

# capstone\_project\_part4

July 24, 2021



Modeling and Forecasting Crime Rate in Colorado

**Data Science Capstone Project, Part IV; (modeling crime rate of various crime categories)** \* Student name: Elena Kazakova \* Student pace: Full-time \* Cohort: DS02222021 \* Scheduled project review date: 07/26/2021 \* Instructor name: James Irving \* Application url: TBD

## TABLE OF CONTENTS

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## 1 Introduction

This is part III of the Capstone Project, the previous parts can be found in the following notebooks:  
1. [Part 0](#), creation of SQLite database with the original data 2. [Part I](#), preprocessing of the data in the tables of the databases and building DataFrames, SQL part 3. [Part II](#), preprocessing of the data in DataFrames and EDA 4. [Part III](#), modeling of the General Crime rate

If you are running this notebook without restarting the kernel replace ‘%load\_ext autoreload’ in imports with ‘%reload\_ext autoreload’

## 2 Imports

```
[1]: # Importing packages
import pandas as pd
import numpy as np
import matplotlib
import matplotlib.pyplot as plt
import seaborn as sns
import itertools
import statsmodels
import statsmodels.tsa.api as tsa
import plotly.express as px
import plotly.io as pio
import math
from math import sqrt
import holidays
import pmdarima as pm

from statsmodels.tsa.stattools import adfuller, acf, pacf
from statsmodels.tsa.seasonal import seasonal_decompose
from statsmodels.tsa.arima.model import ARIMA
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
from statsmodels.tsa.statespace.sarimax import SARIMAX
from sklearn.metrics import mean_squared_error

from pmdarima.arima.stationarity import ADFTest
from pmdarima.arima.utils import ndiffs
from pmdarima.arima.utils import nsdiffs

import pickle
import os
import json

from pathlib import Path
import subprocess
import io
import warnings
warnings.filterwarnings(action='ignore', category=FutureWarning)

from functions_all import *

%load_ext autoreload
%autoreload 2
%matplotlib inline
```

### 3 MODEL&INTERPRET

### 3.1 Splitting into a training and a test sets

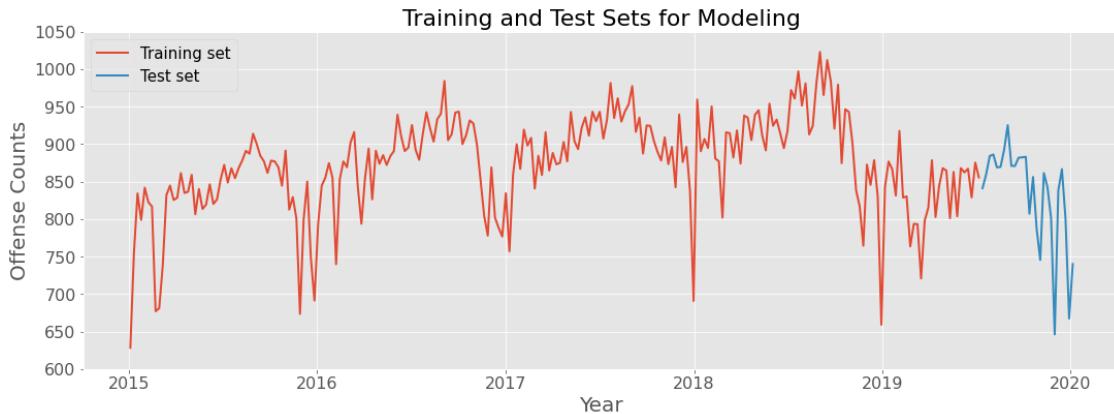
I am cutting off a ~10% tail of my data to create a test set.

```
[2]: with open('data/pickled_ts/ts_weekly.pickle', 'rb') as f:  
    ts_weekly=pickle.load(f)  
  
[3]: train_size = round(len(ts_weekly) * 0.90)  
ts_train, ts_test = ts_weekly[:train_size], ts_weekly[train_size:]  
print('Observations: %d weeks' % (len(ts_weekly)))  
print('Training Observations: %d weeks' % (len(ts_train)))  
print('Testing Observations: %d weeks' % (len(ts_test)))  
  
fig=display_figure_w_TSs(ts_train, ts_test, 'Training set', 'Test set',  
    ↴'Training and Test Sets for Modeling')
```

Observations: 262 weeks

Training Observations: 236 weeks

Testing Observations: 26 weeks



### 3.2 Crime Rate per Offense Category Modeling

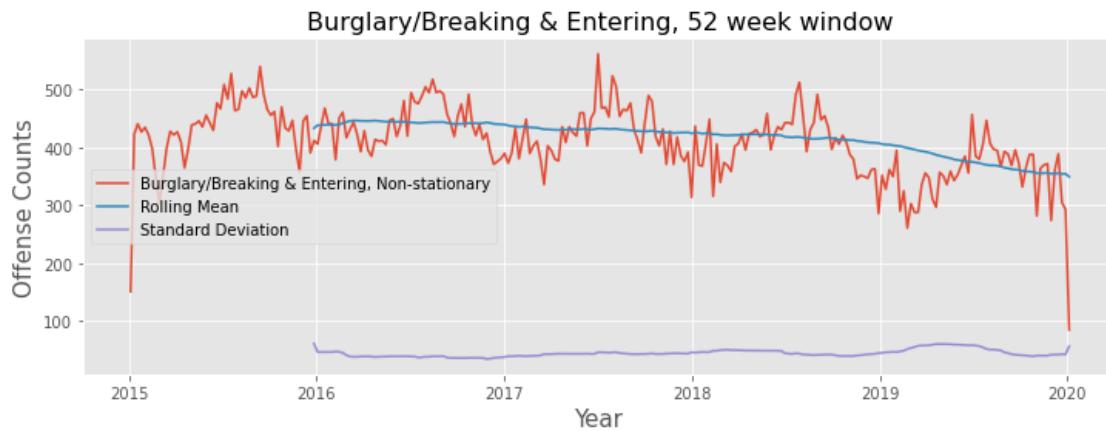
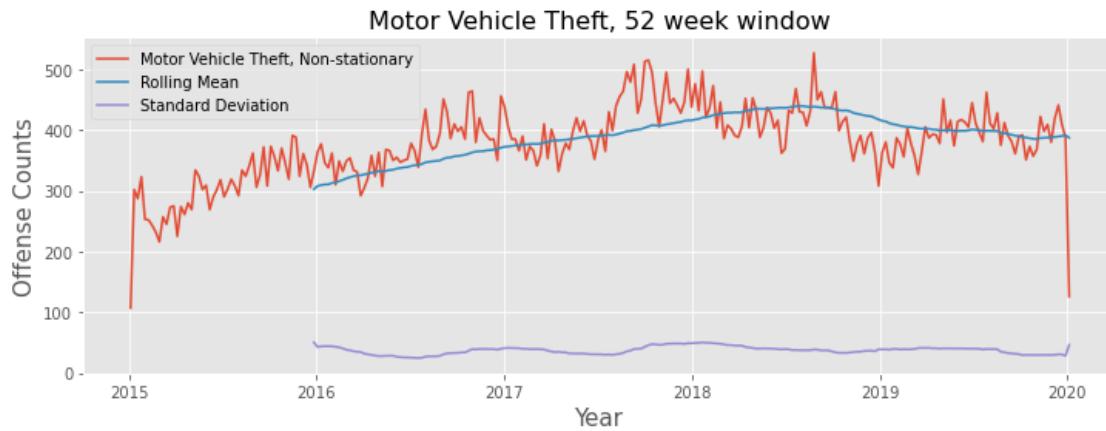
#### 3.2.1 Loading the dictionaries with time-series

