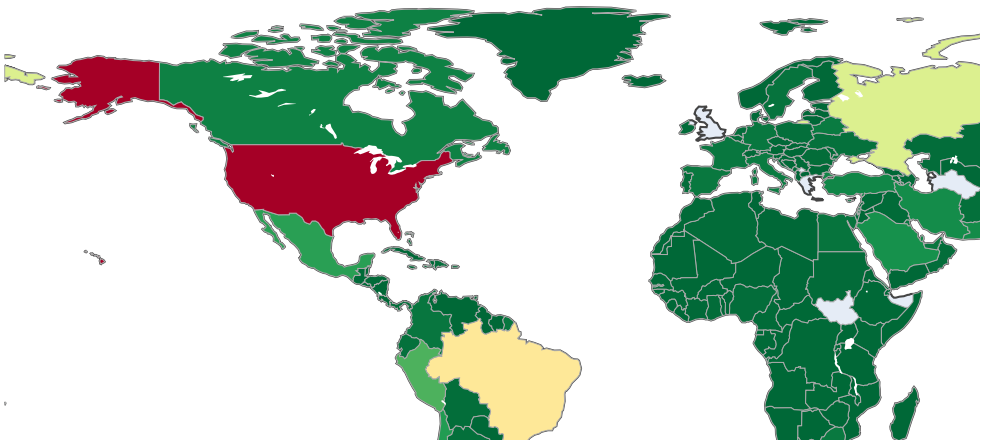
In [24]:
```
fig_a = go.Figure(data=go.Choropleth(
    locations = covid_april['countryterritoryCode'],
    z = covid_april['New Cases'],
    text = covid_april['Country'],
    colorscale = 'RdYlGn',
    autocolorscale=False,
    reversescale=True,
    marker_line_color='darkgray',
    marker_line_width=0.5,
    colorbar_title = 'New Cases',))
fig_a.update_layout(
    title_text='April COVID Cases',
    geo=dict(
        showframe=False,
        showcoastlines=True,
        projection_type='equirectangular'
    ),
    annotations = [dict(
        x=0.55,
        y=0.1,
        xref='paper',
        yref='paper',
        text='Source: Kaggle',
        showarrow = False
    )]
)
```

April COVID Cases



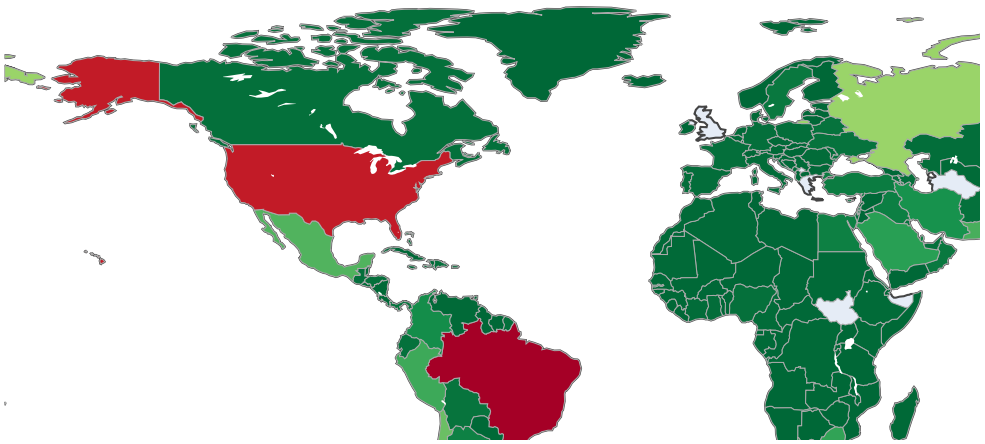
In [25]:
```
fig_m = go.Figure(data=go.Choropleth(
    locations = covid_may['countryterritoryCode'],
    z = covid_may['New Cases'],
    text = covid_may['Country'],
    colorscale = 'RdYlGn',
    autocolorscale=False,
    reversescale=True,
    marker_line_color='darkgray',
    marker_line_width=0.5,
    colorbar_title = 'New Cases',))
fig_m.update_layout(
    title_text='May COVID Cases',
    geo=dict(
        showframe=False,
        showcoastlines=True,
        projection_type='equirectangular'
    ),
    annotations = [dict(
        x=0.55,
        y=0.1,
        xref='paper',
        yref='paper',
        text='Source: Kaggle',
        showarrow = False
    )]
)
```

May COVID Cases



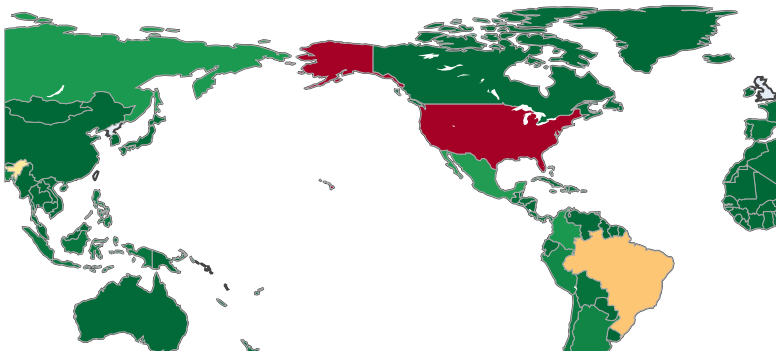
In [26]:
```
fig_june = go.Figure(data=go.Choropleth(
    locations = covid_june['countryterritoryCode'],
    z = covid_june['New Cases'],
    text = covid_june['Country'],
    colorscale = 'RdYlGn',
    autocolorscale=False,
    reversescale=True,
    marker_line_color='darkgray',
    marker_line_width=0.5,
    colorbar_title = 'New Cases',))
fig_june.update_layout(
    title_text='June COVID Cases',
    geo=dict(
        showframe=False,
        showcoastlines=True,
        projection_type='equirectangular'
    ),
    annotations = [dict(
        x=0.55,
        y=0.1,
        xref='paper',
        yref='paper',
        text='Source: Kaggle',
        showarrow = False
    )]
)
```

June COVID Cases



In [27]:
```
fig_july = go.Figure(data=go.Choropleth(
    locations = covid_july['countryterritoryCode'],
    z = covid_july['New Cases'],
    text = covid_july['Country'],
    colorscale = 'RdYlGn',
    autocolorscale=False,
    reversescale=True,
    marker_line_color='darkgray',
    marker_line_width=0.5,
    colorbar_title = 'New Cases',
))
fig_july.update_layout(
    title_text='July COVID Cases',
    geo=dict(
        showframe=False,
        showcoastlines=True,
        projection_type='equirectangular'
    ),
    annotations = [dict(
        x=0.55,
        y=0.1,
        xref='paper',
        yref='paper',
        text='Source: Kaggle',
        showarrow = False
    )]
)
```

July COVID Cases



In [ ]:

In [ ]:

Analysis

The column one scatter plots visualize the relationship between the number of new COVID-19 cases (size of bubble) and the number of COVID-19 related deaths (color of bubble) per country from April to July. Smaller and green bubbles are indicative of fewer new cases and deaths, whereas larger and red bubbles are the opposite. The general trends by continent are as follows:

-In North America the United States experiences a decrease in monthly deaths and cases from April to June. However, in July, the resurgence of new cases in America reaches new heights. Canada sees a general of decreasing cases with consistently low fatalities. In Mexico the graphs indicate an increase in both cases and deaths.
-In South America, Brazil is the serious case of the trend, which is increasing new cases and deaths. Brazil's situation can be considered a result of the lack of lockdown measures.
-Europe undergoes a decrease in both new cases and deaths during the summer months. Likely a result of strict lockdown measures utilized during the first wave of COVID. Russia is an exception and experiences higher levels of new cases.
-Africa does see an increase in cases, especially in South Africa. However, there does not appear to be a substantial increase in COVID-19 related deaths.
-Both Australia and New Zealand retain both low case growth and fatalities.
-In Asia there is a contrast between East Asia and India/Middle East. East Asian countries have near miniscule new cases and deaths, with exception to Japan, which experienced case growth in July. However, the Middle East and India are the opposite, experiencing both an increase in new cases and deaths throughout the summer. India is the most notable as it appears to have the largest case and death increase in Asia. There is also an increase in new cases in South East Asia countries: Indonesia and the Philippines.

