STA 141B

Homework 3

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Submit this ipynb to canvas; also print your completed ipynb to pdf and submit it on gradescope. Work in between the exercise cells and be clear about your answers. For example, you should add cells below the cell starting with 1.1 for the answer to 1.1. You can break your answers into as many cells as you like. Please do not clear your output so that we can see your answers without running all of the cells.

Throughout this homework we will be using the the covidcast api, and you can find the documentation here. We will be using the http api and you should not use the `covidcast` python package. Even though it is available, I want to test you on using the requests package and making http requests directly.

In [1]:
```
import requests
import pandas as pd
import numpy as np
import sqlalchemy as sqla
import requests_cache
import plotnine as p9
requests_cache.install_cache('covidcast_cache')
```

Read the documentation about the Epidata API at this README and we will be using the covidcast "endpoint". Pay special attention to the section "Constructing API Queries". You will be making requests with the request package. Consider the following get request...

```
https://api.covidcast.cmu.edu/epidata/api.php?
endpoint=covidcast&data_source=fb-
survey&signal=smoothed_cli&time_type=day&geo_type=county&time_values=2020040
20200410&geo_value=06001
```

If you put this in your browser you see...

```
{ "epidata":
[{"geo_value":"06001","signal":"smoothed_cli","time_value":20200406,"directio
{"geo_value":"06001","signal":"smoothed_cli","time_value":20200407,"direction
{"geo_value":"06001","signal":"smoothed_cli","time_value":20200408,"direction
{"geo_value":"06001","signal":"smoothed_cli","time_value":20200409,"direction
{"geo_value":"06001","signal":"smoothed_cli","time_value":20200410,"direction
 "result": 1, "message": "success" }
```

which is the json returned from this query. The parameters for the query are

```
endpoint=covidcast
data_source=fb-survey
signal=smoothed_cli
time_type=day
geo_type=county
```

```
time_values=20200406-20200410
geo_value=06001
```

which asks for the smoothed cli signal from the fb survey data for county 06001 from 2020-04-06 to 2020-04-10. Notice that if you want to select all geo_values then you can set geo_value=*.

Exercise 1. Request the value for the smoothed_cli signal from the fb-survey datasource on 2020-10-01 for ALL STATES. Notice that the above is for counties and so you need to change this to states. Do the same for smoothed_hh_cmnty_cli signal from the fb-survey data, and the confirmed_7dav_incidence_prop signal from the jhu-csse data source. Create dataframes from these and join these 3 variables based on the state into a single dataframe. Drop rows with missingness (there should be only about 5 of them dropped this way, corresponding to the US territories). Finally, compute and output the spearman correlation between all variables in this dataframe (there should be 51 rows in the new dataset).

In [2]:

```
url = 'https://api.covidcast.cmu.edu/epidata/covidcast/'
```

In [3]:

```
# api for smoothed_cli signal

smooth_cli_params = {'data_source': 'fb-survey', 'signal': 'smoothed_cli', 'time_type'
           'geo_type': 'state', 'time_values': '20201001', 'geo_values': '*' }
```

In [4]:

```
smoothcli_req = requests.get(url, params=smooth_cli_params)

smcli = smoothcli_req.json()

smcli.__repr__()[0:]

smcli.keys()
```

Out[4]:

```
dict_keys(['epidata', 'result', 'message'])
```

In [5]:

```
smcli_df = pd.DataFrame.from_dict(smcli['epidata'][i] for i in range(len(smcli['epidat

smcli_df.head()
```

Out[5]:

	geo_value	signal	source	geo_type	time_type	time_value	direction	issue	lag	miss
0	ak	smoothed_cli	fb-survey	state	day	20201001	None	20201119	49	
1	al	smoothed_cli	fb-survey	state	day	20201001	None	20201119	49	
2	ar	smoothed_cli	fb-survey	state	day	20201001	None	20201119	49	
3	az	smoothed_cli	fb-survey	state	day	20201001	None	20201119	49	
4	ca	smoothed_cli	fb-survey	state	day	20201001	None	20201119	49	

In [6]:

```
# api for smoothed_hh_cmnty_cli signal


smoothed_hh_cmnty_cli_params = {'data_source': 'fb-survey', 'signal': 'smoothed_hh_cmr
```

```
            'geo_type': 'state', 'time_values': '20201001', 'geo_values': '*' }

smoothed_hh_req = requests.get(url, params=smoothed_hh_cmnty_cli_params)

smoothed_hh_req.json()

smhh = smoothed_hh_req.json()

smhh.keys()
```