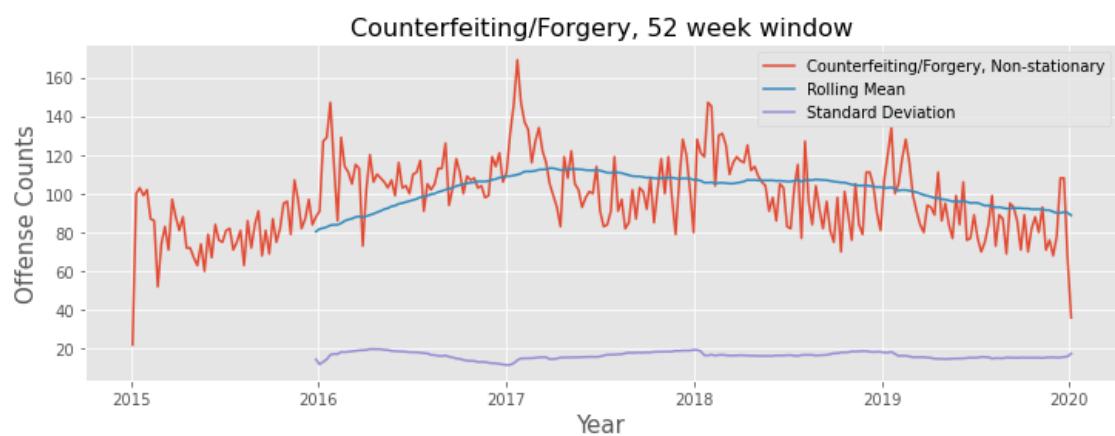
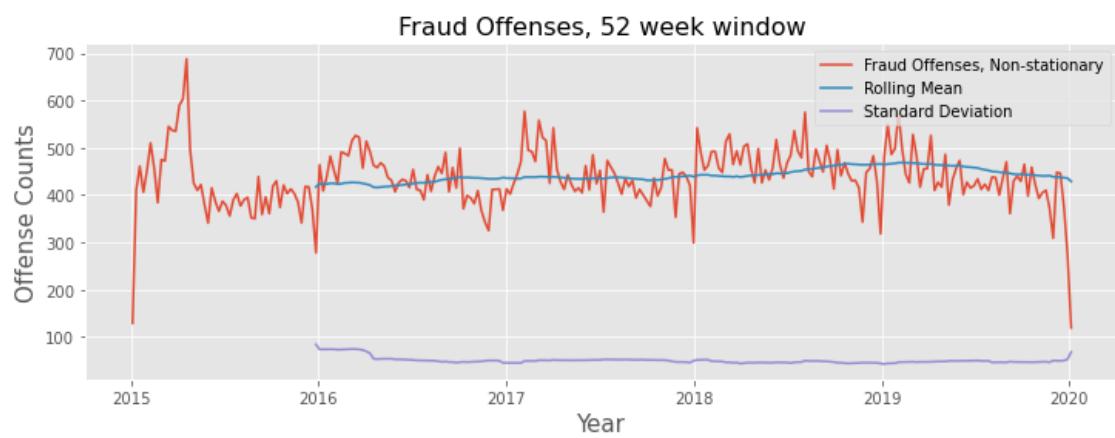
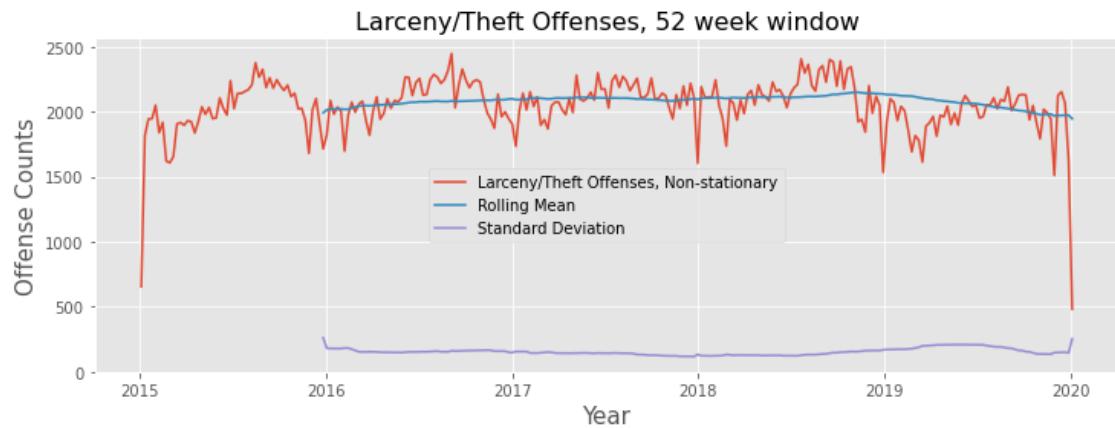
```
[4]: with open('data/pickled_ts/TS_crime_category.pickle', 'rb') as f:  
    TS_crime_category=pickle.load(f)  
  
with open('data/pickled_ts/TS_crime_against.pickle', 'rb') as f:  
    TS_crime_against=pickle.load(f)  
  
with open('data/pickled_ts/TS_crime_location.pickle', 'rb') as f:  
    TS_crime_location=pickle.load(f)
```

### 3.2.2 Checking for stationarity

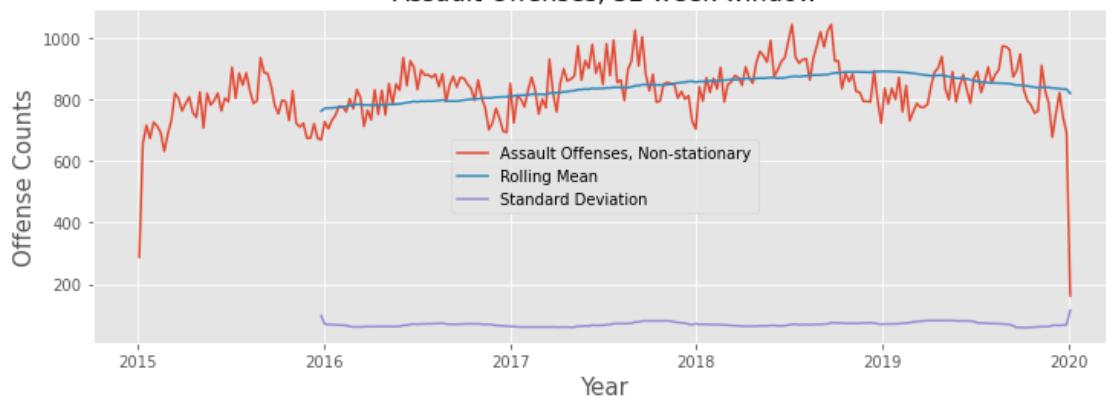
Checking the stationarity of the time-series in Offense category dictionary

```
[5]: df_results1, ts_stationary1, □  
      ↪ts_non_stationary_diff1=check_stationarity_multiple(TS_crime_category, □  
      ↪window=52, plot=True)
```

