Prophet modeling

Here we'll try to mimic the same process of finding the best train-test split, but for Facebook's Prophet library. Let's import everything.

In [1]:

```
from fbprophet import Prophet
from prophet.diagnostics import cross_validation
from prophet.plot import plot_cross_validation_metric
from prophet.diagnostics import performance_metrics
from sklearn.linear_model import LinearRegression
from iexfinance.stocks import Stock
import random
#from trafalgar import*
import pandas as pd
import pandas.tseries
import numpy as np
import seaborn as sb
import matplotlib.pyplot as plt
import statsmodels.api as sm
import matplotlib
import pmdarima as pm
import datetime as dt
from datetime import date
from datetime import timedelta
import yfinance as yf
import requests
from sklearn.model_selection import TimeSeriesSplit
from sktime.forecasting.model_selection import temporal_train_test_split
from pandas.plotting import lag_plot
from pandas import datetime
import re
from tiingo import TiingoClient
import json
from pandas_datareader import data as pdr
```

In [2]:

```
yf.__version__
```

Out[2]:

```
'0.1.63'
```

The test case: C

Just like the previous notebook, we'll try to run through a simple test case and expand it to other stocks. We'll use Citicgroup again.

Quick note: I encountered a bug with my earlier library, yfinance, so I've had to switch to tiingo, so a lot of code will be hashed out from earlier. And in case I can get the bugs worked out.

In [3]:

```
c = yf.Ticker("C")
```

In [4]:

```
df=c.history(period="2y")
```

In [5]:

```
df.head()
```

Out[5]:

Date	Open	High	Low	Close	Volume	Dividends	Stock Splits
2019-07-22	65.965877	66.497558	65.928565	66.329659	7930600	0.0	0
2019-07-23	66.534877	67.327735	66.506895	67.150505	11804300	0.0	0
2019-07-24	66.842676	68.167215	66.842676	68.101921	12512900	0.0	0
2019-07-25	68.055285	68.167220	66.161752	66.590828	15698300	0.0	0
2019-07-26	67.299737	67.756795	67.019902	67.309067	10625900	0.0	0

In [6]:

```
df.head()
```

Out[6]:

Date	Open	High	Low	Close	Volume	Dividends	Stock Splits
2019-07-22	65.965877	66.497558	65.928565	66.329659	7930600	0.0	0
2019-07-23	66.534877	67.327735	66.506895	67.150505	11804300	0.0	0
2019-07-24	66.842676	68.167215	66.842676	68.101921	12512900	0.0	0
2019-07-25	68.055285	68.167220	66.161752	66.590828	15698300	0.0	0
2019-07-26	67.299737	67.756795	67.019902	67.309067	10625900	0.0	0

In [7]:

```
deltas=['d','m','y']
att='200d'
```

In [8]:

```
att[-1]
```

Out[8]:

```
'd'
```

In [9]:

```
spl=len(att)-1
att[:spl]
```

Out[9]:

```
'200'
```

In [10]:

```
end=att[:spl] + ' days'
end
```

Out[10]:

```
'200 days'
```

In [11]:

```
df1=df['Close']
```

In [12]:

```
df1.head()
```

Out[12]:

```
Date
2019-07-22    66.329659
2019-07-23    67.150505
2019-07-24    68.101921
2019-07-25    66.590828
2019-07-26    67.309067
Name: Close, dtype: float64
```

In [13]:

```
df1=df1.to_frame()
```

In [14]:

```
# instantiate Prophet
prof_1 = Prophet()
```

In [15]:

```
df1.head()
```

Out[15]:

	Close
Date	
2019-07-22	**66.329659**
2019-07-23	**67.150505**
2019-07-24	**68.101921**
2019-07-25	**66.590828**
2019-07-26	**67.309067**

In [16]:

```
df1.index.names = ['ds']
df1.columns=['y']
```

In [17]:

```
df1.reset_index(level=0, inplace=True)
```

In [18]:

```
df1.head()
```

Out[18]:

	ds	y
0	**2019-07-22**	**66.329659**
1	**2019-07-23**	**67.150505**
2	**2019-07-24**	**68.101921**
3	**2019-07-25**	**66.590828**
4	**2019-07-26**	**67.309067**

In [19]:

```
df1.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 506 entries, 0 to 505
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype
```

```
 0   ds      506 non-null    datetime64[ns]
 1   y       506 non-null    float64
dtypes: datetime64[ns](1), float64(1)
memory usage: 8.0 KB
```

In [20]:

```
prof_1.fit(df1)
```

```
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to ov
erride this.
```

Out[20]:

```
<fbprophet.forecaster.Prophet at 0x22152b83ba8>
```

In [21]:

```
#Create a new dataframe for the predictions, 3 weeks out
future = prof_1.make_future_dataframe(periods=21)
```

In [22]:

```
forecast = prof_1.predict(future)
```

In [23]:

```
forecast.tail()
```

Out[23]:

	ds	trend	yhat_lower	yhat_upper	trend_lower	trend_upper	additive_terms	additive_terms_lower	additive_terms_
522	**2021-08-08**	**75.221873**	**71.812908**	**81.104707**	**74.972228**	**75.459852**	**1.195774**	**1.195774**	**1.1**
523	**2021-08-09**	**75.292011**	**68.825221**	**78.755743**	**75.001984**	**75.560891**	**-1.283622**	**-1.283622**	**-1.2**
524	**2021-08-10**	**75.362149**	**68.813821**	**78.827274**	**75.024008**	**75.658578**	**-1.775524**	**-1.775524**	**-1.7**
525	**2021-08-11**	**75.432288**	**68.412270**	**78.549017**	**75.076825**	**75.760831**	**-1.994478**	**-1.994478**	**-1.9**
526	**2021-08-12**	**75.502426**	**68.111761**	**78.271051**	**75.078017**	**75.866483**	**-2.323817**	**-2.323817**	**-2.3**

In [24]:

```
forecast.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 527 entries, 0 to 526
Data columns (total 19 columns):
 #   Column                     Non-Null Count  Dtype
---  ------                     --------------  -----
 0   ds                         527 non-null    datetime64[ns]
 1   trend                      527 non-null    float64
 2   yhat_lower                 527 non-null    float64
 3   yhat_upper                 527 non-null    float64
 4   trend_lower                527 non-null    float64
 5   trend_upper                527 non-null    float64
 6   additive_terms             527 non-null    float64
 7   additive_terms_lower       527 non-null    float64
 8   additive_terms_upper       527 non-null    float64
 9   weekly                     527 non-null    float64
 10  weekly_lower               527 non-null    float64
 11  weekly_upper               527 non-null    float64
 12  yearly                     527 non-null    float64
 13  yearly_lower               527 non-null    float64
```