Out[6]:
```
dict_keys(['epidata', 'result', 'message'])
```

In [7]:
```
smhh_df = pd.DataFrame.from_dict(smhh['epidata'][i] for i in range(len(smhh['epidata']

smhh_df.head()
```

Out[7]:

	geo_value	signal	source	geo_type	time_type	time_value	direction	issue
0	ak	smoothed_hh_cmnty_cli	fb-survey	state	day	20201001	None	20201119
1	al	smoothed_hh_cmnty_cli	fb-survey	state	day	20201001	None	20201119
2	ar	smoothed_hh_cmnty_cli	fb-survey	state	day	20201001	None	20201119
3	az	smoothed_hh_cmnty_cli	fb-survey	state	day	20201001	None	20201119
4	ca	smoothed_hh_cmnty_cli	fb-survey	state	day	20201001	None	20201119

In [8]:
```
# api for confirmed_7dav_incidence_prop signal / data_source : jhu-csse


confirmed_7dav_params = {'data_source': 'jhu-csse', 'signal': 'confirmed_7dav_incidenc
            'geo_type': 'state', 'time_values': '20201001', 'geo_values': '*' }

confirmed_7days_req = requests.get(url, params=confirmed_7dav_params)

con7 = confirmed_7days_req.json()
```

In [9]:
```
con7_df = pd.DataFrame.from_dict(con7['epidata'][i] for i in range(len(con7['epidata']

con7_df.head()
```

Out[9]:

	geo_value	signal	source	geo_type	time_type	time_value	direction	
0	ak	confirmed_7dav_incidence_prop	jhu-csse	state	day	20201001	None	202
1	al	confirmed_7dav_incidence_prop	jhu-csse	state	day	20201001	None	202
2	ar	confirmed_7dav_incidence_prop	jhu-csse	state	day	20201001	None	202
3	as	confirmed_7dav_incidence_prop	jhu-csse	state	day	20201001	None	202
4	az	confirmed_7dav_incidence_prop	jhu-csse	state	day	20201001	None	202

In [10]:

```
smcli_df_n = smcli_df.rename(columns={'signal':'signal_smcli', 'source' : 'source_smcl
                          'time_value' : 'time_value_smcli', 'direction' : 'direction_
                          'missing_value' : 'missing_value_smcli','missing_stderr' : '
                          'missing_sample_size' : 'missing_sample_size_smcli', 'value'
                          'sample_size' : 'sample_size_smcli'})

smhh_df_n = smhh_df.rename(columns={'signal':'signal_smhh', 'source' : 'source_smhh',
                          'time_value' : 'time_value_smhh', 'direction' : 'direction_s
                          'missing_value' : 'missing_value_smhh','missing_stderr' : 'm
                          'missing_sample_size' : 'missing_sample_size_smhh', 'value'
                          'sample_size' : 'sample_size_smhh'})

con7_df_n = con7_df.rename(columns={'signal':'signal_con7', 'source' : 'source_con7',
                          'time_value' : 'time_value_con7', 'direction' : 'direction_c
                          'missing_value' : 'missing_value_con7','missing_stderr' : 'm
                          'missing_sample_size' : 'missing_sample_size_con7', 'value'
                          'sample_size' : 'sample_size_con7'})
```

In [11]:

```
smcli_df_n.set_index('geo_value',inplace=True)
smhh_df_n.set_index('geo_value',inplace=True)
con7_df_n.set_index('geo_value',inplace=True)
```

In [12]:

```
combined_df = smcli_df_n.join([smhh_df_n, con7_df_n])
```

In [13]:

```
A = combined_df.corr(method ='spearman')
```

In [14]:

```
A.dropna(how='all', inplace=True)
```

In [15]:

```
A.dropna(axis=1, how='all', inplace=True)
```

In [16]:

```
A
```

Out[16]:

	value_smcli	stderr_smcli	sample_size_smcli	value_smhh	stderr_smhh	san
value_smcli	1.000000	0.598009	-0.284525	0.859276	0.460362	
stderr_smcli	0.598009	1.000000	-0.894208	0.425158	0.945068	
sample_size_smcli	-0.284525	-0.894208	1.000000	-0.141357	-0.963167	
value_smhh	0.859276	0.425158	-0.141357	1.000000	0.358371	
stderr_smhh	0.460362	0.945068	-0.963167	0.358371	1.000000	
sample_size_smhh	-0.282805	-0.893394	0.999367	-0.136923	-0.961810	
issue_con7	0.146663	-0.256415	0.322598	0.116937	-0.281980	
lag_con7	0.146663	-0.256415	0.322598	0.116937	-0.281980	
missing_stderr_con7	-0.171566	-0.322544	0.315681	-0.185291	-0.315681	
missing_sample_size_con7	-0.171566	-0.322544	0.315681	-0.185291	-0.315681	
value_con7	0.768778	0.409050	-0.173122	0.936742	0.384253	