Column two line charts depict the aggregated growth rate of FAANG stocks in the aforementioned time period. The dashed, red line represents the mean growth rate for that month. In April the FAANG growth rate was larger, slightly higher than 1%, however from May-July that rate was depressed and near zero growth (~.3%)

What is surprising is the FAANG growth rate was higher when the United States' death count was its worst and started to decrease as deaths decreased, but cases rose. Potentially due to stock speculation.

Given that East Asian and European cases are low/decreasing there does not seem to be much of a visual relationship between these continents and the FAANG growth rate. In fact when the new cases were at the highest level in the United States in July, the FAANG growth rate had slightly increased from .32% in June to .35% in July.

Monthly FAANG growth rates are below:

April FAANG Rate: 1.18%
May FAANG Rate: 0.37%
June FAANG Rate: 0.32%
July FAANG Rate: 0.35%

In [28]:
```
#print("April FAANG Rate: {:.2%}".format(april_mean))
#print("May FAANG Rate: {:.2%}".format(may_mean))
#print("June FAANG Rate: {:.2%}".format(june_mean))
#print("July FAANG Rate: {:.2%}".format(july_mean))
```

What interactions can we see between U.S. COVID and the USD relative to AFE and EM economies?

In [29]:
```
#us_counties
```

In [30]:
```
#usd_em_econ
```

In [31]:
```
usd_afe = usd_adv_econ[usd_adv_econ['DATE'].dt.date.astype(str) >= '2020-01-21']
#usd_afe
```

In [32]:
```
usd_em = usd_em_econ[usd_em_econ['DATE'].dt.date.astype(str) >= '2020-01-21']
#usd_em
```

In [33]:
```
us_covid = us_counties[us_counties['date'].dt.date.astype(str) <= '2020-11-06']
us_covid = us_covid.drop(columns = ['fips'], axis = 1)
us_covid = us_covid.set_index(['date'])
us_covid = us_covid.rename(columns={"date":"Date","state":"State","cases": "Cases","deaths":"Deaths"})
#us_covid = us_covid.iloc[::,:]

#us_covid = us_covid.groupby(['Date','State'])['Cases','Deaths'].sum()
us_covid = us_covid.groupby([(us_covid.index.month)]).sum()
#piv = us_covid.pivot_table(index = 'date',columns = 'State', values = 'Cases', aggfunc = 'sum')
#piv.pct_change()
```

In [34]:
```
#us_covid
```

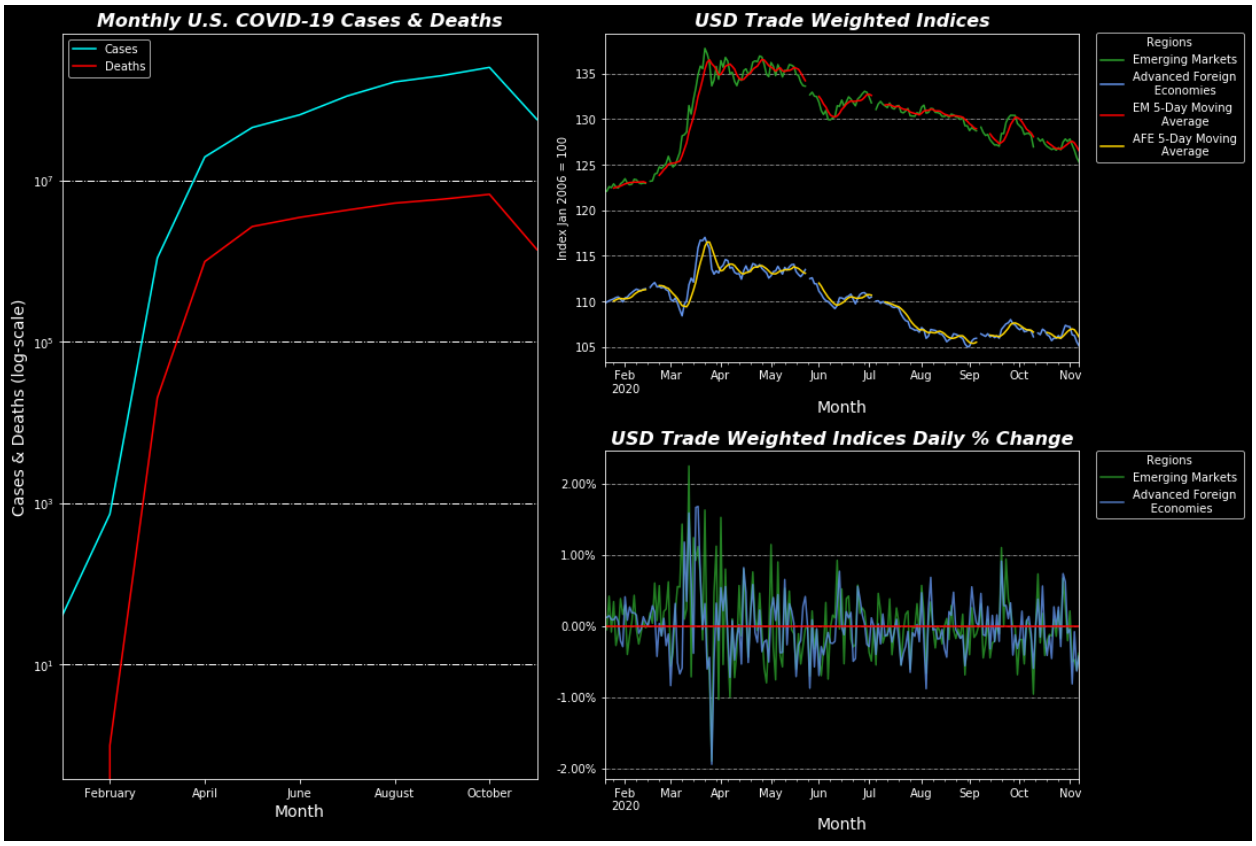
In [35]:
```
#usd_afe
```

In [36]:
```
usd_em
usd = usd_em.merge(usd_afe, on = 'DATE', how = 'left')
usd['DTWEXAFEGS'] = pd.to_numeric(usd['DTWEXAFEGS'],errors = 'coerce')
usd['DTWEXEMEGS'] = pd.to_numeric(usd['DTWEXEMEGS'],errors = 'coerce')
numeric = usd.copy()
usd.dtypes
numeric['EM_Rolling'] = numeric.iloc[:,1].rolling(window=5).mean()
numeric['AFE_Rolling'] = numeric.iloc[:,2].rolling(window=5).mean()
#numeric
```

In [37]:
```
usd_pct = usd.copy()
usd_pct['DTWEXEMEGS'] = pd.to_numeric(usd_pct['DTWEXEMEGS'],errors = 'coe
rce').pct_change()
usd_pct['DTWEXAFEGS'] = pd.to_numeric(usd_pct['DTWEXAFEGS'],errors = 'coe
rce').pct_change()
```