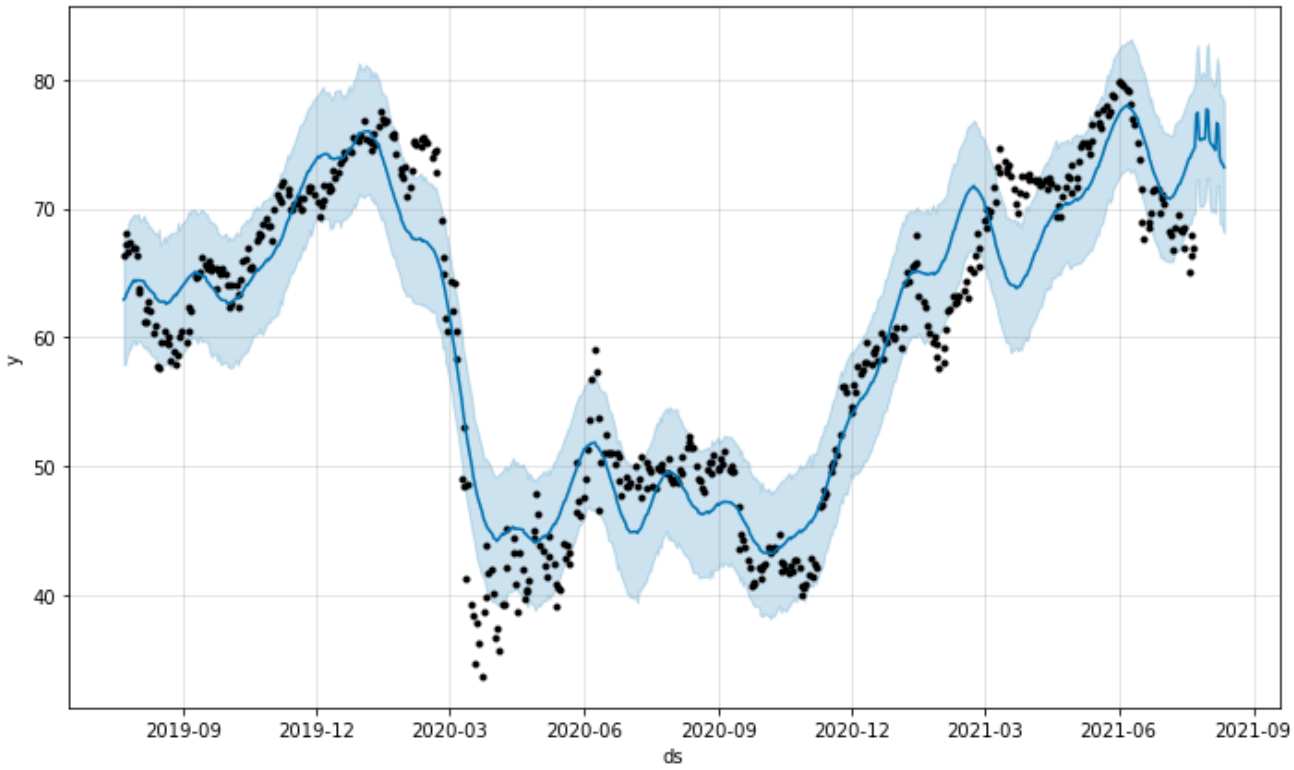
```
 14  yearly_upper                527 non-null    float64
 15  multiplicative_terms        527 non-null    float64
 16  multiplicative_terms_lower  527 non-null    float64
 17  multiplicative_terms_upper  527 non-null    float64
 18  yhat                        527 non-null    float64
dtypes: datetime64[ns](1), float64(18)
memory usage: 78.4 KB
```

In [25]:

```
proph_pred=forecast['yhat']
```

In [26]:

```
prof_1.plot(forecast)
plt.show()
```



In [27]:

```
df1_cv = cross_validation(prof_1, initial='30 days', period='7 days', horizon = '14 days
')
```

```
INFO:prophet:Making 99 forecasts with cutoffs between 2019-08-22 00:00:00 and 2021-07-08
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 18.
INFO:fbprophet:n_changepoints greater than number of observations. Using 22.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
```

In [28]:

```
df1_pm = performance_metrics(df1_cv)
```

In [29]:

```
trains=['30 days','60 days','180 days']
tests=['7 days','14 days','21 days']
```

In [30]:

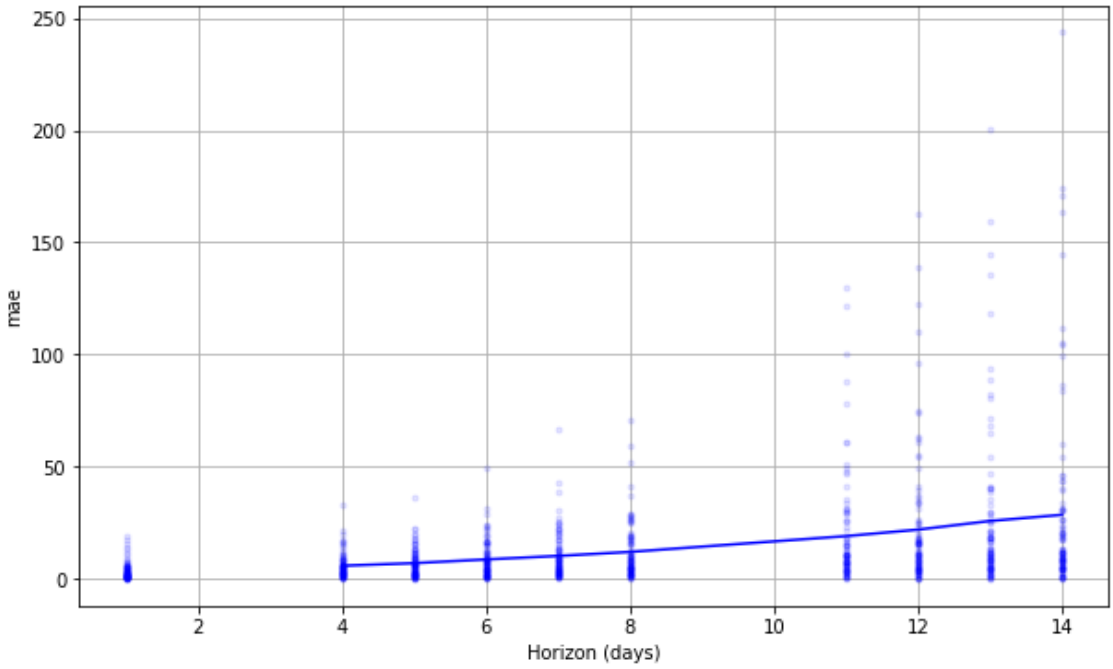
```
df1_pm.tail()
```

Out[30]:

	horizon	mse	rmse	mae	mape	mdape	smape	coverage
4	8 days	299.939991	17.318776	11.819715	0.196839	0.130225	0.194451	0.180684
5	11 days	961.160333	31.002586	18.867193	0.316191	0.172364	0.305642	0.125308
6	12 days	1354.790303	36.807476	21.765605	0.363490	0.189183	0.340397	0.111111
7	13 days	1973.067178	44.419221	25.621233	0.430302	0.217788	0.388603	0.113402
8	14 days	2675.748387	51.727637	28.378834	0.470544	0.212392	0.395549	0.103093

In [31]:

```
fig = plot_cross_validation_metric(df1_cv, metric='mae')
```



STONKS (Again)!!!

Just like in the ARIMA notebook, I want to test a number of train-test splits with Prophet. Since it works a little different from ARIMA, the code will be a little different, but still borrowing a lot. Here, we can import our stock symbols, and clean them up.

In [32]:

```
sp_500=pd.read_csv('Data/constituents_csv.csv')
nsdq=pd.read_csv('Data/nasdaq1.csv')
dow_30=pd.read_excel('Data/dow-jones-industrial-average-components.xls')
```

In [33]:

```
new_cols=['Name','Symbol','Weight%']
dow_30.columns=new_cols
```

In [34]:

```
nsdq.head()
```

Out[34]:

	Unnamed: 0	Symbol	Company Name
0	0	AAIT	iShares MSCI All Country Asia Information Tech...