Exercise 2. Create and engine using sqlalchemy for a sqlite database (you can just use for example `covid.sqlite` as your location in your current directory). You will sequentially pull these three variables above for each state at different dates and write the resulting dataframes

to a single table in the sqlite database. Your date range should be from '2020-08-02' to '2021-11-01' at a frequency of every 7 days. For each date, query the API for the three variables and construct the dataframe of each state at that date. Then append this dataframe to a table (call the table "state") in the sqlite database that you created, using DataFrame.to_sql command. Finally, make a sql query to this table that counts the number of rows in the state table, there should be 51 x the number of dates in your date range.

In [17]:

```
from datetime import timedelta, date

def daterange(start_date, end_date):
     for n in range(0, int((end_date - start_date).days) + 1, 7):
         yield start_date + timedelta(n)

day = []

start_dt = date(2020, 8, 2)
end_dt = date(2021, 11, 1)
for dt in daterange(start_dt, end_dt):
    day.append(dt.strftime("%Y%m%d"))
```

In [18]:

```
# smoothed_cli ==> dataframe for every 7days

lst_smcli = []

for i in range(len(day)):
    url_smcli = 'https://api.covidcast.cmu.edu/epidata/api.php?endpoint=covidcast&data

    smcli_req = requests.get(url_smcli)
    smcli  = smcli_req.json()

    smcli_df = pd.DataFrame.from_dict(smcli['epidata'][j] for j in range(len(smcli['ep
    lst_smcli.append(smcli_df)


smcli_tot_df = pd.concat(lst_smcli)
```

In [19]:

```
smcli_tot_df
```

Out[19]:

	geo_value	signal	time_value	direction	issue	lag	missing_value	missing_stderr	mi
0	ak	smoothed_cli	20200802	None	20200903	32	0	0	
1	al	smoothed_cli	20200802	None	20200903	32	0	0	
2	ar	smoothed_cli	20200802	None	20200903	32	0	0	
3	az	smoothed_cli	20200802	None	20200903	32	0	0	
4	ca	smoothed_cli	20200802	None	20200903	32	0	0	
...	...	...	...	...	...	...	...	...	
46	vt	smoothed_cli	20211031	None	20211105	5	0	0	
47	wa	smoothed_cli	20211031	None	20211105	5	0	0	
48	wi	smoothed_cli	20211031	None	20211105	5	0	0	
49	wv	smoothed_cli	20211031	None	20211105	5	0	0	
50	wy	smoothed_cli	20211031	None	20211105	5	0	0	

3368 rows × 12 columns

In [20]:

```
# smoothed_hh_cmnty_cli ==> dataframe for every 7days

lst_smhh = []

for i in range(len(day)):
    url_smhh = 'https://api.covidcast.cmu.edu/epidata/api.php?endpoint=covidcast&data_

    smhh_req = requests.get(url_smhh)
    smhh  = smhh_req.json()

    smhh_df = pd.DataFrame.from_dict(smhh['epidata'][j] for j in range(len(smhh['epida
    lst_smhh.append(smhh_df)


smhh_tot_df = pd.concat(lst_smhh)
```

In [21]:

```
# confirmed_7dav_incidence_prop ==> dataframe for every 7days

lst_con7 = []

for i in range(len(day)):
    url_con7 = 'https://api.covidcast.cmu.edu/epidata/api.php?endpoint=covidcast&data_

    con7_req = requests.get(url_con7)
    con7 = con7_req.json()

    con7_df = pd.DataFrame.from_dict(con7['epidata'][j] for j in range(len(con7['epida
    lst_con7.append(con7_df)


con7_tot_df = pd.concat(lst_con7)
```