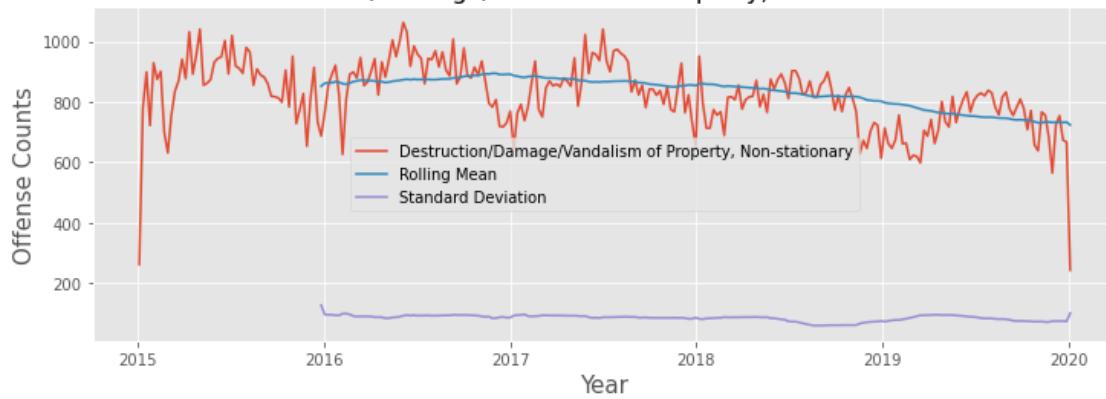




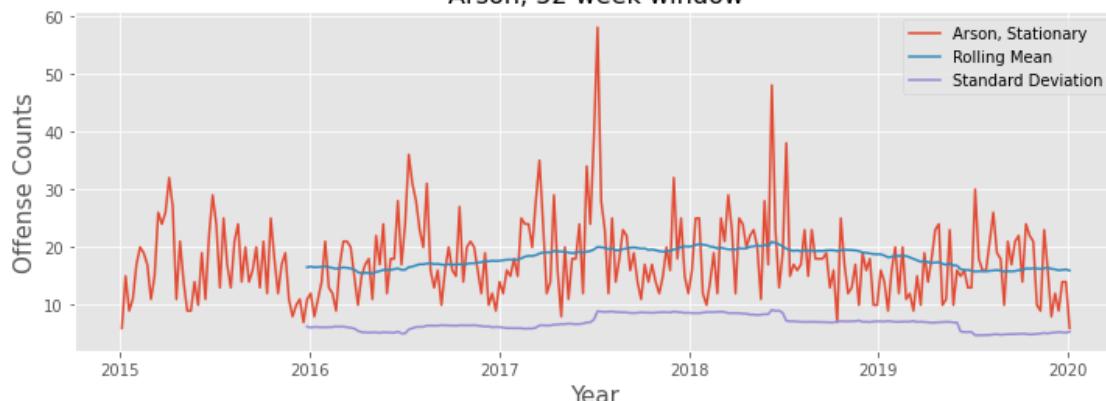
Assault Offenses, 52 week window



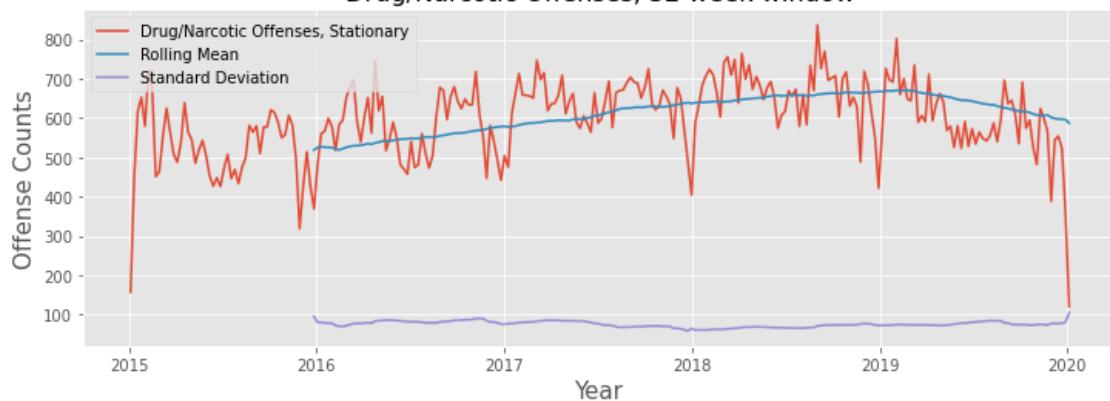
Destruction/Damage/Vandalism of Property, 52 week window