In [38]:
```
plt.style.use('dark_background')
fig2 = plt.figure(constrained_layout = True, figsize = (15,10))
gs = fig2.add_gridspec(2,2)
covid = fig2.add_subplot(gs[:,0])

us_covid[['Cases','Deaths']].plot(ax = covid, color = ['cyan','red'])

covid.set_yscale('log')
covid.set_title('Monthly U.S. COVID-19 Cases & Deaths', fontsize = 16, fo
ntweight = 'bold', fontstyle = 'oblique')
covid.set_xlabel('Month', fontsize = 14)
covid.set_ylabel('Cases & Deaths (log-scale)', fontsize = 14)
covid.set_xticklabels(['','February', 'April','June','August','October'],
fontsize = 10, rotation = 'horizontal')
covid.grid(color = 'white', linestyle = '-.', linewidth = 1, axis = 'y')

### top right

num = fig2.add_subplot(gs[0,1:])
numeric.plot(ax = num, color = 'tab:green', x = 'DATE', y ='DTWEXEMEGS')
numeric.plot(ax = num, color = 'cornflowerblue', x = 'DATE', y = 'DTWEXAF
EGS')
numeric.plot(ax = num, color = 'red', x='DATE', y= 'EM_Rolling')
numeric.plot(ax = num, color = 'gold', x='DATE', y= 'AFE_Rolling')

num.legend(title = 'Regions', labels = ['Emerging Markets', """Advanced F
oreign
      Economies""", """EM 5-Day Moving
        Average""", """AFE 5-Day Moving
        Average"""], loc='upper right',bbox_to_anchor=(1.36, 1.02))
num.set_title('USD Trade Weighted Indices', fontsize = 16, fontweight = '
bold', fontstyle = 'oblique')
num.set_xlabel('Month', fontsize = 14)
num.grid(color = 'white', linestyle = '-.', linewidth = .5, axis = 'x')
```

```
num.grid(color = 'white', linestyle = '-.', linewidth = .5, axis = 'y')
num.set_ylabel('Index Jan 2006 = 100', fontsize = 10)


### bottom right

pct = fig2.add_subplot(gs[1:,1:])
usd_pct.plot(ax = pct, color = 'tab:green',alpha = .8, x = 'DATE', y ='DT
WEXEMEGS')
usd_pct.plot(ax = pct, color = 'cornflowerblue', alpha = .8, x = 'DATE',
y = 'DTWEXAFEGS')

pct.set_xlabel('Month', fontsize = 14)
pct.axhline(0, color = 'red')
pct.set_title('USD Trade Weighted Indices Daily % Change', fontsize = 16,
fontweight = 'bold', fontstyle = 'oblique')
pct.yaxis.set_major_formatter(mtick.PercentFormatter(1.0))
pct.legend(title = 'Regions', labels = ['Emerging Markets', """Advanced F
oreign
     Economies"""],loc='upper right',bbox_to_anchor=(1.36, 1.02))
pct.grid(color = 'white', linestyle = '-.', linewidth = .5, axis = 'y')
```



Analysis

The first graph depicts daily U.S. COVID cases from 1/21 - 11/6 on the logarithmic scale. It is visible that from February to March cases and deaths more than doubled, experiencing the greatest growth of any month. From March to April the growth slows however both cases and deaths still nearly double. In the months after the curve begins to flatten and in October begins to decrease.

The graph in the top right corner shows a Trade Weighted USD compared to Advanced Foreign Economies (AFE) and Emerging Markets (EM) for goods & services. There is an initial appreciation of the dollar against both regions before depreciation beginning in late March. This depreciation trend continues through the end of the graphed time period. The dollar is weaker in November than in March.

The lower right corner graph visualizes daily growth rates in both Trade Weighted USD vs. AFE and EM for goods & services. Heading into March volatility begins to increase and growth rates will break +2% and nearly break -2%. The USD had both substantial increases and decreases relative to both regions, appreciating 2% against EMs and depreciating nearly -2% to AFEs. From the end of March onwards volatility decreased, and with exception to a few days, remained between -1% and 1%.

What's interesting is that in March, when the U.S. COVID cases and deaths growth substantially increases there is both an increase in volatility and an appreciation of the USD. However, when COVID cases begin to flatten circa beginning of April both Trade Weighted Indices also flatten until late-May, early-June before a depreciation trend. Volatility also decreases from the beginning of April, remaining in the -1% to 1% bounds throughout the rest of the time period. However, after April, as U.S. case and death curves continue to flatten, the depreciation trend continues. Thus, the depreciation of the USD is likely not solely due to COVID but relates to other factors in the economy at large.

However, during the period the USD actually appreciated to EMs by 3.1615 from 122.1471 to 125.3086 while the USD depreciated to AFEs by 4.6691 from 109.7980 to 105.1289.

Does the USD or COVID case growth rates best explain the FAANG growth rate?

In [39]:
```
usd_rmb.dtypes
usd_rmb.DEXCHUS = pd.to_numeric(usd_rmb.DEXCHUS, errors='coerce')

usd_rmb = usd_rmb.rename(columns={"DATE": "Date"})
usd_rmb = usd_rmb.set_index('Date')
usd_rmb = usd_rmb.loc['2020-01-21':'2020-07-31']

usd_rmb = usd_rmb.reset_index()
#usd_rmb = usd_rmb.drop(columns = ['RMB_Growth_Rate'], axis = 1)
usd_rmb['RMB_GR'] = usd_rmb['DEXCHUS'].pct_change()
usd_rmb = usd_rmb.iloc[1:]
#usd_rmb
```

In [40]:
```
#faangs = faangs.drop(columns = ['total', 'Month'], axis = 1)
faangs1 = faangs
faangs1['Total'] = (faangs['Close_FB'] + faangs['Close_Apple'] + faangs['
Close_Amazon'] +
                    faangs['Close_Google'] + faangs['Close_Netflix'])
faangs1['Date'] =  pd.to_datetime(faangs1['Date'])
faangs1 = faangs1.set_index('Date')
faangs1 = faangs1.loc['2020-01-21':'2020-07-31']
faangs1 = faangs1.reset_index()
faangs1 = faangs1.groupby('Date', as_index = False)['Total'].sum()
faangs1['Faang_GR'] = faangs1['Total'].pct_change()
faangs1 = faangs1.iloc[1:]
#faangs1
```

In [41]:
```
us_covid2 = us_counties.rename(columns={"date":"Date","state":"State","ca
ses": "Cases","deaths":"Deaths"})
us_covid2 = us_covid2.set_index('Date')
us_covid2 = us_covid2.loc['2020-01-21':'2020-07-31']
us_covid2 = us_covid2.reset_index()
us_covid2 = us_covid2.groupby('Date', as_index = False)['Cases'].sum()
us_covid2['Case_GR'] = us_covid2['Cases'].pct_change()
us_covid2 = us_covid2.iloc[1:]
#us_covid2
```

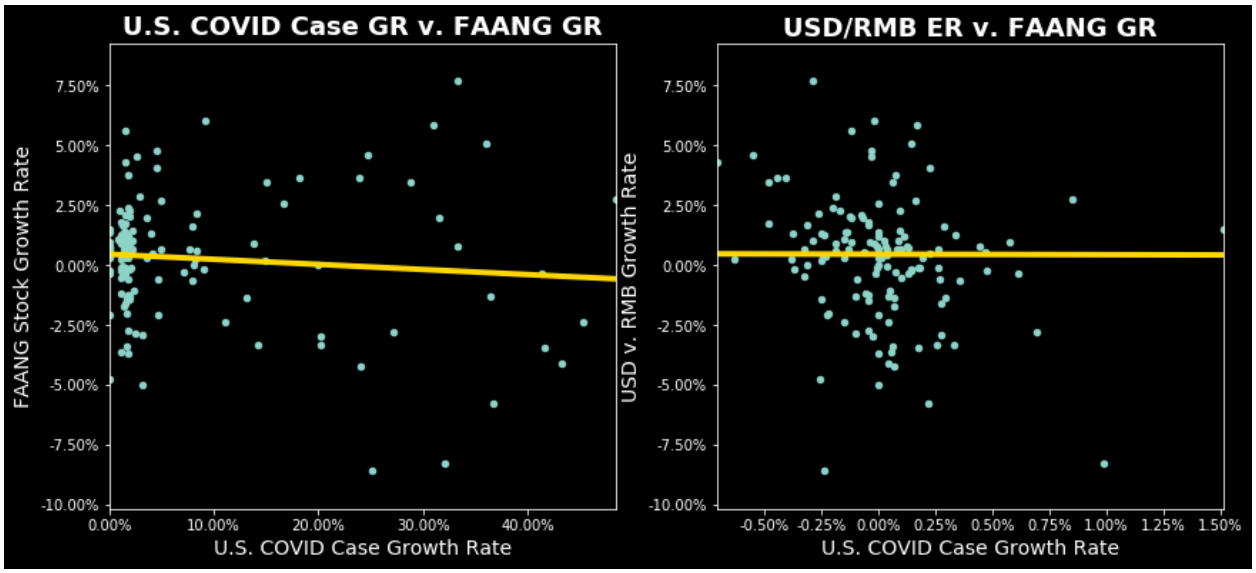
In [42]:
```
covid_faang = us_covid2.merge(faangs1, on = 'Date', how = 'left')
covid_faang = covid_faang.dropna()
covid_faang = usd_rmb.merge(covid_faang, on = 'Date', how = 'left')
covid_faang = covid_faang.drop(columns = ['Total','Cases','DEXCHUS'])
covid_faang = covid_faang.dropna()
covid_faang = covid_faang.drop(2)
#covid_faang
```