In [22]:

```
smcli_tot_df_n = smcli_tot_df.rename(columns={'signal':'signal_smcli', 'source' : 'sou
                          'time_value' : 'time_value_smcli', 'direction' : 'direction_
                          'missing_value' : 'missing_value_smcli','missing_stderr' : '
                          'missing_sample_size' : 'missing_sample_size_smcli', 'value'
                          'sample_size' : 'sample_size_smcli'})

smhh_tot_df_n = smhh_tot_df.rename(columns={'signal':'signal_smhh', 'source' : 'source
                          'time_value' : 'time_value_smhh', 'direction' : 'direction_s
                          'missing_value' : 'missing_value_smhh','missing_stderr' : 'm
                          'missing_sample_size' : 'missing_sample_size_smhh', 'value'
                          'sample_size' : 'sample_size_smhh'})

con7_tot_df_n = con7_tot_df.rename(columns={'signal':'signal_con7', 'source' : 'source
                          'time_value' : 'time_value_con7', 'direction' : 'direction_c
                          'missing_value' : 'missing_value_con7','missing_stderr' : 'm
                          'missing_sample_size' : 'missing_sample_size_con7', 'value'
                          'sample_size' : 'sample_size_con7'})




smcli_tot_df_n.reset_index(drop=True, inplace=True)
smhh_tot_df_n.reset_index(drop=True, inplace=True)
con7_tot_df_n.reset_index(drop=True, inplace=True)
```

In [23]:

```
smcli_tot_df_n.drop(smcli_tot_df_n[smcli_tot_df_n['geo_value'] == 'pr'].index,inplace=
smhh_tot_df_n.drop(smhh_tot_df_n[smhh_tot_df_n['geo_value'] == 'pr'].index,inplace=Tru
```

In [24]:

```
A = smcli_tot_df_n.set_index('geo_value')
```

```
B = smhh_tot_df_n.set_index('geo_value')
C = con7_tot_df_n.set_index('geo_value')
AB = pd.concat([A,B], axis=1, sort=False)

row_lst = []
for i in smcli_df['geo_value']:
    row_lst.append(i)

row_lst2 = []
for i in C.index:
    row_lst2.append(i)

difference = set(row_lst).symmetric_difference(set(row_lst2))
difference = list(difference)

C = C.loc[~C.index.isin(difference)]
```

In [25]:

```
combined_tot = pd.concat([AB,C], axis=1, sort=False)
```

In [26]:

```
from sqlalchemy import create_engine
import sqlalchemy as sqla

combined_conn = sqla.create_engine('sqlite:///covid.sqlite')


combined_tot.to_sql('state', combined_conn, if_exists='replace')
```

In [27]:

```
# Number of rows total in state table (sql)

pd.read_sql_query("select count(*) from state", combined_conn)
```

Out[27]:

	count(*)
0	3366

Exercise 3. Using `read_sql_query` , select all variables where the state is california from the state table, and read it into a pandas dataframe. Filtering out CA should be done in SQL and then the pd.DataFrame should be constructed, the filter should not happen after you read in the full data. In the end you should have one row for each date.

For the two FB indicator variables, produce a plot comparing that to the death indicences. Plot the FB indicator variables as a time series in a secondary y axis and the death indicence as the primary y axis. You can just use pd.DataFrame.plot(). You should have the actual date on the X axis and not just an index number. Remark on which indicator looks more variable and why they are good "leading indicators". A leading indicator is a variable that rises and falls before the indicator of interest such as covid deaths.

In [28]:

```
CA_df = pd.read_sql_query("select * from state where geo_value = 'ca'" , combined_conr
```

In [29]:

```
CA_df
```

Out[29]:

	geo_value	signal_smcli	time_value_smcli	direction_smcli	issue_smcli	lag_smcli	missing_value_s
0	ca	smoothed_cli	20200802	None	20200903	32	
1	ca	smoothed_cli	20200809	None	20200903	25	
2	ca	smoothed_cli	20200816	None	20200903	18	

	geo_value	signal_smcli	time_value_smcli	direction_smcli	issue_smcli	lag_smcli	missing_value_s
3	ca	smoothed_cli	20200823	None	20200903	11	
4	ca	smoothed_cli	20200830	None	20201119	81	
...	...	...	...	...	...	...	
61	ca	smoothed_cli	20211003	None	20211008	5	
62	ca	smoothed_cli	20211010	None	20211015	5	
63	ca	smoothed_cli	20211017	None	20211022	5	
64	ca	smoothed_cli	20211024	None	20211029	5	
65	ca	smoothed_cli	20211031	None	20211105	5	

66 rows × 34 columns

In [30]:

```
# smooth_cli : COVID-Like Symptoms
# smooth_hh_cmnty_cli : COVID-Like Symptoms in Community
# confirmed_7dav_incidence_prop : Cases per 100,000 People

import matplotlib.pyplot as plt

CA_df[['time_value_smcli', 'issue_smcli','lag_smcli', 'value_smcli',
      'time_value_smhh','issue_smcli', 'lag_smcli', 'value_smhh',
      'time_value_con7', 'issue_con7','lag_con7', 'value_con7']]
```