	Unnamed: 0	Symbol	Company Name
1	1	AAL	American Airlines Group, Inc.
2	2	AAME	Atlantic American Corporation
3	3	AAOI	Applied Optoelectronics, Inc.
4	4	AAON	AAON, Inc.

In [35]:

```
nsdq.drop(columns='Unnamed: 0',inplace=True)
```

In [36]:

```
len(nsdq)
```

Out[36]:

1734

The following cells were necessary for cleaning the nasdaq stock list. But I saved it, and that's what I'm using.

In [37]:

```
#no_data=[]
#for each in nsdq['Symbol']:
#    x=yf.Ticker(each)
#    df=x.history(period='1d')
#    if len(df)==0:
#        no_data.append(each)
```

In [38]:

```
#len(no_data)
```

In [39]:

```
#nd_index=[]
#for each in no_data:
#    y=nsdq.loc[nsdq['Symbol']==each].index
#    nd_index.append(y[0])
```

In [40]:

```
#nsdq = nsdq.drop(labels=nd_index,drop=True, axis=0)
#nsdq.reset_index()
```

In [41]:

```
#nsdq.to_csv("/Users/Daniel/Documents/Flatiron/Capstone/Project/nasdaq1.csv")
```

In [42]:

```
def tt_test_p (asset,train_val,test_val):
    """This function will take in a financial asset (stock, etf) as well as 2 lists of in
tegers (training and testing days).
    Then the asset will be looked up through yahoo finance and gather the price history.
It will then run through the values
    of the training and testing lists and run prophet models on all of them. It will reco
rd the metrics and return a
    dataframe with all the results."""

    stock = yf.Ticker(asset)
    df1=stock.history(period='2y')
    print("Processing: ",stock)
    prof_1 = Prophet()
    df1=df1['Close']
    df1=df1.to_frame()
    df1.index.names = ['ds']
    df1.columns=['y']
```

```
    df1.reset_index(level=0, inplace=True)
    prof_1.fit(df1)
    future = prof_1.make_future_dataframe(periods=21)
    forecast = prof_1.predict(future)
    for train_val in trains:
        for test_val in tests:
            df1_cv = cross_validation(prof_1, initial=train_val, period=test_val, horizo
n = '21 days')
            df1_pm = performance_metrics(df1_cv)
            print('Training: ', train_val)
            print('Testing: ', test_val)
            print (df1_pm.tail())

    return forecast
```

In [43]:

```
cols2=['Symbol','Train_Len','Test_Len','MAE','RMSE']
reslts = pd.DataFrame(columns=cols2)
reslts.reset_index()
```

Out[43]:

index	Symbol	Train_Len	Test_Len	MAE	RMSE

In [44]:

```
results_CAT=tt_test_p('CAT',trains,tests)
```

```
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to ov
erride this.
```

```
Processing:  yfinance.Ticker object <CAT>
```

```
INFO:prophet:Making 98 forecasts with cutoffs between 2019-08-22 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 18.
INFO:fbprophet:n_changepoints greater than number of observations. Using 22.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 49 forecasts with cutoffs between 2019-08-29 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  7 days
   horizon           mse        rmse         mae      mape     mdape  \
9  15 days  14081.636698  118.666072   56.370148  0.424938  0.129169
10 18 days  31779.382010  178.267726   77.124908  0.583894  0.149977
11 19 days  46985.803870  216.762090   91.371872  0.690002  0.136772
12 20 days  56904.901220  238.547482   97.103331  0.734245  0.122270
13 21 days  76548.677425  276.674317  111.848019  0.846784  0.143794

       smape  coverage
9   0.342360  0.148936
10  0.393280  0.121482
11  0.423197  0.104807
12  0.439419  0.103488
13  0.468400  0.089982
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 22.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 33 forecasts with cutoffs between 2019-08-29 00:00:00 and 2021-07-01
00:00:00
```

```
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  14 days
   horizon           mse         rmse          mae      mape     mdape  \
9  15 days  14225.386401  119.270224   53.696336  0.397086  0.119754
10 18 days  33796.263333  183.837600   73.806354  0.545734  0.111239
11 19 days  50635.571903  225.023492   88.239568  0.655285  0.097225
12 20 days  57806.417415  240.429652   88.612827  0.664990  0.141793
13 21 days  82679.597762  287.540602  106.924913  0.806204  0.155568

       smape  coverage
9   0.305102  0.134402
10  0.351024  0.099068
11  0.393283  0.085050
12  0.407489  0.068513
13  0.446834  0.049107
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 22.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 93 forecasts with cutoffs between 2019-09-26 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  21 days
   horizon            mse         rmse          mae      mape     mdape  \
9  15 days   21289.018757  145.907569   68.820655  0.534181  0.122917
10 18 days   46619.837476  215.916274   90.872850  0.707162  0.137109
11 19 days   67402.819403  259.620530  105.842290  0.816667  0.117197
12 20 days   86356.386011  293.864571  118.141535  0.907733  0.133697
13 21 days  108480.043632  329.363088  128.849838  0.989780  0.132180

       smape  coverage
9   0.344911  0.097739
10  0.353601  0.078723
11  0.382096  0.104965
12  0.411040  0.102515
13  0.418456  0.070479
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 47 forecasts with cutoffs between 2019-09-26 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  7 days
   horizon           mse         rmse         mae      mape     mdape     smape  \
9  15 days  12537.516963  111.971054  52.143933  0.389352  0.116175  0.326270
10 18 days  28244.574650  168.061223  70.026818  0.524561  0.139177  0.364386
11 19 days  41773.181489  204.384886  82.119698  0.611702  0.134983  0.385777
12 20 days  50035.039822  223.685135  85.916894  0.639124  0.133445  0.394631
13 21 days  67964.361046  260.699753  98.839719  0.735644  0.137563  0.416080

    coverage
9   0.172298
10  0.136957
11  0.110623
12  0.101669
13  0.091438
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 31 forecasts with cutoffs between 2019-10-10 00:00:00 and 2021-07-01
00:00:00
```

```
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  14 days
   horizon           mse        rmse         mae      mape     mdape     smape  \
9  15 days  10582.160725  102.869630   44.751334  0.324306  0.094942  0.268366
10 18 days  25561.543409  159.879778   59.716962  0.431302  0.105282  0.294652
11 19 days  38738.869963  196.821924   71.343673  0.516756  0.103774  0.332768
12 20 days  42655.337705  206.531687   69.476680  0.506732  0.134095  0.348229
13 21 days  63751.007035  252.489618   85.337902  0.626008  0.134666  0.387161

    coverage
9   0.155287
10  0.112619
11  0.088824
12  0.071451
13  0.051265
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 76 forecasts with cutoffs between 2020-01-23 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  21 days
   horizon           mse        rmse         mae      mape     mdape  \
9  15 days  16322.963491  127.761354   58.464798  0.451291  0.129172
10 18 days  35584.324810  188.638079   74.152995  0.573262  0.118584
11 19 days  51361.734168  226.631274   85.086056  0.648104  0.104124
12 20 days  66023.279630  256.949955   94.503834  0.713551  0.126211
13 21 days  83207.635307  288.457337  102.215648  0.769518  0.126175

       smape  coverage
9   0.323397  0.127273
10  0.320809  0.097403
11  0.344550  0.112013
12  0.371410  0.109238
13  0.376310  0.075000
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 38 forecasts with cutoffs between 2020-01-30 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  180 days
Testing:  7 days
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days  1845.480316  42.959054  26.378122  0.197642  0.083046  0.192440
10 18 days  2623.039243  51.215615  29.458428  0.226645  0.083046  0.209472
11 19 days  3133.402553  55.976804  31.562902  0.241378  0.089305  0.226127
12 20 days  3439.504762  58.647291  32.998636  0.249614  0.096818  0.236796
13 21 days  3813.937498  61.757085  34.454501  0.260913  0.099329  0.244475

    coverage
9   0.193818
10  0.159155
11  0.135705
12  0.122488
13  0.101316
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 26 forecasts with cutoffs between 2020-01-23 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
```

```
. Consider increasing initial.
```

```
Training:  180 days
Testing:  14 days
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days   844.415393  29.058826  21.353366  0.150006  0.080631  0.167027
10 18 days   934.505871  30.569689  22.416441  0.156593  0.075015  0.170099
11 19 days  1195.094502  34.570139  24.732547  0.174926  0.090316  0.198824
12 20 days  1398.035494  37.390313  26.663914  0.189184  0.097795  0.219781
13 21 days  1575.793505  39.696266  27.850901  0.199015  0.088908  0.229328

    coverage
9   0.175926
10  0.129630
11  0.109989
12  0.086745
13  0.061891
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
```

```
Training:  180 days
Testing:  21 days
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days  3065.019745  55.362620  31.218013  0.251450  0.102076  0.209599
10 18 days  4430.523137  66.562175  33.920783  0.279765  0.117197  0.199091
11 19 days  5287.009273  72.711823  36.203366  0.291335  0.097113  0.226097
12 20 days  5913.710726  76.900655  38.232270  0.299202  0.093696  0.248777
13 21 days  6504.887295  80.652882  39.843000  0.304486  0.108372  0.256124

    coverage
9   0.126486
10  0.099882
11  0.132883
12  0.126819
13  0.088358
```