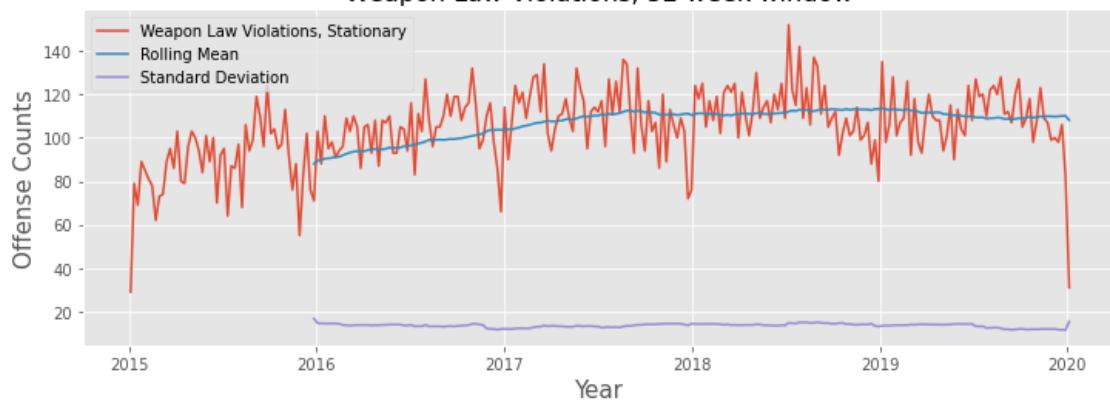
Arson, 52 week window



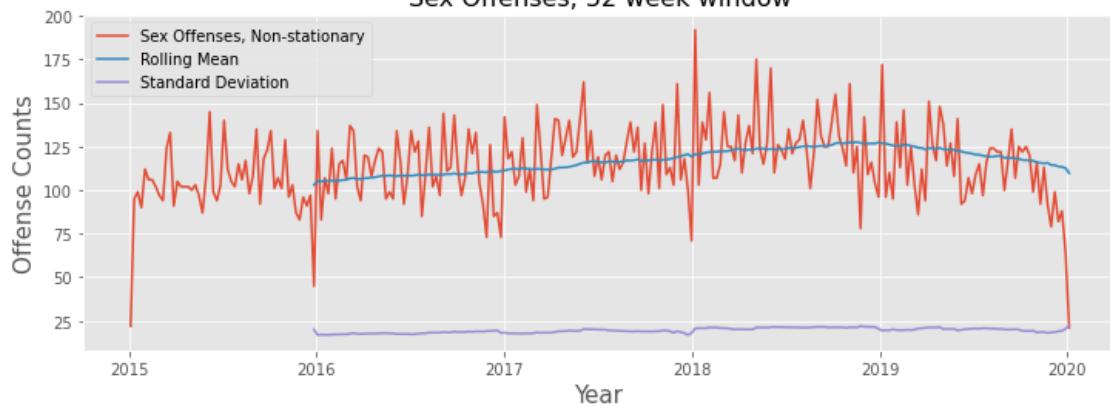
Drug/Narcotic Offenses, 52 week window

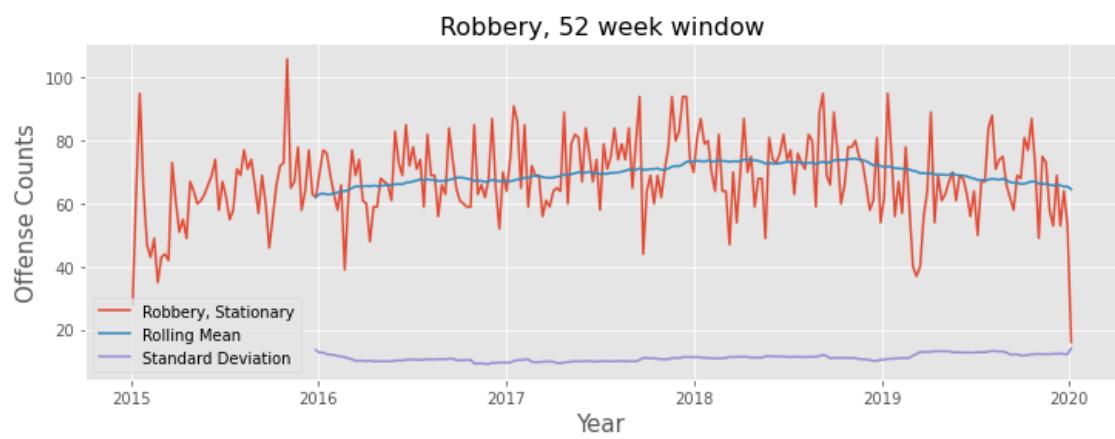
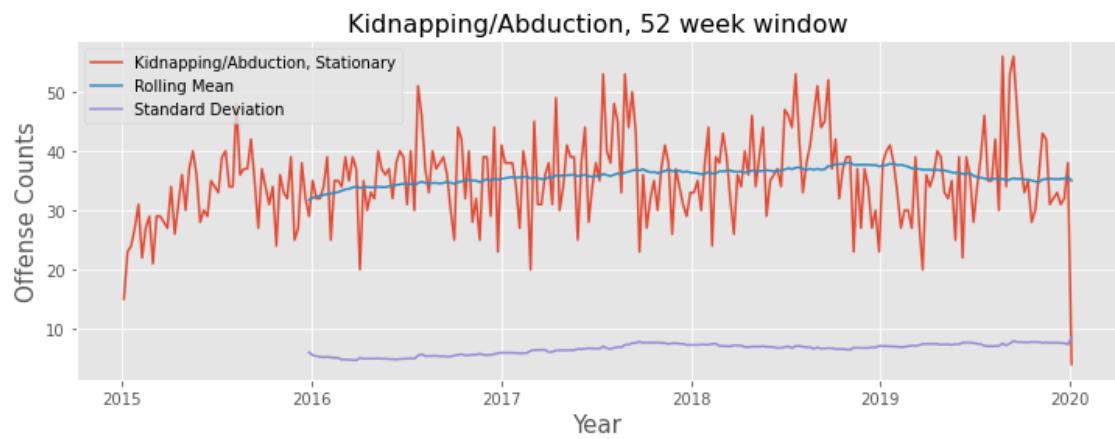