Out[30]:

	time_value_smcli	issue_smcli	lag_smcli	value_smcli	time_value_smhh	issue_smcli	lag_smcli	va
0	20200802	20200903	32	0.632992	20200802	20200903	32	
1	20200809	20200903	25	0.585508	20200809	20200903	25	
2	20200816	20200903	18	0.544658	20200816	20200903	18	
3	20200823	20200903	11	0.493013	20200823	20200903	11	
4	20200830	20201119	81	0.387622	20200830	20201119	81	
...	...	...	...	...	...	...	...	
61	20211003	20211008	5	1.025760	20211003	20211008	5	
62	20211010	20211015	5	0.950833	20211010	20211015	5	
63	20211017	20211022	5	0.803861	20211017	20211022	5	
64	20211024	20211029	5	1.020906	20211024	20211029	5	
65	20211031	20211105	5	0.952377	20211031	20211105	5	

66 rows × 12 columns

In [31]:

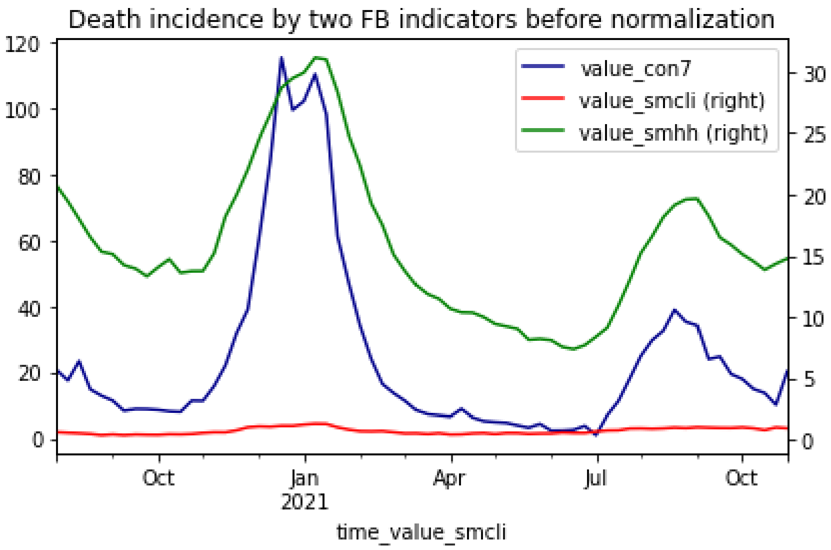
```
CA_df['time_value_smcli'] = pd.to_datetime(CA_df['time_value_smcli'],format='%Y%m%d')
CA_df['time_value_smhh'] = pd.to_datetime(CA_df['time_value_smhh'],format='%Y%m%d')
CA_df['time_value_con7'] = pd.to_datetime(CA_df['time_value_con7'],format='%Y%m%d')
CA_df['issue_smcli'] = pd.to_datetime(CA_df['issue_smcli'],format='%Y%m%d')
CA_df['issue_smhh'] = pd.to_datetime(CA_df['issue_smhh'],format='%Y%m%d')
CA_df['issue_con7'] = pd.to_datetime(CA_df['issue_con7'],format='%Y%m%d')
```

In [32]:
```
CA_df[['value_smcli','value_smhh','value_con7']].describe()
```

Out[32]:

	value_smcli	value_smhh	value_con7
count	66.000000	66.000000	66.000000
mean	0.735004	16.057523	24.539989
std	0.258101	6.212961	27.918370
min	0.387622	7.377266	1.005165
25%	0.530021	11.578685	8.003312
50%	0.630900	14.930156	14.229803
75%	0.962807	19.252738	28.491176
max	1.323246	31.142245	115.274324

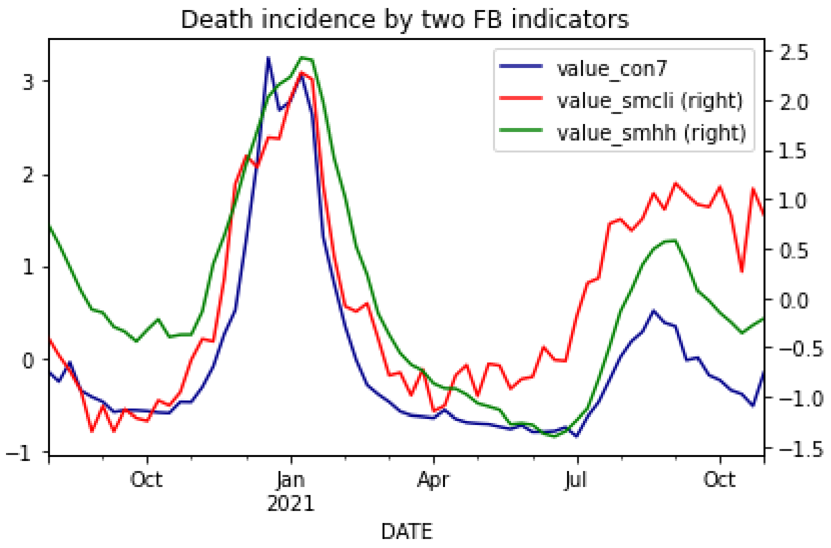
In [33]:
```
ax = CA_df.plot(kind='line', x='time_value_smcli', y='value_con7', color='DarkBlue')

ax2=CA_df.plot(kind='line', x='time_value_smcli', y=['value_smcli', 'value_smhh'], sec
ax2.set_title("Death incidence by two FB indicators before normalization")
plt.tight_layout()
plt.show()
```