In [43]:
```
reg = linreg().fit(X = covid_faang[['Case_GR']], y = covid_faang['Faang_G
R'])
covid_faang['yhat1'] = reg.predict(covid_faang[['Case_GR']])
```

In [44]:
```
reg2 = linreg().fit(X = covid_faang[['RMB_GR']], y = covid_faang['Faang_G
R'])
covid_faang['yhat2'] = reg.predict(covid_faang[['RMB_GR']])
```

In [45]:
```
plt.style.use('dark_background')

fig, ax = plt.subplots(nrows = 1, ncols = 2, figsize = (14,6))

#COVID, FAANG

covid_faang.plot.scatter(ax = ax[0], x = 'Case_GR',y='Faang_GR')
covid_faang.sort_values('Case_GR').set_index('Case_GR')['yhat1'].plot(ax
= ax[0], color = 'gold', lw = 4)

vals = ax[0].get_yticks()
ax[0].set_yticklabels(['{:,.2%}'.format(x) for x in vals])

valsx = ax[0].get_xticks()
ax[0].set_xticklabels(['{:,.2%}'.format(y) for y in valsx])

ax[0].set_title('U.S. COVID Case GR v. FAANG GR', fontsize = 18, fontweig
ht = 'bold')
ax[0].set_ylabel('FAANG Stock Growth Rate', fontsize = 14)
ax[0].set_xlabel('U.S. COVID Case Growth Rate', fontsize = 14)


#RMB, FAANG

covid_faang.plot.scatter(ax = ax[1], x = 'RMB_GR', y = 'Faang_GR')
covid_faang.sort_values('RMB_GR').set_index('RMB_GR')['yhat2'].plot(ax =
ax[1], color = 'gold',lw = 4)

vals1 = ax[1].get_yticks()
ax[1].set_yticklabels(['{:,.2%}'.format(x) for x in vals1])

valsx1 = ax[1].get_xticks()
ax[1].set_xticklabels(['{:,.2%}'.format(y) for y in valsx1])

ax[1].set_title('USD/RMB ER v. FAANG GR', fontsize = 18, fontweight = 'bo
ld')
ax[1].set_ylabel('USD v. RMB Growth Rate', fontsize = 14)
ax[1].set_xlabel('U.S. COVID Case Growth Rate', fontsize = 14)
```

Out[45]: Text(0.5, 0, 'U.S. COVID Case Growth Rate')



In [46]:
```
reg.score(X = covid_faang[['Case_GR']], y = covid_faang['Faang_GR'])
```

Out[46]: 0.009477868000497658

In [47]:
```
reg2.score(X = covid_faang[['RMB_GR']], y = covid_faang['Faang_GR'])
```

Out[47]: 0.048063144472155546

Analysis

The graphs depict the relationships between USD v. RMB and FAANG stock growth rates with U.S. COVID case percent change from 1/21 - 9/31. It is visible that increases in COVID growth rates caused a decrease in FAANG growth rate, while a slight increase in USD v. RMB growth rate. While it is expected that increased COVID cases is correlated worse stock performance, it is surprising that increases in COVID growth had a relationship with USD appreciation.

The analysis that US COVID Case GR and FAANGs are negatively correlated. However, there is a slight positive correlation between the the USD v. RMB GR and FAANG GR.

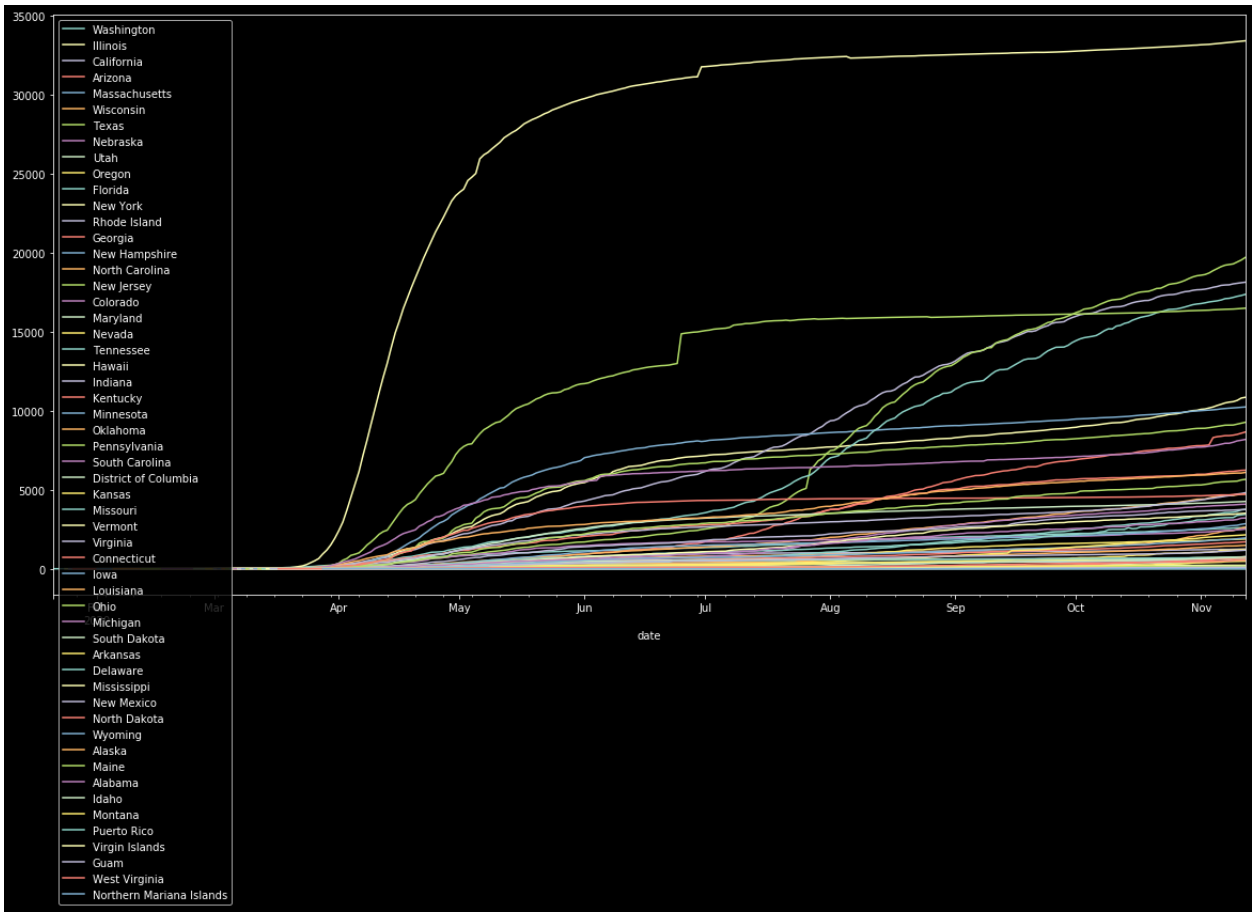
What trends exist between US COVID deaths and the FAANG stocks prices?