Weapon Law Violations, 52 week window

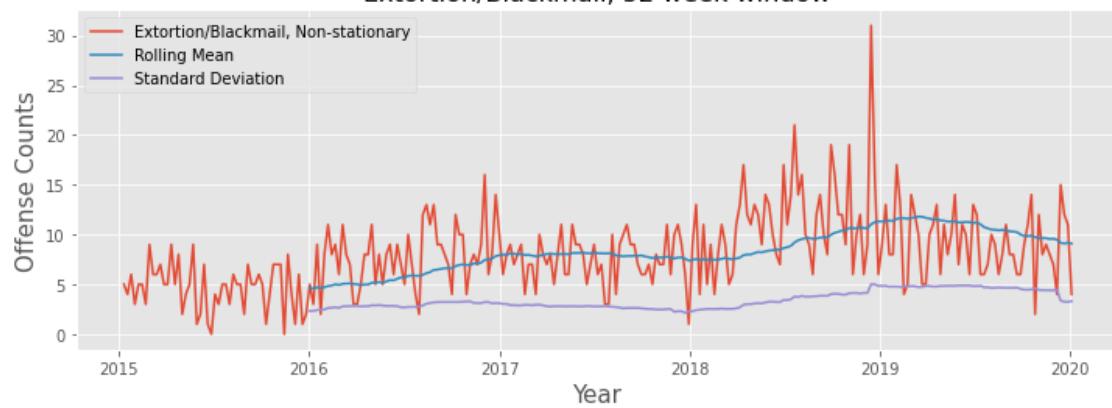


Sex Offenses, 52 week window

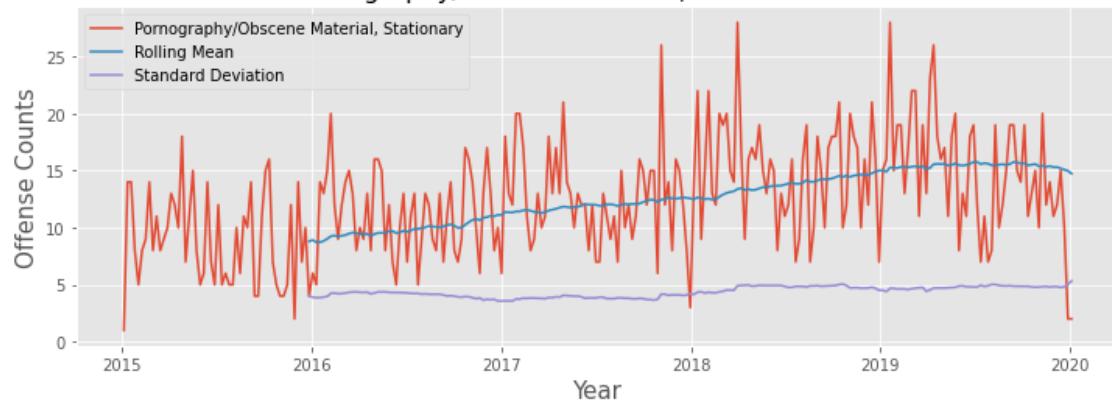




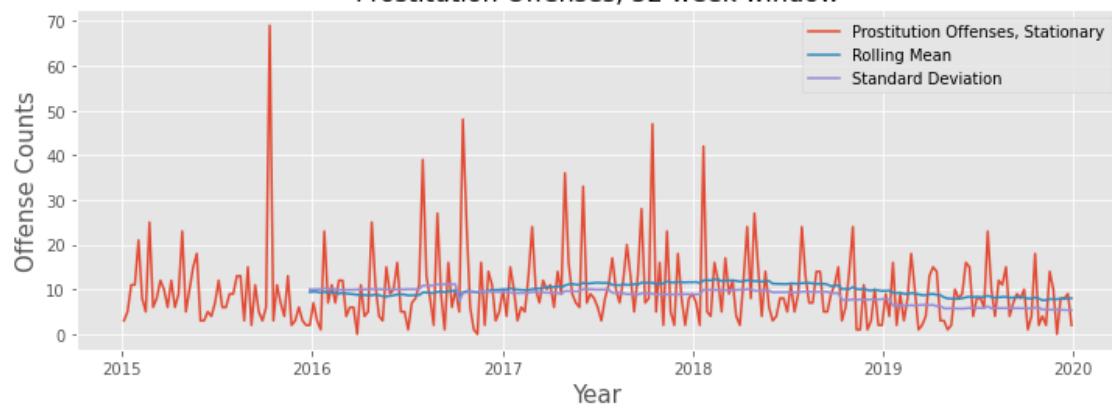
Extortion/Blackmail, 52 week window



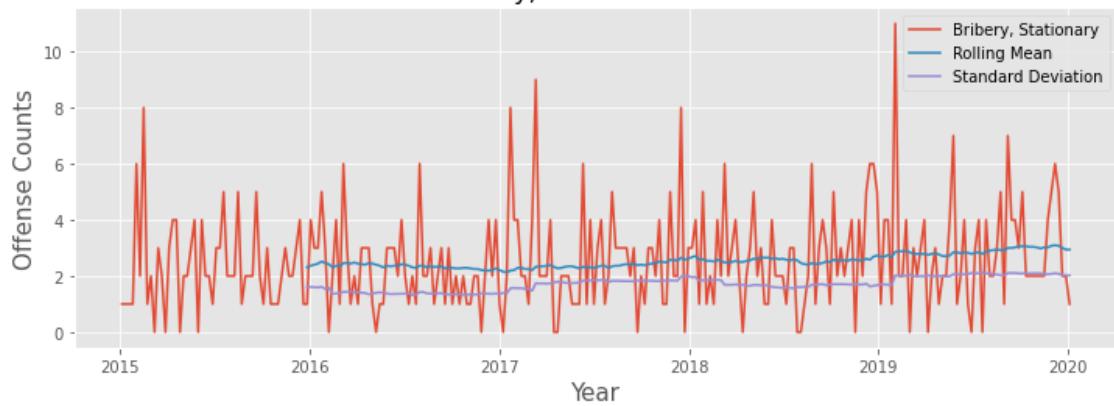
Pornography/Obscene Material, 52 week window