In [45]:

```
results_MMM=tt_test_p('MMM',trains,tests)
```

```
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to ov
erride this.
```

```
Processing:  yfinance.Ticker object <MMM>
```

```
INFO:prophet:Making 98 forecasts with cutoffs between 2019-08-22 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 18.
INFO:fbprophet:n_changepoints greater than number of observations. Using 22.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 49 forecasts with cutoffs between 2019-08-29 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  7 days
   horizon            mse         rmse         mae      mape     mdape  \
9  15 days   19584.880196  139.945990   65.706700  0.421617  0.114499
10 18 days   44393.525044  210.697710   91.652212  0.587120  0.129993
11 19 days   65513.379084  255.955815  108.511197  0.692952  0.118303
12 20 days   84341.588569  290.416233  120.643289  0.770383  0.117025
13 21 days  101195.123900  318.111810  127.992282  0.821257  0.135961
```

```
       smape  coverage
9   0.348675  0.195035
10  0.406874  0.204759
11  0.429670  0.184949
12  0.438039  0.154653
13  0.439478  0.152926
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 22.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 33 forecasts with cutoffs between 2019-08-29 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  14 days
   horizon           mse        rmse         mae      mape     mdape  \
9  15 days  21890.510708  147.954421   69.194706  0.437402  0.120160
10 18 days  48710.894268  220.705447   97.444791  0.615167  0.100111
11 19 days  70245.724988  265.039101  114.567717  0.726643  0.091700
12 20 days  87987.145732  296.626273  125.752459  0.799766  0.122913
13 21 days  97914.025689  312.912169  127.899716  0.819148  0.130091

       smape  coverage
9   0.348159  0.219825
10  0.396171  0.212422
11  0.409796  0.205648
12  0.410555  0.164140
13  0.400796  0.190774
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 22.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 93 forecasts with cutoffs between 2019-09-26 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  21 days
   horizon            mse        rmse         mae      mape     mdape  \
9  15 days   24820.841789  157.546316   74.524774  0.483124  0.125160
10 18 days   52178.228716  228.425543  101.553609  0.663267  0.125160
11 19 days   73151.750573  270.465803  117.172517  0.761008  0.127459
12 20 days   91521.833693  302.525757  129.590143  0.840341  0.132394
13 21 days  112210.832575  334.978854  141.705236  0.921339  0.135961

       smape  coverage
9   0.301350  0.097739
10  0.380970  0.142553
11  0.418906  0.177305
12  0.432818  0.206963
13  0.441331  0.214096
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 47 forecasts with cutoffs between 2019-09-26 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  7 days
   horizon           mse        rmse         mae      mape     mdape  \
9  15 days  15922.971376  126.186257   59.160930  0.380625  0.108886
10 18 days  36750.157663  191.703306   81.717038  0.524269  0.115550
```

```
10 16 days  30750.157665  191.705306   81.717056  0.524269  0.115550
11 19 days  54722.333440  233.928052   96.227145  0.613473  0.117577
12 20 days  71001.925831  266.461866  106.540190  0.677832  0.125075
13 21 days  84485.226879  290.663425  111.434479  0.712460  0.132506

       smape  coverage
9   0.335183  0.198458
10  0.383683  0.216588
11  0.397859  0.195259
12  0.402011  0.155673
13  0.399317  0.165245
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 31 forecasts with cutoffs between 2019-10-10 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  14 days
   horizon           mse        rmse        mae      mape     mdape     smape  \
9  15 days  13585.748564  116.557919  54.348527  0.344498  0.109078  0.317553
10 18 days  30873.901610  175.709708  74.940056  0.473486  0.097135  0.358241
11 19 days  45030.441320  212.203773  87.820526  0.555502  0.103086  0.369437
12 20 days  57078.982090  238.912080  96.266050  0.608792  0.120351  0.368682
13 21 days  58726.595865  242.335709  93.866890  0.597989  0.131277  0.355459

    coverage
9   0.229597
10  0.237449
11  0.222060
12  0.186091
13  0.206360
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 76 forecasts with cutoffs between 2020-01-23 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  21 days
   horizon           mse        rmse         mae      mape     mdape  \
9  15 days  13169.203105  114.757148   55.826421  0.366923  0.117635
10 18 days  27979.200307  167.269843   74.047688  0.490965  0.119911
11 19 days  39290.584946  198.218528   84.647457  0.554015  0.122881
12 20 days  49556.100233  222.611995   93.196947  0.606952  0.119744
13 21 days  61320.655340  247.630078  101.421784  0.662492  0.136810

       smape  coverage
9   0.254018  0.104545
10  0.309971  0.152597
11  0.332805  0.189123
12  0.343262  0.197947
13  0.352341  0.218182
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 38 forecasts with cutoffs between 2020-01-30 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  180 days
Testing:  7 days
```

```
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days  2379.554256  48.780675  26.774863  0.177557  0.080437  0.188989
10 18 days  3670.144472  60.581717  30.939552  0.210085  0.081530  0.217636
11 19 days  4461.591141  66.795143  33.544754  0.225975  0.090182  0.229607
12 20 days  5007.171748  70.761372  35.685683  0.238131  0.099967  0.236123
13 21 days  5615.231877  74.934851  37.510835  0.251431  0.088989  0.241987

    coverage
9   0.248727
10  0.267222
11  0.239657
12  0.187321
13  0.199880
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 26 forecasts with cutoffs between 2020-01-23 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  180 days
Testing:  14 days
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days   776.707184  27.869467  18.624050  0.117959  0.077260  0.136504
10 18 days  1169.635852  34.199939  20.450709  0.130420  0.058023  0.161755
11 19 days  1521.112360  39.001440  22.770487  0.147077  0.069289  0.181461
12 20 days  1899.786529  43.586541  25.174704  0.162228  0.116819  0.191778
13 21 days  2309.106101  48.053159  26.854964  0.174131  0.069827  0.198267

    coverage
9   0.277778
10  0.296296
11  0.274972
12  0.207602
13  0.243177
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
```

```
Training:  180 days
Testing:  21 days
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days  3062.190947  55.337067  30.229309  0.208318  0.106569  0.185546
10 18 days  5191.534134  72.052301  36.120251  0.258644  0.108049  0.232170
11 19 days  6198.650465  78.731509  38.515857  0.270194  0.108870  0.247998
12 20 days  7115.455506  84.353159  40.642993  0.280432  0.085540  0.251635
13 21 days  8156.990674  90.316060  42.913675  0.294125  0.114600  0.256440

    coverage
9   0.126486
10  0.180964
11  0.224099
12  0.230769
13  0.257796
```