In [34]:
```
# normalized_df=(df-df.mean())/df.std()

CA_df_norm = CA_df
```

In [35]:
```
CA_df_norm['value_smcli'] = (CA_df_norm['value_smcli'] - CA_df_norm['value_smcli'].mea
CA_df_norm['value_smhh'] = (CA_df_norm['value_smhh'] - CA_df_norm['value_smhh'].mean()
CA_df_norm['value_con7'] = (CA_df_norm['value_con7'] - CA_df_norm['value_con7'].mean()
```

In [36]:
```
ax = CA_df_norm.plot(kind='line', x='time_value_smcli', y='value_con7', color='DarkBlu

ax2=CA_df_norm.plot(kind='line', x='time_value_smcli', y=['value_smcli', 'value_smhh']
                    secondary_y=True,color=['Red','Green'],xlabel='DATE', ax=ax)

ax2.set_title("Death incidence by two FB indicators")
plt.tight_layout()
plt.show()
```



It seems like FB-indicator that has smoothed_cli signal is more variable than smoothed_hh_cmnty_cli signal. The reason is that I had to normalized the values because smoothed_cli value was relatively small compare to the other values. Therefore, after I normalized the values, the smoothed_cli FB-indicator was stretched which turned out to be more variable. Hence, we could say that it is better leading indicator because we can observe the changes more precisely.

Exercise 4. Using read_sql_query, for each variable compute the average of all states grouped by date. Read it into a pandas dataframe. The averaging should be done in SQL and then the pd.DataFrame should be constructed, the average should not happen after you read in the full data. In the end you should have one row for each date. The rest of this is identical to the previous exercise...

For the two FB indicator variables, produce a plot comparing that to the death indicences. Plot the FB indicator variables as a time series in a secondary y axis and the death indicence as the primary y axis. You can just use pd.DataFrame.plot(). You should have the actual date on the X axis and not just an index number.

In [37]:

```
sql_query = """
SELECT time_value_smcli as DATE, avg(value_smcli) as smoothed_cli,avg(value_smhh) as s
FROM state
GROUP BY time_value_smcli, time_value_smhh, time_value_con7"""

AVG_df = pd.read_sql_query(sql_query, combined_conn )
AVG_df['DATE'] = pd.to_datetime(AVG_df['DATE'],format='%Y%m%d')
AVG_df
```

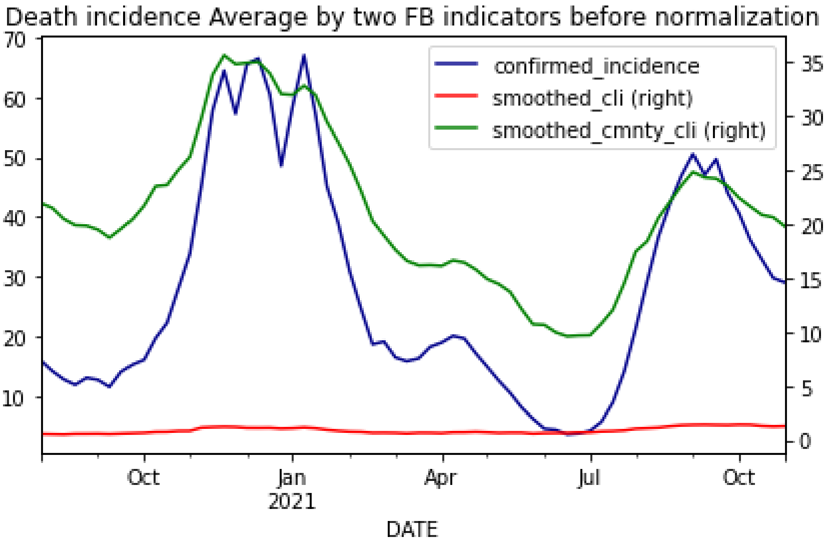
Out[37]:

	DATE	smoothed_cli	smoothed_cmnty_cli	confirmed_incidence
0	2020-08-02	0.574020	21.953618	15.915165
1	2020-08-09	0.553214	21.510479	14.169415
2	2020-08-16	0.531083	20.494328	12.775469
3	2020-08-23	0.585938	19.913992	11.864382
4	2020-08-30	0.589086	19.860055	13.037337
...	...	...	...	...
61	2021-10-03	1.437019	22.451489	40.638336

	DATE	smoothed_cli	smoothed_cmnty_cli	confirmed_incidence
62	2021-10-10	1.426947	21.640540	36.076048
63	2021-10-17	1.322472	20.870089	32.881530
64	2021-10-24	1.269287	20.645673	29.769561
65	2021-10-31	1.301458	19.821706	29.040812

66 rows × 4 columns

```
In [38]:
ax = AVG_df.plot(kind='line', x='DATE', y='confirmed_incidence', color='DarkBlue')

ax2=AVG_df.plot(kind='line', x='DATE', y=['smoothed_cli', 'smoothed_cmnty_cli'], secor
ax2.set_title("Death incidence Average by two FB indicators before normalization")
plt.tight_layout()
plt.show()
```



```
In [39]:
AVG_df_norm = AVG_df

AVG_df_norm['smoothed_cli'] = (AVG_df_norm['smoothed_cli'] - AVG_df_norm['smoothed_cli
AVG_df_norm['smoothed_cmnty_cli'] = (AVG_df_norm['smoothed_cmnty_cli'] - AVG_df_norm['
AVG_df_norm['confirmed_incidence'] = (AVG_df_norm['confirmed_incidence'] - AVG_df_norm
```

```
In [40]:
AVG_df_norm
```

Out[40]:

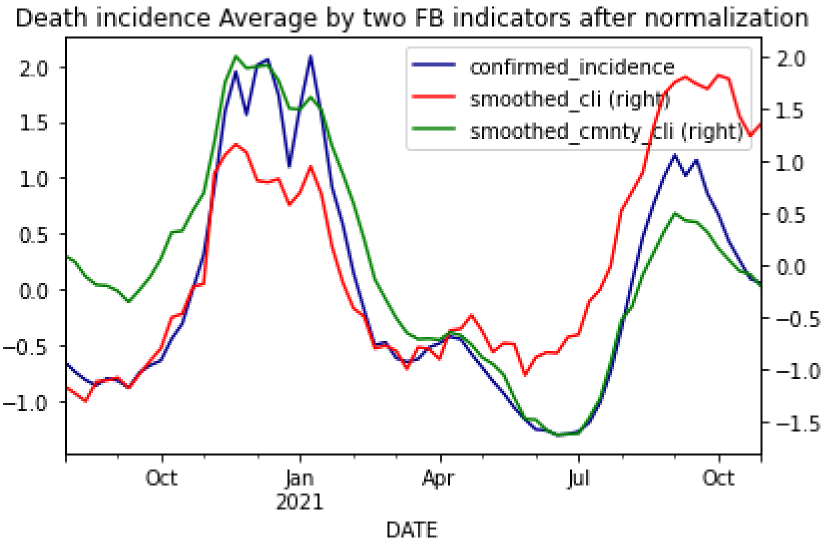
	DATE	smoothed_cli	smoothed_cmnty_cli	confirmed_incidence
0	2020-08-02	-1.161440	0.097384	-0.645830
1	2020-08-09	-1.233546	0.035380	-0.739223
2	2020-08-16	-1.310241	-0.106799	-0.813796
3	2020-08-23	-1.120139	-0.188000	-0.862537
4	2020-08-30	-1.109228	-0.195547	-0.799787
...	...	...	...	...
61	2021-10-03	1.829354	0.167046	0.676798
62	2021-10-10	1.794448	0.053578	0.432727
63	2021-10-17	1.432381	-0.054223	0.261828

	DATE	smoothed_cli	smoothed_cmnty_cli	confirmed_incidence
64	2021-10-24	1.248064	-0.085623	0.095346
65	2021-10-31	1.359556	-0.200912	0.056359

66 rows × 4 columns

In [41]:

```
ax = AVG_df_norm.plot(kind='line', x='DATE', y='confirmed_incidence', color='DarkBlue'

ax2 = AVG_df_norm.plot(kind='line', x='DATE', y=['smoothed_cli', 'smoothed_cmnty_cli']
                      secondary_y=True,color=['Red','Green'],xlabel='DATE', ax=ax)

ax2.set_title("Death incidence Average by two FB indicators after normalization")
plt.tight_layout()
plt.show()
```