In [48]:
```
import pandas as pd
import matplotlib.pyplot as plt
import datetime as dt
import seaborn as sns
from numpy.polynomial.polynomial import polyfit
import matplotlib.gridspec as gridspec
import numpy as np
import matplotlib as mpl
mpl.rcParams.update(mpl.rcParamsDefault)
import math
import os
import requests, io
import zipfile as zf
import shutil
import statsmodels.formula.api as smf
%matplotlib inline
```

In [49]:
```
state_level = pd.DataFrame(us_counties.groupby(['date','state'])['deaths'
].sum())
state_level = state_level.reset_index('state')
state_level = state_level.reset_index('date')
state_level = state_level.sort_values(by=['date','state'])
state_level = state_level.set_index('date')
#state_level
```

In [50]:
```
state = pd.Series(state_level['state'].unique())
#plt.style.available
```

In [51]:
```
plt.style.use('dark_background')
fig,ax = plt.subplots()
for i in state:
    state_level.loc[state_level['state'] == i,:]['deaths'].plot(ax =ax,fi
gsize = (20,10),label=i)
    ax.legend(loc='best')
#ax.legend()
#state_level['deaths'].mean().plot(ax =ax,figsize = (10,5))
#state_level['death'].plot(ax =ax,figsize = (10,5))
#plt.plot(state_level['date'],state_level['deaths'],label=state_level['st
ate'])
#plot(state_level['death'], label=state_level['state'])
```



In [52]:
```
#state_level.iloc[:,1]
```

In [53]:
```
state_level_pivot = pd.pivot_table(state_level,index=['date'],columns=['s
tate'],
                   values=['deaths'],fill_value=np.nan)
state_level_pivot = state_level_pivot.dropna()
#state_level_pivot
```

In [54]:
```
for i in range(0,55):
    state_level_pivot['death_'+str(i)] = state_level_pivot.iloc[:,i].roll
ing(window=7).mean()

#state_level_pivot
```

In [55]:
```
import datetime
df2_2 = state_level.reset_index('date')
df2_2['Date'] = pd.to_datetime(df2_2['date'])
df2_2['Date'] = df2_2['Date'].dt.strftime('%d.%m.%Y')
df2_2['month'] = pd.DatetimeIndex(df2_2['Date']).month
df2_2['day'] = pd.DatetimeIndex(df2_2['Date']).day
df2_2['dayofyear'] = pd.DatetimeIndex(df2_2['Date']).dayofyear
df2_2['weekofyear'] = pd.DatetimeIndex(df2_2['Date']).weekofyear
df2_2['weekday'] = pd.DatetimeIndex(df2_2['Date']).weekday
df2_2['quarter'] = pd.DatetimeIndex(df2_2['Date']).quarter
df2_2['is_month_start'] = pd.DatetimeIndex(df2_2['Date']).is_month_start
df2_2['is_month_end'] = pd.DatetimeIndex(df2_2['Date']).is_month_end
df2_2 = df2_2.drop(['Date'], axis = 1)
df2_2 = df2_2.drop(['date'], axis = 1)
df2_2= pd.get_dummies(df2_2, columns=['month'], drop_first=True, prefix='
month')
df2_2 = pd.get_dummies(df2_2, columns=['weekday'], drop_first=True, prefi
x='wday')
df2_2 = pd.get_dummies(df2_2, columns=['quarter'], drop_first=True, prefi
x='qrtr')
df2_2= pd.get_dummies(df2_2, columns=['is_month_start'], drop_first=True,
prefix='m_start')
df2_2 = pd.get_dummies(df2_2, columns=['is_month_end'], drop_first=True,
prefix='m_end')
df2_2= pd.get_dummies(df2_2, columns=['state'], drop_first=True, prefix='
state')
#df2_2
#df2_2
```

In [56]:
```
from sklearn.model_selection import train_test_split

X = df2_2.drop(columns=["deaths"]).values
y = df2_2.deaths.values
X_train, X_holdout, y_train, y_holdout = train_test_split(X, y, shuffle=F
alse, test_size=0.5, random_state = 0)
X_val, X_test, y_val, y_test = train_test_split(X_holdout, y_holdout, shu
ffle=False, test_size=0.5, random_state = 0)
```

In [57]:
```
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_absolute_error
model_1 = LinearRegression()
model_1.fit(X_train,y_train)

y_predicted    = model_1.predict(X_val)
MAE_sklearn = mean_absolute_error(y_val, y_predicted)
yy = model_1.predict(X_train)
MAE_sklearn_train = mean_absolute_error(y_train, yy)
```

In [58]:
```
MAE_sklearn
```

Out[58]:
```
1846.8099381232194
```

In [59]:
```
us_level = pd.DataFrame(state_level.groupby('date')['deaths'].sum())
#us_level
```

In [60]:
```
path_netflix = '/Users/jarrodhoran/Downloads/Netflix.csv'
netflix = pd.read_csv(path_netflix).tail(365)
netflix['Date'] = pd.to_datetime(netflix['Date'])
netflix = netflix[netflix['Date'].dt.year == 2020]
#pd.reset_option('display.max_rows', None)
#pd.set_option('display.max_rows', None)
netflix = netflix.set_index('Date')
#netflix
```

In [61]:
```
netflix_sub = netflix.iloc[:,3:4]
#netflix_sub
```

In [62]:
```
path_amazon = '/Users/jarrodhoran/Downloads/Amazon.csv'
amazon = pd.read_csv(path_amazon).tail(365)
amazon['Date'] = pd.to_datetime(amazon['Date'])
amazon = amazon[amazon['Date'].dt.year == 2020]
#pd.reset_option('display.max_rows', None)
amazon = amazon.set_index('Date')
```

In [63]:
```
amazon_sub = amazon.iloc[:,3:4]
#amazon_sub
```

In [64]:
```
amazon_sub1 = amazon_sub.reset_index('Date')
#amazon_sub1
```

In [65]:
```
path_google = '/Users/jarrodhoran/Downloads/Google.csv'
google = pd.read_csv(path_google).tail(365)
google['Date'] = pd.to_datetime(google['Date'])
google = google[google['Date'].dt.year == 2020]
#pd.reset_option('display.max_rows', None)
google = google.set_index('Date')
#google
```