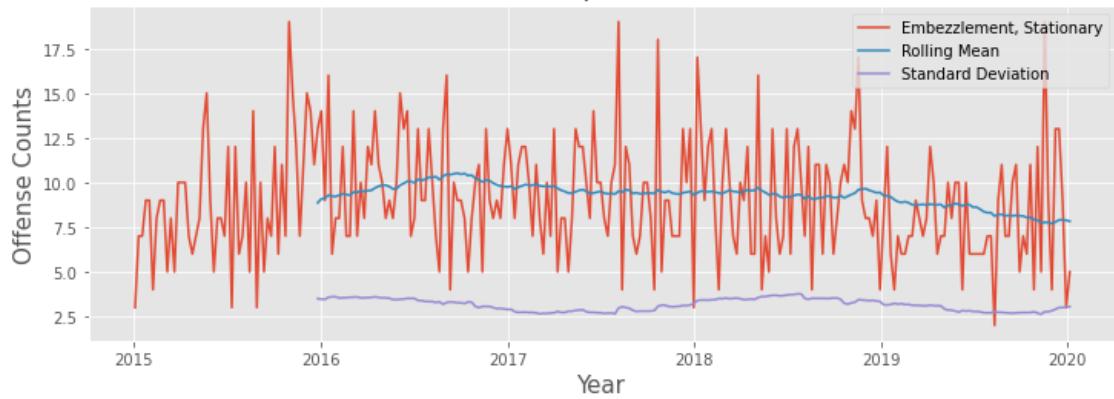
Prostitution Offenses, 52 week window



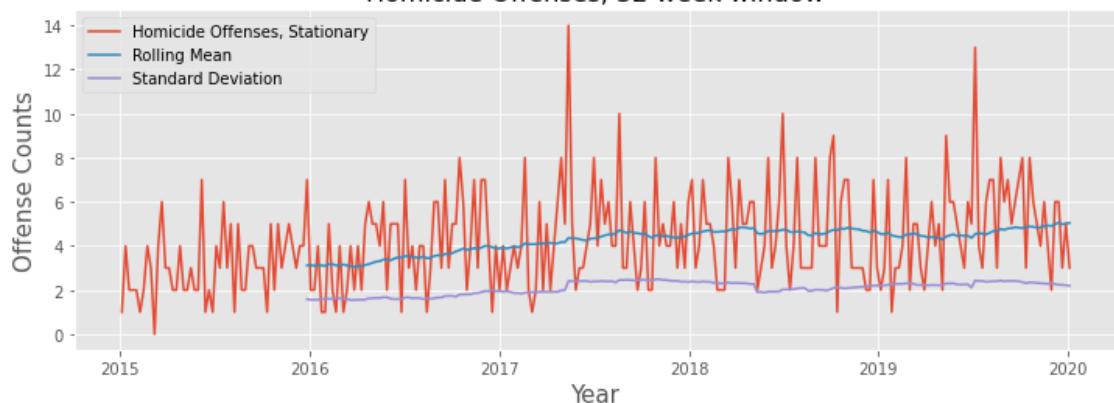
Bribery, 52 week window



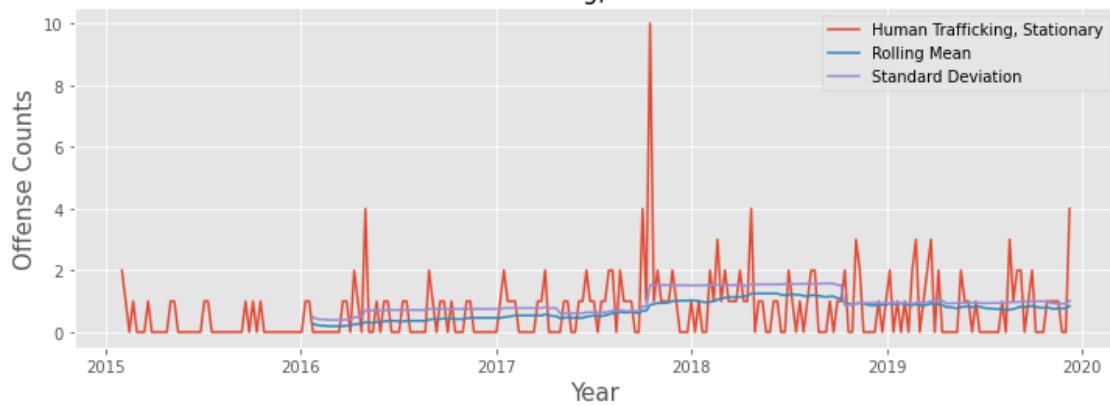
Embezzlement, 52 week window



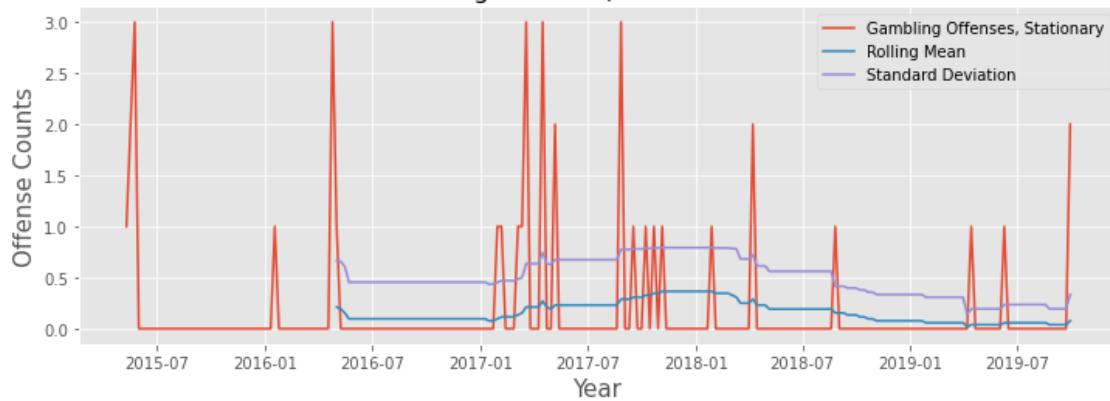
Homicide Offenses, 52 week window



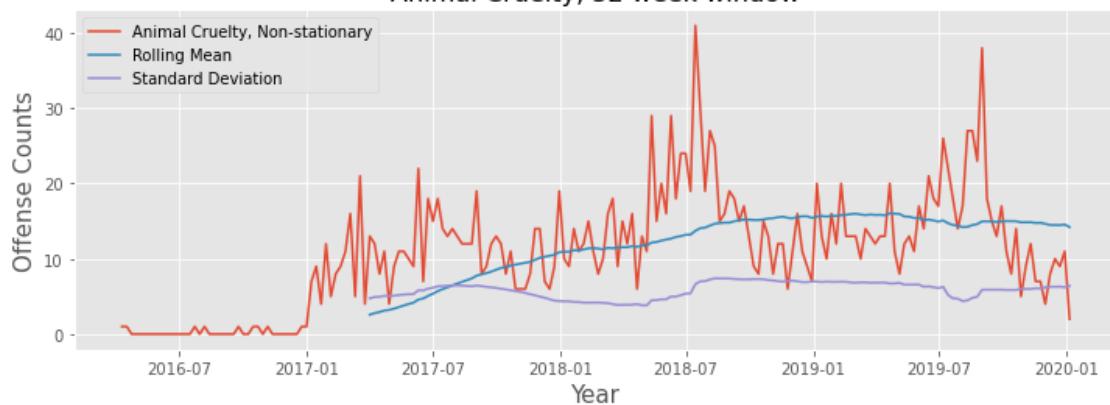
Human Trafficking, 52 week window



Gambling Offenses, 52 week window



Animal Cruelty, 52 week window



```
[6] : df_results1
```

[6] :

Number	Crime Category	Critical Value	P-value	\
1	Motor Vehicle Theft	-2.47862	0.120763	
2	Burglary/Breaking & Entering	-1.57887	0.494197	
3	Larceny/Theft Offenses	-2.07108	0.256303	
4	Fraud Offenses	-2.34796	0.156966	
5	Counterfeiting/Forgery	-2.55755	0.102093	
6	Assault Offenses	-2.36468	0.151953	
7	Destruction/Damage/Vandalism of Property	-1.47935	0.543701	
8	Arson	-5.43906	2.80274e-06	
9	Drug/Narcotic Offenses	-3.0009	0.0348101	
10	Weapon Law Violations	-3.79849	0.00292282	
11	Sex Offenses	-1.69734	0.432483	
12	Stolen Property Offenses	-2.60219	0.0925456	
13	Kidnapping/Abduction	-5.83445	3.90605e-07	
14	Robbery	-5.64789	1.00156e-06	
15	Extortion/Blackmail	-1.88379	0.339725	
16	Pornography/Obscene Material	-3.26358	0.0165871	
17	Prostitution Offenses	-16.6825	1.51221e-29	
18	Bribery	-17.0216	8.44947e-30	
19	Embezzlement	-6.24598	4.57491e-08	
20	Homicide Offenses	-5.49933	2.08847e-06	
21	Human Trafficking	-8.46655	1.51701e-13	
22	Gambling Offenses	-12.6476	1.39041e-23	
23	Animal Cruelty	-2.23411	0.194099	

Number	Lags	Observations	Critical value, 1%	Critical value, 5%	\
1	7	254	-3.45636	-2.87299	
2	3	258	-3.45595	-2.87281	
3	4	257	-3.45605	-2.87285	
4	16	245	-3.45733	-2.87341	
5	4	257	-3.45605	-2.87285	
6	3	258	-3.45595	-2.87281	
7	4	257	-3.45605	-2.87285	
8	3	258	-3.45595	-2.87281	
9	3	258	-3.45595	-2.87281	
10	3	258	-3.45595	-2.87281	
11	12	249	-3.45689	-2.87322	
12	5	256	-3.45616	-2.8729	
13	2	259	-3.45585	-2.87276	
14	2	259	-3.45585	-2.87276	
15	10	250	-3.45678	-2.87317	
16	5	256	-3.45616	-2.8729	
17	0	260	-3.45575	-2.87272	
18	0	261	-3.45566	-2.87268	
19	3	258	-3.45595	-2.87281	

20	3	258	-3.45595	-2.87281
21	1	252	-3.45657	-2.87308
22	0	229	-3.45923	-2.87425
23	3	192	-3.46488	-2.87671

Critical value, 10% Stationary?