Exercise 5 The Pearson correlation between variables a and b can be computed from 5 quantities...

```
n = count of rows
cross = sum(a * b)
sqr_1 = sum(a * a)
sqr_2 = sum(b * b)
mu_1 = avg(a)
mu_2 = avg(b)
```

using the following equation

```
(cross - n*mu_1*mu_2) / ((sqr_1 - n*mu_1**2) * (sqr_2 -
n*mu_2**2))**0.5
```

Using only SQL commands, compute these quantities for variables smoothed_hh_cmnty_cli and smoothed_cli and grouped by date, reading this into a DataFrame. Compute the Pearson correlation for each date using these quantities, and plot the time series of pearson correlation.

In [42]:

```
sqlm = """
SELECT time_value_smcli as DATE, count(*) as n, sum(value_smcli * value_smhh) as cross
FROM state
GROUP BY time_value_smcli, time_value_smhh, time_value_con7
"""
```

```
PC_df = pd.read_sql_query(sqlm, combined_conn)
```

In [43]:

```
PC_df['Pearson_Corr'] = (PC_df['cross'] - PC_df['n']*PC_df['mu_1']*PC_df['mu_2'])/((PC
```

In [44]:

```
PC_df['DATE'] = pd.to_datetime(PC_df['DATE'],format='%Y%m%d')
```

In [45]:

```
PC_df
```

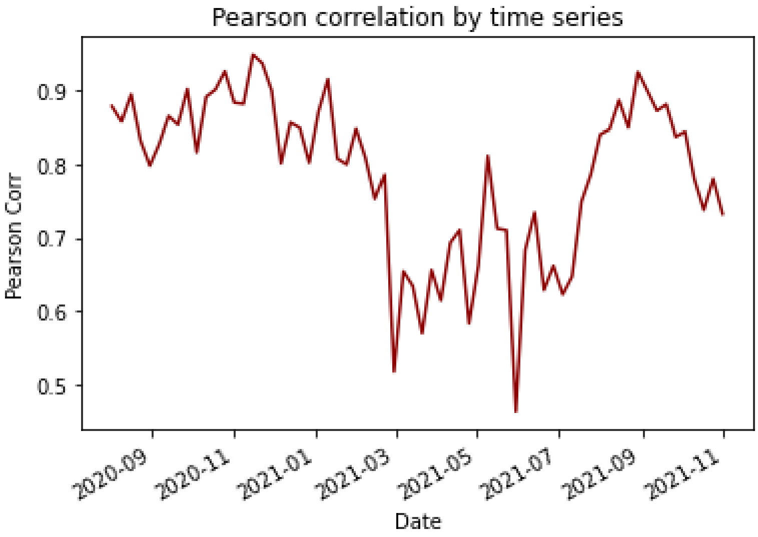
Out[45]:

	DATE	n	cross	sqr_1	sqr_2	mu_1	mu_2	Pearson_Corr
0	2020-08-02	51	728.738019	20.198575	27406.761105	0.574020	21.953618	0.878458
1	2020-08-09	51	680.666318	18.566663	26097.445373	0.553214	21.510479	0.857869
2	2020-08-16	51	621.989518	16.839664	23698.226133	0.531083	20.494328	0.894634
3	2020-08-23	51	666.420844	21.020592	22318.089812	0.585938	19.913992	0.832099
4	2020-08-30	51	667.706250	21.445257	22230.500342	0.589086	19.860055	0.798028
...	...	...	...	...	...	...	...	...
61	2021-10-03	51	1785.479387	118.382480	27815.001177	1.437019	22.451489	0.844003
62	2021-10-10	51	1710.256945	119.347296	25830.233433	1.426947	21.640540	0.779403
63	2021-10-17	51	1528.213551	102.726999	24188.487728	1.322472	20.870089	0.737789
64	2021-10-24	51	1443.177847	91.543754	23733.396199	1.269287	20.645673	0.780139
65	2021-10-31	51	1409.770536	95.942302	21765.419315	1.301458	19.821706	0.732414

66 rows × 8 columns

In [46]:

```
fig, ax = plt.subplots()
ax.plot('DATE','Pearson_Corr', data=PC_df, color='DarkRed')
ax.set_title("Pearson correlation by time series")
ax.set_xlabel("Date")
ax.set_ylabel("Pearson Corr")
fig.autofmt_xdate()
plt.show();
```


Pearson correlation by time series
Pearson Corr
Date