In [46]:

```
results_AXP=tt_test_p('AXP',trains,tests)
```

```
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to ov
erride this.
```

```
Processing:  yfinance.Ticker object <AXP>
```

```
INFO:prophet:Making 98 forecasts with cutoffs between 2019-08-22 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 18.
INFO:fbprophet:n_changepoints greater than number of observations. Using 22.
INFO:prophet:Making 49 forecasts with cutoffs between 2019-08-29 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  7 days
   horizon           mse        rmse        mae      mape     mdape     smape  \
9  15 days   7109.748458   84.319324  44.277285  0.406533  0.140316  0.351291
10 18 days  15766.688340  125.565474  60.672086  0.557334  0.156489  0.400720
11 19 days  23081.211832  151.925020  71.519858  0.648293  0.130631  0.420585
12 20 days  29375.300453  171.392242  77.989923  0.701150  0.127520  0.423625
13 21 days  34074.722776  184.593399  82.493604  0.738984  0.158063  0.435804

    coverage
9   0.180851
10  0.164722
11  0.171395
12  0.204299
13  0.232934
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 22.
INFO:prophet:Making 33 forecasts with cutoffs between 2019-08-29 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  14 days
   horizon           mse        rmse        mae      mape     mdape     smape  \
9  15 days   7015.243664   83.757051  45.169863  0.396576  0.112557  0.338232
10 18 days  16107.155856  126.913970  63.269358  0.555115  0.121081  0.389113
11 19 days  23746.288093  154.098307  74.293991  0.652938  0.122958  0.407195
12 20 days  29704.136228  172.348879  78.656835  0.696477  0.183258  0.395122
13 21 days  31041.213798  176.185169  79.551065  0.707424  0.194979  0.401357

    coverage
9   0.169971
10  0.130124
11  0.163455
12  0.200583
13  0.239881
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 22.
INFO:prophet:Making 93 forecasts with cutoffs between 2019-09-26 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  21 days
   horizon           mse        rmse        mae      mape     mdape     smape  \
9  15 days  10961.651421  104.697906  55.659261  0.528491  0.121489  0.335663
10 18 days  22804.295842  151.010913  73.792809  0.708800  0.105889  0.362296
11 19 days  31936.728457  178.708501  84.384389  0.788893  0.090174  0.376885
12 20 days  40305.511091  200.762325  92.685556  0.845596  0.126093  0.392271
13 21 days  50145.091431  223.930997  99.409960  0.898093  0.133221  0.391278

    coverage
9   0.141622
10  0.112057
11  0.093617
12  0.199226
13  0.244681
```

```
INFO:prophet:Making 47 forecasts with cutoffs between 2019-09-26 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  7 days
   horizon           mse        rmse        mae      mape     mdape     smape  \
9  15 days   5304.482373   72.831877  36.852474  0.342213  0.119812  0.312319
10 18 days  11236.002568  106.000012  48.369880  0.450285  0.124324  0.346544
11 19 days  16155.326411  127.103605  55.975606  0.511900  0.121397  0.361216
12 20 days  20181.723171  142.062392  59.924037  0.542365  0.142165  0.363162
13 21 days  21732.552298  147.419647  61.249499  0.552483  0.149234  0.373816

    coverage
9   0.187387
10  0.181733
11  0.184460
12  0.215375
13  0.245695
```

```
INFO:prophet:Making 31 forecasts with cutoffs between 2019-10-10 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  14 days
   horizon           mse        rmse        mae      mape     mdape     smape  \
9  15 days   5381.328950   73.357542  38.877820  0.342305  0.110500  0.316125
10 18 days  12672.516445  112.572272  53.866140  0.473181  0.117752  0.360831
11 19 days  18960.751465  137.698045  63.232396  0.556721  0.126041  0.376786
12 20 days  23830.697208  154.371944  66.367931  0.589001  0.160235  0.362424
13 21 days  23387.855629  152.930885  65.294581  0.581759  0.165906  0.366113

    coverage
9   0.177517
10  0.121438
11  0.163451
12  0.224198
13  0.257625
```

```
INFO:prophet:Making 76 forecasts with cutoffs between 2020-01-23 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  21 days
   horizon           mse        rmse        mae      mape     mdape     smape  \
9  15 days   6712.859311   81.932041  40.933744  0.401040  0.119809  0.251271
10 18 days  12778.427728  113.041708  50.842083  0.508792  0.102951  0.272013
11 19 days  17091.981238  130.736304  56.475540  0.542873  0.116974  0.290241
12 20 days  20964.607727  144.791601  60.823390  0.564441  0.123691  0.305832
13 21 days  25420.299119  159.437446  63.341322  0.580004  0.130567  0.304280

    coverage
9   0.151515
10  0.120130
11  0.099838
12  0.212610
13  0.260606
```

```
INFO:prophet:Making 38 forecasts with cutoffs between 2020-01-30 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  180 days
Testing:  7 days
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days  1973.367560  44.422602  23.096423  0.231412  0.097012  0.216633
10 18 days  3030.645492  55.051299  27.064228  0.277904  0.092799  0.239419
11 19 days  3589.645524  59.913651  29.183994  0.291797  0.094227  0.249986
12 20 days  3883.598709  62.318526  30.206382  0.295548  0.122631  0.256809
13 21 days  4377.735260  66.164456  31.403424  0.307262  0.089988  0.263007
```

```
    coverage
9   0.235636
10  0.215109
11  0.221739
12  0.260048
13  0.297010
```

```
INFO:prophet:Making 26 forecasts with cutoffs between 2020-01-23 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  180 days
Testing:  14 days
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days  1101.356012  33.186684  20.254910  0.187390  0.091955  0.196220
10 18 days  1518.064538  38.962348  23.646563  0.221055  0.092343  0.217219
11 19 days  1748.554572  41.815722  25.453883  0.241525  0.113280  0.230372
12 20 days  1854.966134  43.069318  26.350352  0.255120  0.124182  0.240819
13 21 days  2100.025030  45.826030  27.537672  0.271408  0.084656  0.249988

    coverage
9   0.231481
10  0.170370
11  0.211560
12  0.273879
13  0.313353


Training:  180 days
Testing:  21 days
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days  3738.033148  61.139457  27.121142  0.294049  0.085462  0.193497
10 18 days  5950.460775  77.139230  32.295357  0.364414  0.100432  0.209364
11 19 days  7004.182022  83.690991  35.060414  0.372086  0.090174  0.228440
12 20 days  7691.765901  87.702713  36.724913  0.367572  0.087195  0.241666
13 21 days  8623.657669  92.863651  38.043273  0.375487  0.119891  0.246816

    coverage
9   0.183784
10  0.142186
11  0.118243
12  0.250520
13  0.307692
```