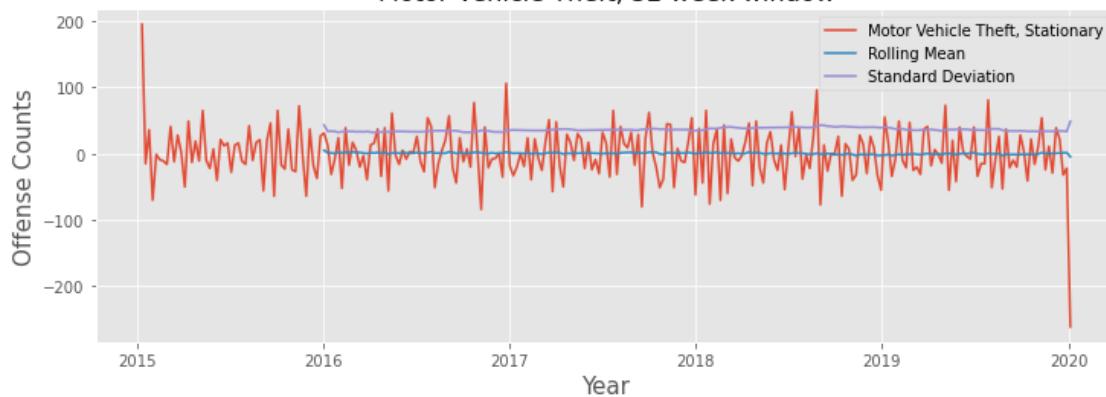
Number			
1		-2.57287	False
2		-2.57277	False
3		-2.5728	False
4		-2.5731	False
5		-2.5728	False
6		-2.57277	False
7		-2.5728	False
8		-2.57277	True
9		-2.57277	True
10		-2.57277	True
11		-2.57299	False
12		-2.57282	False
13		-2.57275	True
14		-2.57275	True
15		-2.57297	False
16		-2.57282	True
17		-2.57273	True
18		-2.57271	True
19		-2.57277	True
20		-2.57277	True
21		-2.57292	True
22		-2.57354	True
23		-2.57486	False

There are **12** time-series that are already stationary and **11** that are not and which require additional processing (differencing).

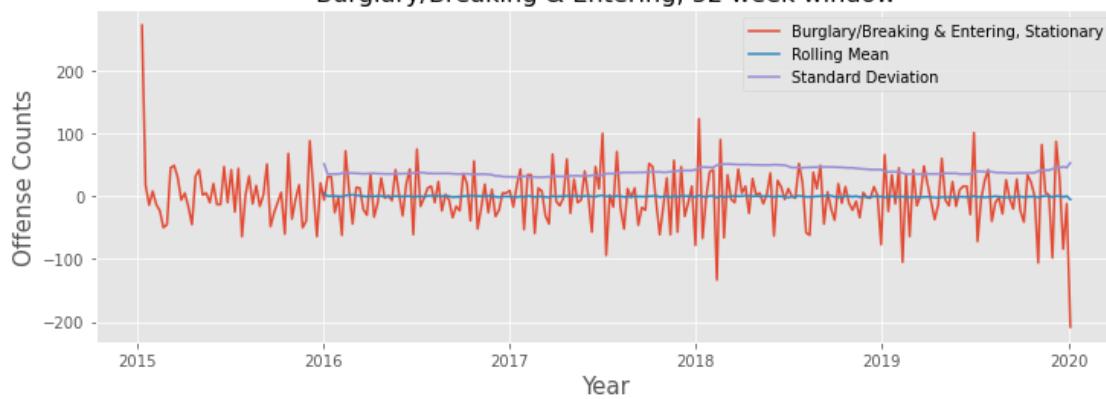
### Differencing the time series that are not stationary

```
[7]: df_results2, ts_stationary2, ts_non_stationary_diff2=check_stationarity_multiple(ts_non_stationary_diff1,
    ↪ window=52, plot=True)
```