In [66]:
```
google_sub = google.iloc[:,3:4]
#google_sub
```

In [67]:
```
google_sub1 = google_sub.reset_index('Date')
#google_sub1
```

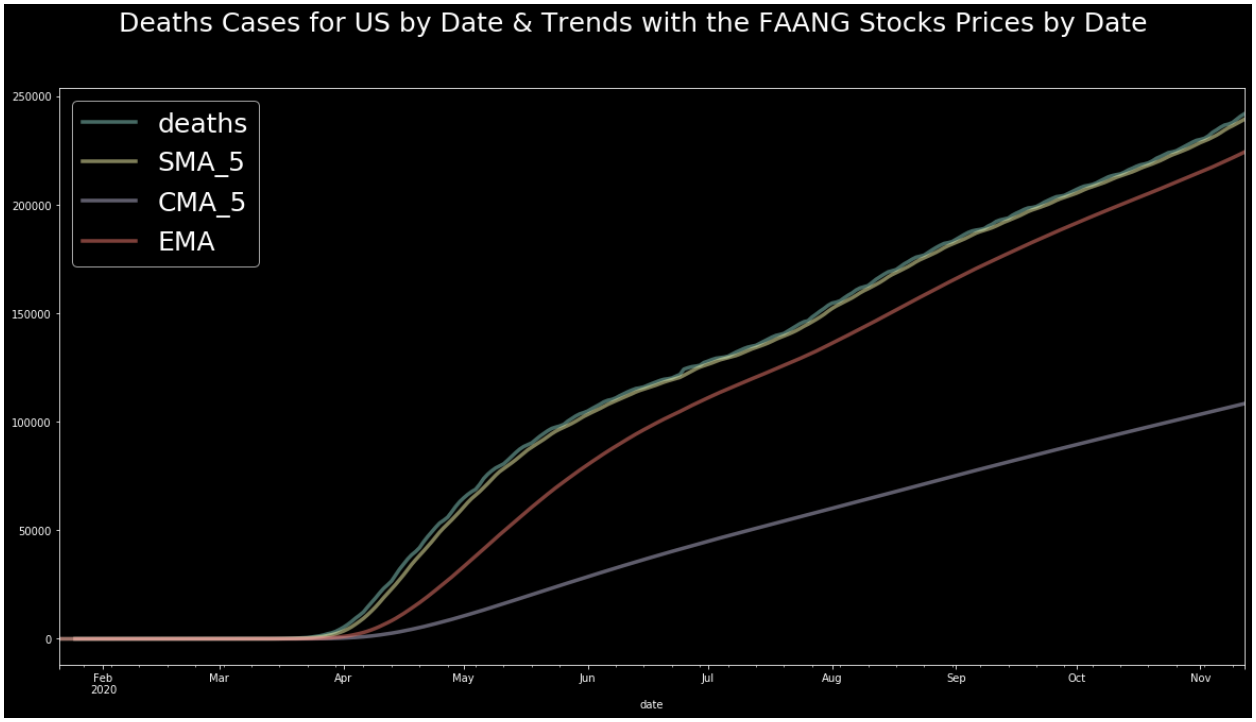
In [68]:
```
path_apple = '/Users/jarrodhoran/Downloads/Apple.csv'
apple = pd.read_csv(path_apple).tail(365)
apple['Date'] = pd.to_datetime(apple['Date'])
apple = apple[apple['Date'].dt.year == 2020]
#pd.reset_option('display.max_rows', None)
apple = apple.set_index('Date')
#apple
```

In [69]:
```
apple_sub = apple.iloc[:,3:4]
apple_sub1 = apple_sub.reset_index('Date')
#apple_sub1
```

In [70]:
```
path_facebook = '/Users/jarrodhoran/Downloads/Facebook.csv'
facebook = pd.read_csv(path_facebook).tail(365)
facebook = facebook
facebook['Date'] = pd.to_datetime(facebook['Date'])
facebook = facebook[facebook['Date'].dt.year == 2020]
#pd.reset_option('display.max_rows', None)
facebook = facebook.set_index('Date')
#facebook
```

In [71]:
```
facebook_sub = facebook.iloc[:,3:4]
facebook_sub1 = facebook_sub.reset_index('Date')
#facebook_sub1
```

In [72]:
```
fig, ax1 = plt.subplots()
fig.suptitle('Deaths Cases for US by Date & Trends with the FAANG Stocks
Prices by Date',fontsize=25)
us_level['deaths'].plot(ax =ax1,figsize = (20,10),lw=3.5,alpha = 0.5)
#us_level['SMA_3'] = us_level.iloc[:,0].rolling(window=3).mean()
#us_level['SMA_4'] = us_level.iloc[:,0].rolling(window=4).mean()
us_level['SMA_5'] = us_level.iloc[:,0].rolling(window=5).mean()
us_level['CMA_5'] = us_level.iloc[:,0].expanding(min_periods=5).mean()
us_level['EMA'] = us_level.iloc[:,0].ewm(span=40,adjust=False).mean()
#us_level['SMA_3'].plot(ax=ax,lw=4)
#us_level['SMA_4'].plot(ax=ax)
us_level['SMA_5'].plot(ax=ax1,alpha = 0.5,lw=3.5)
us_level['CMA_5'].plot(ax=ax1,alpha = 0.5,lw=3.5)
us_level['EMA'].plot(ax=ax1,alpha = 0.5,lw=3.5)
ax1.legend(fontsize=25)
plt.savefig('COVID19.png')
```