In [47]:

```
results_AAPL=tt_test_p('AAPL',trains,tests)
```

```
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to ov
erride this.
```

```
Processing:  yfinance.Ticker object <AAPL>
```

```
INFO:prophet:Making 98 forecasts with cutoffs between 2019-08-22 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 17.
INFO:fbprophet:n_changepoints greater than number of observations. Using 21.
INFO:fbprophet:n_changepoints greater than number of observations. Using 24.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 49 forecasts with cutoffs between 2019-08-29 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
```

```
Testing:  7 days
   horizon           mse        rmse        mae      mape     mdape     smape  \
9  15 days   2280.819602   47.757927  27.683946  0.398606  0.097443  0.350964
10 18 days   4965.219413   70.464313  37.650713  0.555663  0.139601  0.419327
11 19 days   7300.343269   85.442046  44.766469  0.660672  0.110273  0.449069
12 20 days   8781.417376   93.709217  47.460545  0.702236  0.095616  0.446265
13 21 days  11718.787054  108.253347  53.364706  0.789605  0.110193  0.463596

    coverage
9   0.131206
10  0.138870
11  0.143341
12  0.151976
13  0.120789
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 21.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 33 forecasts with cutoffs between 2019-08-29 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  14 days
   horizon           mse        rmse        mae      mape     mdape     smape  \
9  15 days   2400.221978   48.992060  29.132708  0.419009  0.105096  0.379178
10 18 days   5459.017862   73.885167  39.373054  0.580966  0.102269  0.433789
11 19 days   8177.059723   90.427096  46.834577  0.693175  0.098624  0.453842
12 20 days   9278.316918   96.324020  47.776921  0.711746  0.109629  0.443134
13 21 days  12888.901828  113.529299  54.572367  0.811508  0.104695  0.453207

    coverage
9   0.120408
10  0.127640
11  0.156146
12  0.165598
13  0.126190
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 21.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 93 forecasts with cutoffs between 2019-09-26 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  21 days
   horizon           mse        rmse        mae      mape     mdape     smape  \
9  15 days   2640.965929   51.390329  26.519505  0.389227  0.103966  0.287681
10 18 days   5463.575131   73.916001  35.515835  0.535368  0.084425  0.365202
11 19 days   7735.591313   87.952210  42.087098  0.626938  0.094919  0.409007
12 20 days   9825.471338   99.123516  46.036139  0.684408  0.089502  0.398666
13 21 days  12340.194132  111.086426  51.247882  0.755518  0.079937  0.416175

    coverage
9   0.206782
10  0.263830
11  0.238298
12  0.195358
13  0.140957
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 47 forecasts with cutoffs between 2019-09-26 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  7 days
```

```
   horizon           mse        rmse        mae      mape     mdape     smape  \
9  15 days   2155.511930   46.427491  26.407547  0.368283  0.097341  0.338345
10 18 days   4705.226276   68.594652  35.640764  0.510725  0.100730  0.394296
11 19 days   6934.760696   83.275211  42.285353  0.606498  0.102006  0.418278
12 20 days   8285.795332   91.026344  44.519772  0.639270  0.107213  0.414438
13 21 days  11122.704945  105.464235  50.039831  0.718850  0.098123  0.431444

    coverage
9   0.123667
10  0.138569
11  0.143810
12  0.141871
13  0.120469
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 31 forecasts with cutoffs between 2019-10-10 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  14 days
   horizon           mse        rmse        mae      mape     mdape     smape  \
9  15 days   2167.662594   46.558164  27.203684  0.377947  0.088661  0.364465
10 18 days   4933.834380   70.241258  36.532645  0.522555  0.084425  0.417426
11 19 days   7409.046710   86.075820  43.540427  0.626607  0.099226  0.438118
12 20 days   8235.971527   90.752254  44.006250  0.635123  0.099226  0.427545
13 21 days  11593.264948  107.672025  50.438800  0.726750  0.112497  0.438722

    coverage
9   0.125754
10  0.133650
11  0.148162
12  0.166084
13  0.116807
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 76 forecasts with cutoffs between 2020-01-23 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  21 days
   horizon           mse        rmse        mae      mape     mdape     smape  \
9  15 days   2783.195490   52.756000  26.686585  0.385712  0.082646  0.275753
10 18 days   5747.414725   75.811706  35.628135  0.529823  0.067482  0.325581
11 19 days   8099.357789   89.996432  42.145435  0.618950  0.104749  0.360496
12 20 days  10256.212447  101.272960  46.014507  0.674536  0.082259  0.352288
13 21 days  12823.977144  113.243000  51.161807  0.743925  0.078701  0.374756

    coverage
9   0.221212
10  0.259740
11  0.243506
12  0.230938
13  0.182576
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 38 forecasts with cutoffs between 2020-01-30 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  180 days
Testing:  7 days
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days   707.761727  26.603792  14.891014  0.180287  0.069788  0.177853
10 18 days  1030.328909  32.098737  16.744380  0.209431  0.075951  0.210108
11 19 days  1279.325114  35.767655  18.491381  0.228341  0.075796  0.231680
```

```
11 19 days  1279.523114  35.767655  18.491561  0.226541  0.075790  0.231660
12 20 days  1436.280843  37.898296  19.376898  0.237973  0.084419  0.238747
13 21 days  1594.489014  39.931053  20.043769  0.247508  0.078701  0.245878

    coverage
9   0.166182
10  0.166837
11  0.181028
12  0.193301
13  0.144617
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 26 forecasts with cutoffs between 2020-01-23 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  180 days
Testing:  14 days
   horizon         mse       rmse        mae      mape     mdape     smape  \
9  15 days  383.807468  19.591005  13.238439  0.152348  0.068940  0.184770
10 18 days  474.015771  21.771903  14.037651  0.164695  0.075286  0.216323
11 19 days  674.428901  25.969769  15.851923  0.187623  0.075860  0.238635
12 20 days  807.125810  28.409960  16.894739  0.201386  0.087061  0.242730
13 21 days  918.964339  30.314425  17.705792  0.212523  0.071885  0.246675

    coverage
9   0.157407
10  0.166667
11  0.183502
12  0.202729
13  0.158869
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
```

```
Training:  180 days
Testing:  21 days
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days  1277.043885  35.735751  15.463019  0.208922  0.055044  0.146853
10 18 days  1997.632376  44.694881  18.010791  0.254322  0.057322  0.178220
11 19 days  2352.152423  48.498994  19.901919  0.268780  0.066599  0.205109
12 20 days  2616.891921  51.155566  20.748189  0.275716  0.054789  0.209722
13 21 days  2899.093881  53.843234  21.789390  0.284642  0.073753  0.212504

    coverage
9   0.252973
10  0.334900
11  0.300676
12  0.269231
13  0.188150
```

In [48]:

```
results_AMGN=tt_test_p('AMGN',trains,tests)
```

```
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to ov
erride this.
```

```
Processing:  yfinance.Ticker object <AMGN>
```

```
INFO:prophet:Making 98 forecasts with cutoffs between 2019-08-22 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 17.
INFO:fbprophet:n_changepoints greater than number of observations. Using 21.
INFO:fbprophet:n_changepoints greater than number of observations. Using 24.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 49 forecasts with cutoffs between 2019-08-29 00:00:00 and 2021-07-01
```

```
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  7 days
   horizon            mse        rmse         mae      mape     mdape  \
9  15 days   47387.335007  217.686323   98.050944  0.477810  0.065042
10 18 days  111477.207504  333.882026  144.202129  0.706353  0.096972
11 19 days  166108.985762  407.564701  173.106623  0.849318  0.097685
12 20 days  212000.000810  460.434578  190.238848  0.939273  0.080261
13 21 days  263122.673281  512.954845  208.081856  1.030818  0.090589

       smape  coverage
9   0.322126  0.152482
10  0.360104  0.153054
11  0.365508  0.150118
12  0.365036  0.123607
13  0.363188  0.157137
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 21.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 33 forecasts with cutoffs between 2019-08-29 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  14 days
   horizon            mse        rmse         mae      mape     mdape  \
9  15 days   41683.632756  204.165699   95.242582  0.465289  0.069900
10 18 days  103135.708891  321.147488  144.800438  0.709194  0.089450
11 19 days  155095.285161  393.821387  173.575342  0.848223  0.070293
12 20 days  194702.535133  441.251102  184.807881  0.911514  0.079188
13 21 days  235511.293782  485.295058  198.364430  0.982030  0.077180

       smape  coverage
9   0.337938  0.162682
10  0.389047  0.164596
11  0.389451  0.127243
12  0.375844  0.103499
13  0.367323  0.148512
```

```
INFO:fbprophet:n_changepoints greater than number of observations. Using 21.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 93 forecasts with cutoffs between 2019-09-26 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  30 days
Testing:  21 days
   horizon            mse        rmse         mae      mape     mdape  \
9  15 days   31625.804125  177.836453   83.734651  0.415045  0.073530
10 18 days   82817.603884  287.780479  126.182440  0.632879  0.090390
11 19 days  128464.559387  358.419530  151.552368  0.758204  0.082869
12 20 days  173422.891507  416.440742  173.171699  0.867036  0.076147
13 21 days  229063.485672  478.605773  194.740719  0.973048  0.091701

       smape  coverage
9   0.325498  0.141622
10  0.353914  0.154610
11  0.344332  0.134752
12  0.351019  0.123791
13  0.353224  0.164894
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
```

```
INFO:prophet:Making 47 forecasts with cutoffs between 2019-09-26 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  7 days
   horizon            mse        rmse         mae      mape     mdape  \
9  15 days   29918.833698  172.970615   74.236551  0.350217  0.074184
10 18 days   67937.339027  260.647922  105.733290  0.498741  0.081657
11 19 days   99833.750646  315.964793  124.591808  0.585603  0.093202
12 20 days  125079.989805  353.666495  133.947300  0.631272  0.089340
13 21 days  149583.116147  386.759765  142.504516  0.672778  0.084632

       smape  coverage
9   0.262958  0.168690
10  0.296726  0.173423
11  0.301199  0.162072
12  0.298452  0.130396
13  0.293442  0.165655
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 31 forecasts with cutoffs between 2019-10-10 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  14 days
   horizon            mse        rmse         mae      mape     mdape  \
9  15 days   25787.707581  160.585515   71.516393  0.335537  0.061096
10 18 days   60573.379735  246.116598  105.545762  0.493591  0.066271
11 19 days   89205.029399  298.672110  124.794409  0.581434  0.079294
12 20 days  108060.914961  328.726201  129.196153  0.605346  0.078115
13 21 days  119615.372989  345.854555  133.139822  0.624629  0.077081

       smape  coverage
9   0.280728  0.184821
10  0.326509  0.181140
11  0.328650  0.147798
12  0.315036  0.114640
13  0.304044  0.155094
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 76 forecasts with cutoffs between 2020-01-23 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  60 days
Testing:  21 days
   horizon            mse        rmse         mae      mape     mdape  \
9  15 days  13885.998953  117.838869   53.362524  0.249014  0.065395
10 18 days  28810.810995  169.737477   73.003704  0.344045  0.079869
11 19 days  40469.147334  201.169449   82.885800  0.387270  0.072497
12 20 days  51609.819054  227.177946   92.293726  0.429814  0.082308
13 21 days  64758.374053  254.476667  100.833747  0.467404  0.077335

       smape  coverage
9   0.208756  0.174242
10  0.236286  0.178571
11  0.234104  0.120942
12  0.242247  0.121701
13  0.245920  0.175758
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 38 forecasts with cutoffs between 2020-01-30 00:00:00 and 2021-07-01
```

```
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  180 days
Testing:  7 days
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days  1499.850815  38.727907  22.559377  0.102177  0.059832  0.103712
10 18 days  2169.268371  46.575405  25.522071  0.116430  0.064758  0.119239
11 19 days  2518.638853  50.186042  26.934470  0.122711  0.075806  0.125265
12 20 days  2688.212431  51.847974  28.145261  0.128379  0.076060  0.129037
13 21 days  2993.865664  54.716229  28.760361  0.131625  0.077802  0.130002

    coverage
9   0.198909
10  0.199360
11  0.185375
12  0.152871
13  0.182416
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
INFO:prophet:Making 26 forecasts with cutoffs between 2020-01-23 00:00:00 and 2021-07-01
00:00:00
WARNING:prophet:Seasonality has period of 365.25 days which is larger than initial window
. Consider increasing initial.
```

```
Training:  180 days
Testing:  14 days
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days   959.324411  30.972963  18.225613  0.082207  0.051678  0.097485
10 18 days  1462.988791  38.249036  20.798806  0.093625  0.065086  0.117545
11 19 days  1723.668977  41.517093  22.618245  0.101869  0.065881  0.126464
12 20 days  1866.964293  43.208382  24.432630  0.110635  0.076713  0.131964
13 21 days  2177.819516  46.667114  25.235003  0.113559  0.066191  0.133555

    coverage
9   0.212963
10  0.214815
11  0.164422
12  0.131579
13  0.171053
```

```
WARNING:fbprophet:Optimization terminated abnormally. Falling back to Newton.
```

```
Training:  180 days
Testing:  21 days
   horizon          mse       rmse        mae      mape     mdape     smape  \
9  15 days  1113.579002  33.370331  20.950030  0.095849  0.051149  0.089028
10 18 days  1525.985051  39.063859  23.947707  0.111502  0.079294  0.101905
11 19 days  1564.089275  39.548569  24.571217  0.112192  0.079294  0.104434
12 20 days  1745.341699  41.777287  26.117422  0.119420  0.076147  0.110906
13 21 days  1872.341594  43.270563  27.370840  0.125123  0.085423  0.116411

    coverage
9   0.156757
10  0.153937
11  0.130631
12  0.142412
13  0.153846
```

After looking over these results, it seems unlike ARIMA, Prophet likes the 180/7 split. Although it doesn't matter that much when using Prophet; it automatically takes all the data available and uses it. The train/test split is mainly used here for cross-validation.

Putting it all together

So let's make us a function! Ultimately, we'll want it to be able to select the best of 4 stocks input by the user. As

always, let's start simple.