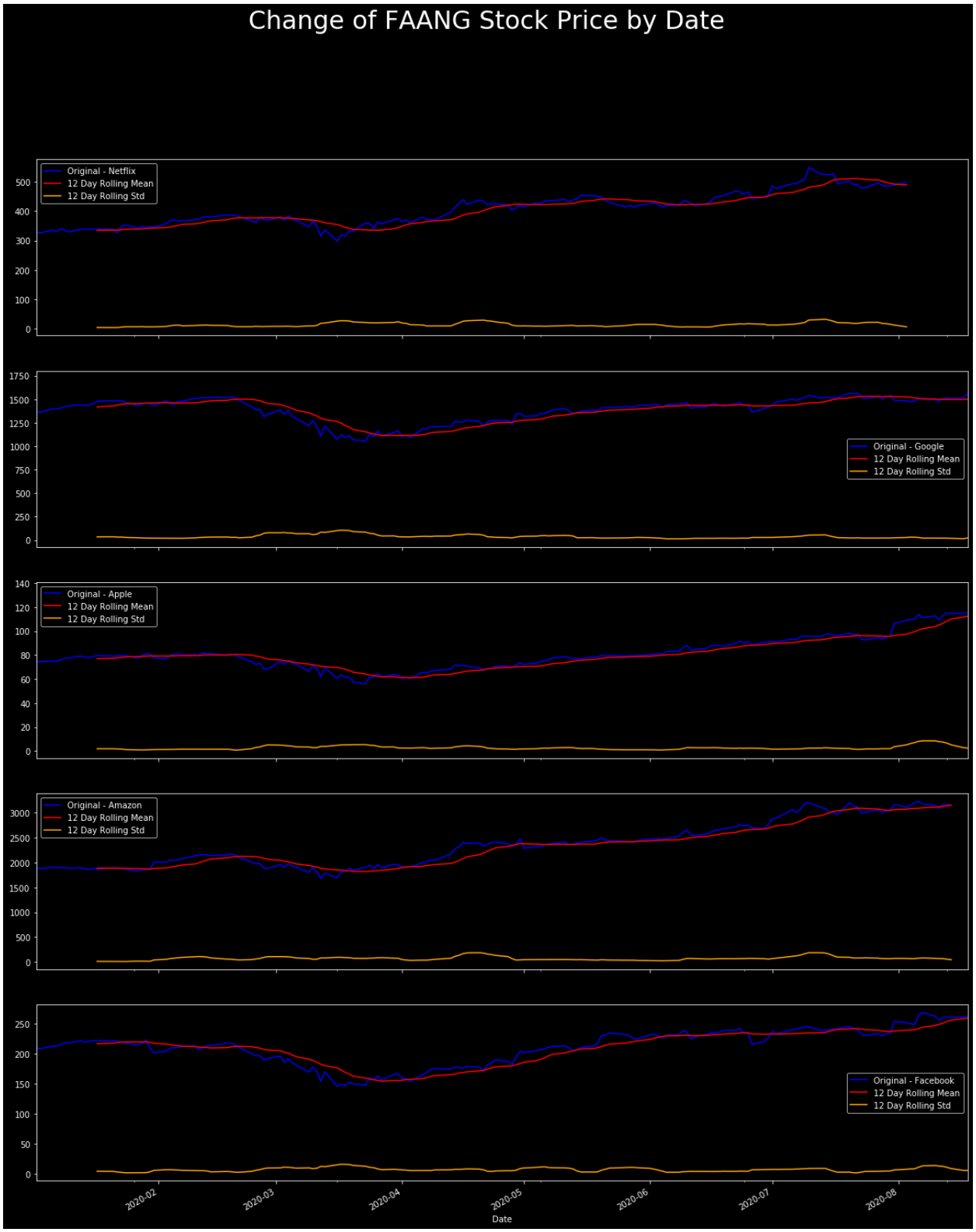


In [73]:
```
#amazon_sub1
```

In [74]:
```
#us_level
```

In [75]:
```
netflix_sub1 = netflix_sub.reset_index('Date')
```

In [76]:
```
fig,ax = plt.subplots(5,figsize=(20,25),sharex=True)
from statsmodels.tsa.stattools import adfuller
def test_stationarity(timeseries,i,name):

    #Determing rolling statistics
    timeseries['rolmean'] = timeseries.iloc[:,1:2].rolling(window=12).mea
n()
    timeseries['rolstd']= timeseries.iloc[:,1:2].rolling(window=12).std()

    #Plot rolling statistics:
    plt.style.use('dark_background')
    timeseries.plot(x='Date',y='Close',color='blue',label='Original'+' -
'+str(name).title(),ax=ax[i])
    timeseries.plot(x='Date',y='rolmean',color='red', label='12 Day Rolli
ng Mean',ax=ax[i])
    timeseries.plot(x='Date',y='rolstd',color='orange', label = '12 Day R
olling Std',ax=ax[i])
    ax[i].legend(loc='best')
    #ax[i].show(block=False)

#ax[0].title('Rolling Mean & Standard Deviation - Netflix')
fig.suptitle('Change of FAANG Stock Price by Date',fontsize = 30)
test_stationarity(netflix_sub1,0,'netflix')
test_stationarity(google_sub1,1,'google')
test_stationarity(apple_sub1,2,'apple')
test_stationarity(amazon_sub1,3,'amazon')
test_stationarity(facebook_sub1,4,'facebook')
plt.savefig('FAANG1.png')
```



Which other FAANG stock best predicts Google?

In [77]:
```
netflix_sub1 = netflix_sub1.rename(columns={"Close": "Close_Netflix",'rol
mean':'rolmean_Netflix',
                                           'rolstd':'rolstd_Netflix'})
amazon_sub1 = amazon_sub1.rename(columns={"Close": "Close_Amazon",'rolmea
n':'rolmean_Amazon',
                                         "rolstd":'rolstd_Amazon'})
apple_sub1 = apple_sub1.rename(columns={"Close": "Close_Apple",
                                        'rolmean':'rolmean_Apple',
                                       'rolstd':'rolstd_Apple'})
google_sub1 = google_sub1.rename(columns={"Close": "Close_Google",
                                          "rolmean":"rolmean_Google",
                                          "rolstd":'rolstd_Google'})
facebook_sub1 = facebook_sub1.rename(columns={"Close": "Close_Facebook",
                                              'rolmean':'rolmean_FB',
                                              'rolstd':'rolstd_FB'})
#facebook_sub1
```

In [78]:
```
stonks = apple_sub1.merge(google_sub1, on = 'Date', how = 'left')
stonks = stonks.merge(amazon_sub1, on = 'Date', how = 'left')
stonks = stonks.merge(netflix_sub1, on ='Date', how = 'left')
stonks = stonks.merge(facebook_sub1, on ='Date', how = 'left')
#stonks = stonks.rename(columns = {"Close_x": "Close_Apple"})
```

In [79]:
```
stonks = stonks.set_index('Date')
```

In [80]:
```
normalized_stonks = pd.DataFrame(index = stonks.index)
```

In [81]:
```
from sklearn import preprocessing
x = stonks.values #returns a numpy array
min_max_scaler = preprocessing.MinMaxScaler()
x_scaled = min_max_scaler.fit_transform(x)
normalized_stonks = pd.DataFrame(x_scaled)
```

In [82]:
```
normalized_stonks = normalized_stonks.rename(columns = {0:"Close_Apple",1
:'rolmean_Apple',2:'rolstd_Apple',
                                        3: "Close_Google",4:"rolmean_Google",5
:'rolstd_Google',
                                        6: "Close_Amazon",7:'rolmean_Amazon',8
:'rolstd_Amazon',
                                        9: "Close_Netflix",10:'rolmean_Netflix
',11:'rolstd_Netflix',
                                        12: "Close_Facebook",13:'rolmean_FB',1
4:'rolstd_FB'})
```

In [83]:
```
normalized_stonks=normalized_stonks.dropna()
```

In [84]:
```
#normalized_stonks
```

In [85]:
```
reg1 = smf.ols('Close_Google ~ Close_Amazon',normalized_stonks).fit()
normalized_stonks['yhat1'] = reg1.predict()
```

In [86]:
```
reg2 = smf.ols('Close_Google ~ Close_Apple',normalized_stonks).fit()
normalized_stonks['yhat2'] = reg2.predict()
```

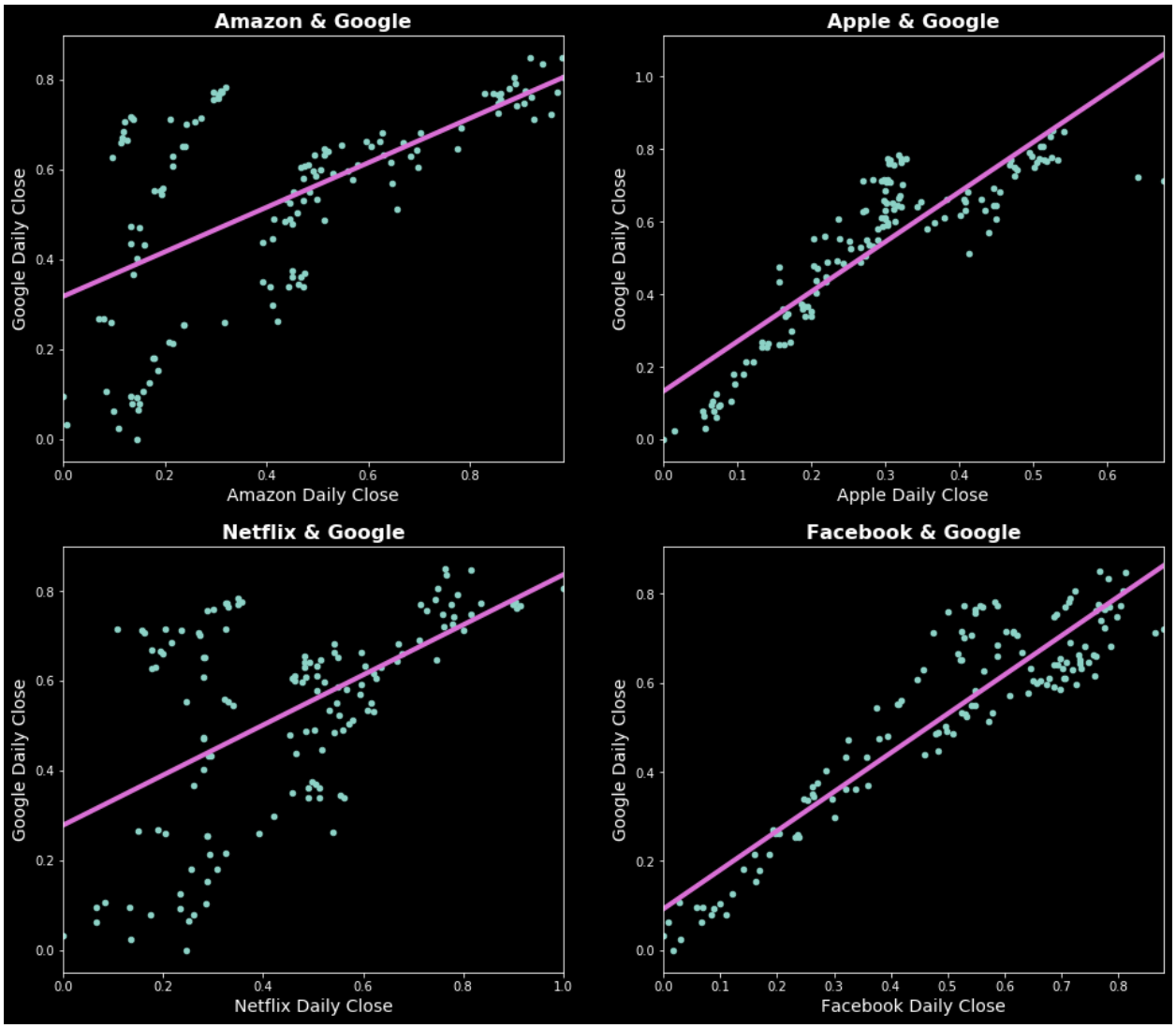
In [87]:
```
reg3 = smf.ols('Close_Google ~ Close_Netflix',normalized_stonks).fit()
normalized_stonks['yhat3'] = reg3.predict()
```

In [88]:
```
reg4 = smf.ols('Close_Google ~ Close_Facebook',normalized_stonks).fit()
normalized_stonks['yhat4'] = reg4.predict()
```

In [89]:
```
fig,ax = plt.subplots(nrows = 2, ncols = 2, figsize = (16,14))

#top left

normalized_stonks.plot.scatter(ax = ax[0,0], x = 'Close_Amazon', y = 'Clo
se_Google')
normalized_stonks.sort_values('Close_Amazon').set_index('Close_Amazon')['
yhat1'].plot(ax = ax[0,0],

color = 'orchid',lw = 4)


ax[0,0].set_xlabel('Amazon Daily Close', fontsize = 14)
ax[0,0].set_ylabel('Google Daily Close', fontsize = 14)
ax[0,0].set_title('Amazon & Google', fontsize = 16, fontweight = 'bold')


#top right

normalized_stonks.plot.scatter(ax = ax[0,1], x = 'Close_Apple', y = 'Clos
e_Google')
normalized_stonks.sort_values('Close_Apple').set_index('Close_Apple')['yh
at2'].plot(ax = ax[0,1],

color = 'orchid',lw = 4)

ax[0,1].set_xlabel('Apple Daily Close', fontsize = 14)
ax[0,1].set_ylabel('Google Daily Close', fontsize = 14)
ax[0,1].set_title('Apple & Google', fontsize = 16, fontweight = 'bold')

#bottom left

normalized_stonks.plot.scatter(ax = ax[1,1], x = 'Close_Facebook', y = 'C
lose_Google')
normalized_stonks.sort_values('Close_Facebook').set_index('Close_Facebook
')['yhat4'].plot(ax = ax[1,1],
```

```
color = 'orchid',lw = 4)

ax[1,1].set_xlabel('Facebook Daily Close', fontsize = 14)
ax[1,1].set_ylabel('Google Daily Close', fontsize = 14)
ax[1,1].set_title('Facebook & Google', fontsize = 16, fontweight = 'bold'
)


#bottom right

normalized_stonks.plot.scatter(ax = ax[1,0], x = 'Close_Netflix', y = 'Cl
ose_Google')
normalized_stonks.sort_values('Close_Netflix').set_index('Close_Netflix')
['yhat3'].plot(ax = ax[1,0],

color = ['orchid']

,lw = 4)

ax[1,0].set_xlabel('Netflix Daily Close', fontsize = 14)
ax[1,0].set_ylabel('Google Daily Close', fontsize = 14)
ax[1,0].set_title('Netflix & Google', fontsize = 16, fontweight = 'bold')
```

Out[89]: Text(0.5, 1.0, 'Netflix & Google')



In [90]:
```
print(reg4.summary(),reg2.summary(),reg1.summary(),reg3.summary())
```

```
                            OLS Regression Results
==============================================================================
=======
Dep. Variable:           Close_Google   R-squared:
0.848
Model:                            OLS   Adj. R-squared:
0.847
Method:                 Least Squares   F-statistic:
753.0
Date:                Fri, 11 Dec 2020   Prob (F-statistic):           4
.47e-57
Time:                        18:07:23   Log-Likelihood:
141.27
No. Observations:                 137   AIC:
 278.5
```

```
-276.5

Df Residuals:                      135   BIC:
-272.7
Df Model:                            1
Covariance Type:            nonrobust
==============================================================================
==========
                     coef    std err          t      P>|t|      [0.025
0.975]
------------------------------------------------------------------------------
----------
Intercept          0.0922      0.018      5.216      0.000       0.057
0.127
Close_Facebook     0.8769      0.032     27.441      0.000       0.814
0.940
==============================================================================
=======
Omnibus:                       10.678   Durbin-Watson:
0.193
Prob(Omnibus):                  0.005   Jarque-Bera (JB):
11.732
Skew:                           0.706   Prob(JB):
0.00283
Kurtosis:                       2.755   Cond. No.
5.44
==============================================================================
=======

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is
correctly specified.                              OLS Regression Results
==============================================================================
=======
Dep. Variable:           Close_Google   R-squared:
0.762
Model:                            OLS   Adj. R-squared:
0.760
Method:                 Least Squares   F-statistic:
431.2
Date:                Fri, 11 Dec 2020   Prob (F-statistic):           7
.33e-44
Time:                        18:07:23   Log-Likelihood:
110.44
No. Observations:                 137   AIC:
-216.9
Df Residuals:                     135   BIC:
-211.0
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
========
                    coef    std err          t      P>|t|      [0.025
```

```
0.975]
------------------------------------------------------------------------------
Intercept       0.1324      0.021      6.188      0.000       0.090
0.175
Close_Apple     1.3703      0.066     20.766      0.000       1.240
1.501
==============================================================================
Omnibus:                        0.145   Durbin-Watson:
0.130
Prob(Omnibus):                  0.930   Jarque-Bera (JB):
0.043
Skew:                           0.043   Prob(JB):
0.979
Kurtosis:                       3.013   Cond. No.
7.71
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is
correctly specified.                            OLS Regression Results
==============================================================================
Dep. Variable:           Close_Google   R-squared:
0.361
Model:                            OLS   Adj. R-squared:
0.357
Method:                 Least Squares   F-statistic:
76.41
Date:                Fri, 11 Dec 2020   Prob (F-statistic):           8
.01e-15
Time:                        18:07:23   Log-Likelihood:
42.954
No. Observations:                 137   AIC:
-81.91
Df Residuals:                     135   BIC:
-76.07
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025
0.975]
------------------------------------------------------------------------------
Intercept        0.3174      0.029     10.964      0.000       0.260
0.375
Close_Amazon     0.4960      0.057      8.741      0.000       0.384
0.608
==============================================================================
```

```
=======
Omnibus:                        2.358   Durbin-Watson:
0.079
Prob(Omnibus):                  0.308   Jarque-Bera (JB):
1.754
Skew:                           0.084   Prob(JB):
0.416
Kurtosis:                       2.472   Cond. No.
4.47
================================================================================
=======

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is
correctly specified.                            OLS Regression Results
================================================================================
=======
Dep. Variable:           Close_Google   R-squared:
0.301
Model:                            OLS   Adj. R-squared:
0.295
Method:                 Least Squares   F-statistic:
58.03
Date:                Fri, 11 Dec 2020   Prob (F-statistic):           4
.05e-12
Time:                        18:07:23   Log-Likelihood:
36.725
No. Observations:                 137   AIC:
-69.45
Df Residuals:                     135   BIC:
-63.61
Df Model:                           1
Covariance Type:            nonrobust
================================================================================
==========
                    coef    std err          t      P>|t|      [0.025
0.975]
--------------------------------------------------------------------------------
----------
Intercept         0.2781      0.037      7.513      0.000       0.205
0.351
Close_Netflix     0.5582      0.073      7.618      0.000       0.413
0.703
================================================================================
=======
Omnibus:                        4.002   Durbin-Watson:
0.071
Prob(Omnibus):                  0.135   Jarque-Bera (JB):
2.337
Skew:                           0.033   Prob(JB):
0.311
Kurtosis:                       2.363   Cond. No.
```

```
                                                                    Cond. No.
5.59
==============================================================================
=======

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

Analysis

The charts above use a normalized end-of-day price for the FAANG stocks. The analysis reveals that when predicting the stock price of Google, the end-of-day price for Facebook is the best predictor with an R^2 of .848. The remaining order is Apple (R^2: .762), Amazon (R^2: .361), and Netflix (R^2: .301). Thus, it is likely that the stock prices for Facebook and Google experienced the most similar percent change throughout the time period.
There is a low P-value, which is indicative that the results are unlikely to occur randomly.