In [49]:

```
results_AMGN.tail()
```

Out[49]:

	ds	trend	yhat_lower	yhat_upper	trend_lower	trend_upper	additive_terms	additive_terms_lower	additive_terms
521	2021-08-08	229.728690	232.846488	248.777844	229.150404	230.175757	11.104362	11.104362	11
522	2021-08-09	229.633713	228.852723	245.428324	228.993875	230.155174	7.474945	7.474945	7
523	2021-08-10	229.538737	228.747299	245.012943	228.852219	230.105378	7.798091	7.798091	7
524	2021-08-11	229.443760	230.008994	245.361434	228.599488	230.100186	8.057594	8.057594	8
525	2021-08-12	229.348784	229.707544	245.486597	228.417961	230.087677	8.162935	8.162935	8

In [50]:

```
pred_cols=['ds','yhat']
```

In [51]:

```
AMGN_preds=results_AMGN[pred_cols]
```

In [52]:

```
AMGN_preds.tail()
```

Out[52]:

	ds	yhat
521	2021-08-08	240.833052
522	2021-08-09	237.108659
523	2021-08-10	237.336828
524	2021-08-11	237.501354
525	2021-08-12	237.511719

In [53]:

```
AMGN_preds=AMGN_preds.tail(21)
```

In [54]:

```
AMGN_preds.head()
```

Out[54]:

	ds	yhat
505	2021-07-23	246.003762
506	2021-07-24	248.921539
507	2021-07-25	248.109571
508	2021-07-26	243.474530
509	2021-07-27	242.708102

In [55]:

In [55]:

```
AMGN_preds.reset_index(level=0, drop=True,inplace=True)
```

In [56]:

```
AMGN_preds.head()
```

Out[56]:

	ds	yhat
0	**2021-07-23**	**246.003762**
1	**2021-07-24**	**248.921539**
2	**2021-07-25**	**248.109571**
3	**2021-07-26**	**243.474530**
4	**2021-07-27**	**242.708102**

In [57]:

```
AMGN_preds['yhat'][20]
```

Out[57]:

```
237.51171863532227
```

In [58]:

```
AMGN_preds['yhat'][0]
```

Out[58]:

```
246.00376195404905
```

In [59]:

```
change_percent=((AMGN_preds['yhat'][20]-AMGN_preds['yhat'][0])/AMGN_preds['yhat'][0])*10
0
```

In [60]:

```
change_percent=round(change_percent,2)
```

In [61]:

```
change_percent
```

Out[61]:

```
-3.45
```

In [62]:

```
def pct_change(df):
    """This function will quickly calculate the percentage change from the predictions da
taframe.
    One that has been produced from the earlier Prophet function"""
    df1=df['yhat']
    df1=df1.tail(21)
    df1.reset_index(level=0, drop=True,inplace=True)
    change=((df1[20]-df1[0])/df1[0])*100
    change=round(change, 2)
    if change >0:
        print(f"According to the model, you stand to gain {change}% over the next 21 days
")
    else:
        change_abs=abs(change)
        print(f"According to the model, you stand to lose {change_abs}% over the next 21
days")
    return None
```

In [63]:

```
pct_change(results_AAPL)
```

```
According to the model, you stand to gain 5.16% over the next 21 days
```

In [64]:

```
pct_change(results_AXP)
```

```
According to the model, you stand to gain 2.04% over the next 21 days
```

In [65]:

```
pct_change(results_MMM)
```

```
According to the model, you stand to lose 2.58% over the next 21 days
```

In [66]:

```
pct_change(results_CAT)
```

```
According to the model, you stand to lose 6.2% over the next 21 days
```

In [67]:

```
def fcast(stock):
    """This function will take a stock and perform Prophet modeling on it and return the
forecast dataframe"""
    stock=stock.upper() #make sure the symbol is in uppercase
    prof=Prophet()
    stonk = yf.Ticker(stock)
    df1=stonk.history(period='1y')
    df1=df1['Close']
    df1=df1.to_frame()
    df1.index.names = ['ds']
    df1.columns=['y']
    df1.reset_index(level=0, inplace=True)
    prof.fit(df1)
    future = prof.make_future_dataframe(periods=21)
    forecast = prof.predict(future)
    #The next 2 lines are disabled for the final function
#    prof.plot(forecast)
 #   plt.show()
    return forecast
```

In [68]:

```
HAL=fcast('HAL')
```

```
INFO:fbprophet:Disabling yearly seasonality. Run prophet with yearly_seasonality=True to
override this.
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to ov
erride this.
```

In [69]:

```
HAL.head()
```

Out[69]:

	ds	trend	yhat_lower	yhat_upper	trend_lower	trend_upper	additive_terms	additive_terms_lower	additive_terms_u
0	2020-07-23	15.361697	13.585789	17.189172	15.361697	15.361697	0.089397	0.089397	0.089
1	2020-07-24	15.334423	13.693948	17.211390	15.334423	15.334423	0.121897	0.121897	0.121
2	2020-07-27	15.252602	13.648942	17.229513	15.252602	15.252602	0.136222	0.136222	0.136

3	2020-07-28	15.22[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	2020-07-29	15.198055	13.707243	17.450188	15.198055	15.198055	0.266268	0.266268	0.266	

In [70]:

```
MMM=fcast('MMM')
```

```
INFO:fbprophet:Disabling yearly seasonality. Run prophet with yearly_seasonality=True to
override this.
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to ov
erride this.
```

In [71]:

```
AXP=fcast('AXP')
```

```
INFO:fbprophet:Disabling yearly seasonality. Run prophet with yearly_seasonality=True to
override this.
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to ov
erride this.
```

In [72]:

```
def pred_4():
    """This function will prompt the user to input 4 different stock/ETF symbols. It will
then use Prophet
    to forecast the next 21 days of the stock price, and return the values (in percent) o
f potential gain and loss."""
    stocks=[]
    pcts=[]
    stock1,stock2,stock3,stock4=input("Enter 4 stock symbols: ").split(",")
    stocks=[stock1,stock2,stock3,stock4]
    for stock in stocks:
        stock=stock.upper()
        df=fcast(stock)
        df1=df['yhat']
        df1=df1.tail(21)
        df1.reset_index(level=0, drop=True,inplace=True)
        change=((df1[20]-df1[0])/df1[0])*100
        change=round(change, 2)
        pcts.append(change)
    for i in range(0,4):
        print(f"Stock: {stocks[i].upper()}")
        print(f"Percent Change: {pcts[i]}")
    maxp=pcts.index(max(pcts))
    print()
    print(f'According to the model, {stocks[maxp].upper()} has the highest upside.')
    print("\n" * 3)
    print('FOR ENTERTAINMENT PURPOSES ONLY. This does not substitute for advise from a fi
nancial advisor.')
    print('The creator and affiliates are not responsible for any potential losses. But t
otally responsible for any gains.')
    return None
```

In [73]:

```
pred_4()
```

```
Enter 4 stock symbols: amzn,msft,f,t
```

```
INFO:fbprophet:Disabling yearly seasonality. Run prophet with yearly_seasonality=True to
override this.
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to ov
erride this.
INFO:fbprophet:Disabling yearly seasonality. Run prophet with yearly_seasonality=True to
override this.
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to ov
erride this.
```

```
INFO:fbprophet:Disabling yearly seasonality. Run prophet with yearly_seasonality=True to
override this.
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to ov
erride this.
INFO:fbprophet:Disabling yearly seasonality. Run prophet with yearly_seasonality=True to
override this.
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to ov
erride this.
```

```
Stock: AMZN
Percent Change: 2.34
Stock: MSFT
Percent Change: 2.61
Stock: F
Percent Change: 2.84
Stock: T
Percent Change: -2.86

According to the model, F has the highest upside.
```

```
FOR ENTERTAINMENT PURPOSES ONLY. This does not substitute for advise from a financial adv
isor.
The creator and affiliates are not responsible for any potential losses. But totally resp
onsible for any gains.
```

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