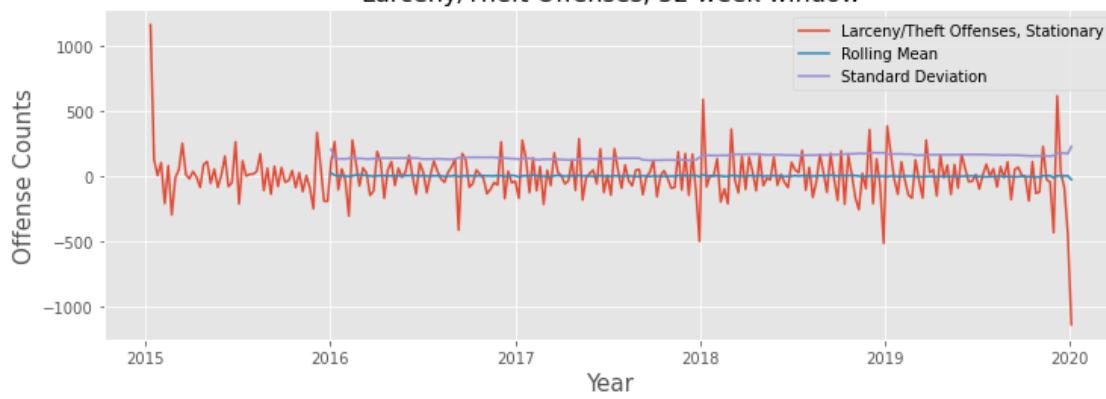
**Motor Vehicle Theft, 52 week window**

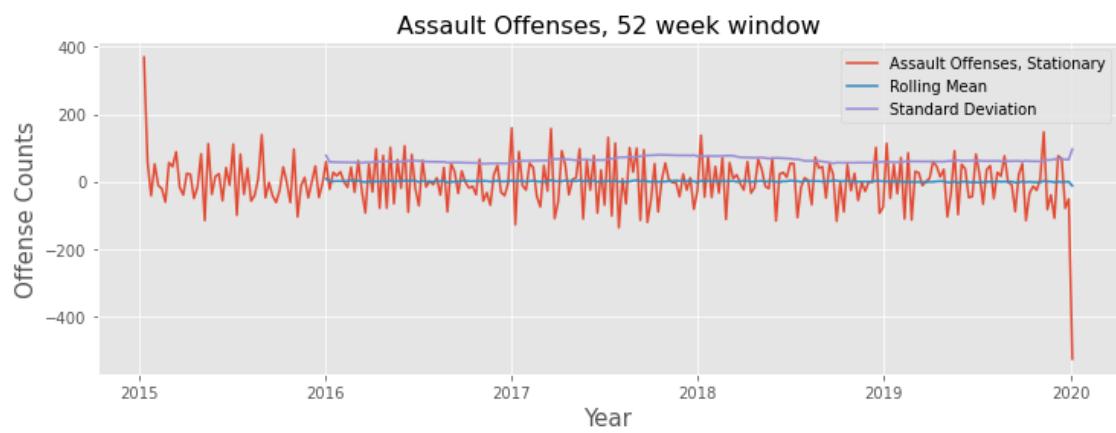
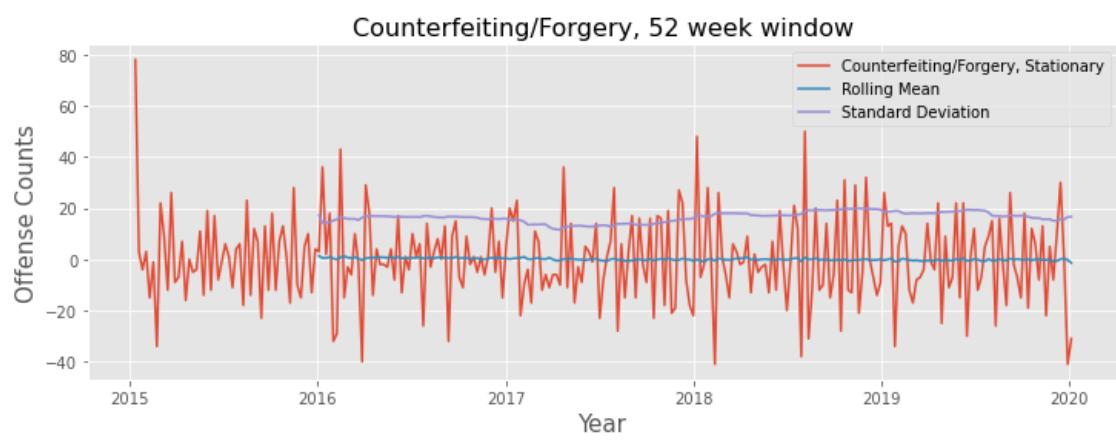
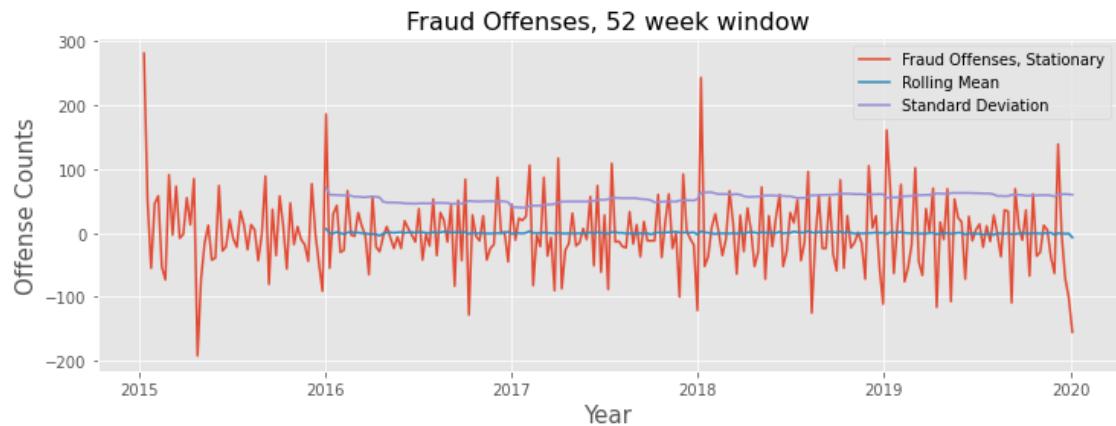


**Burglary/Breaking & Entering, 52 week window**

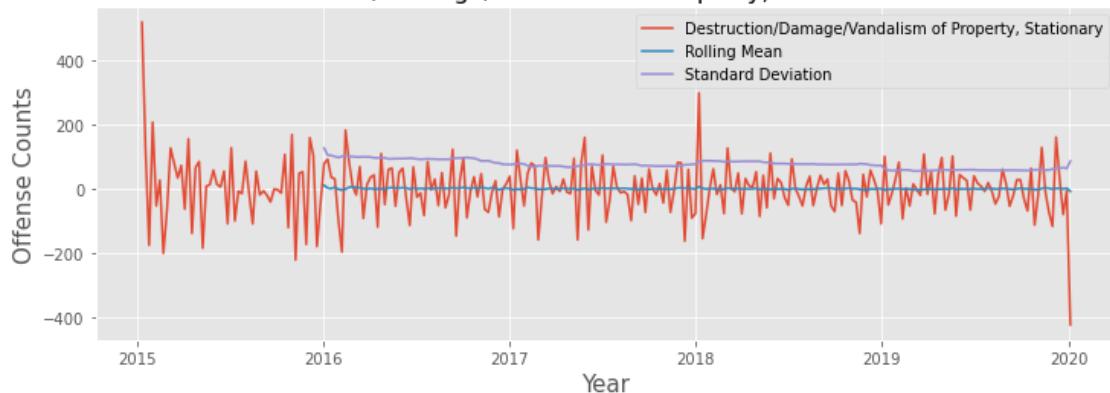


**Larceny/Theft Offenses, 52 week window**

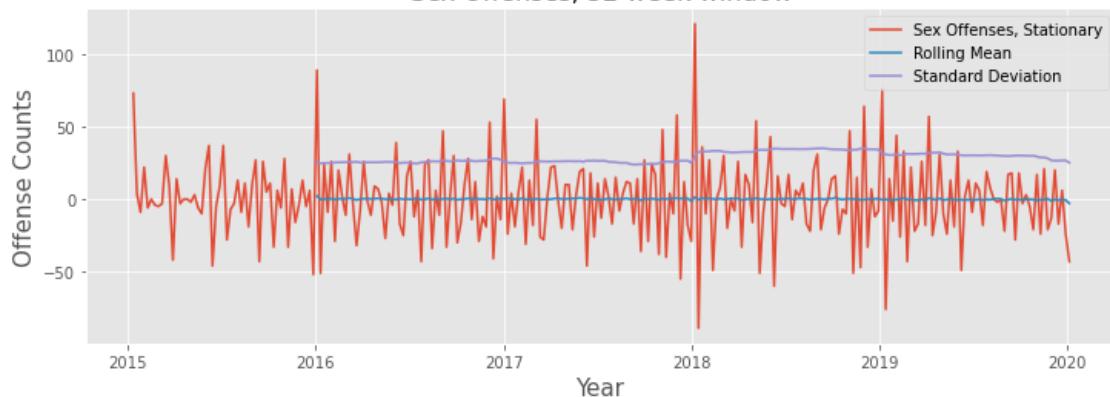




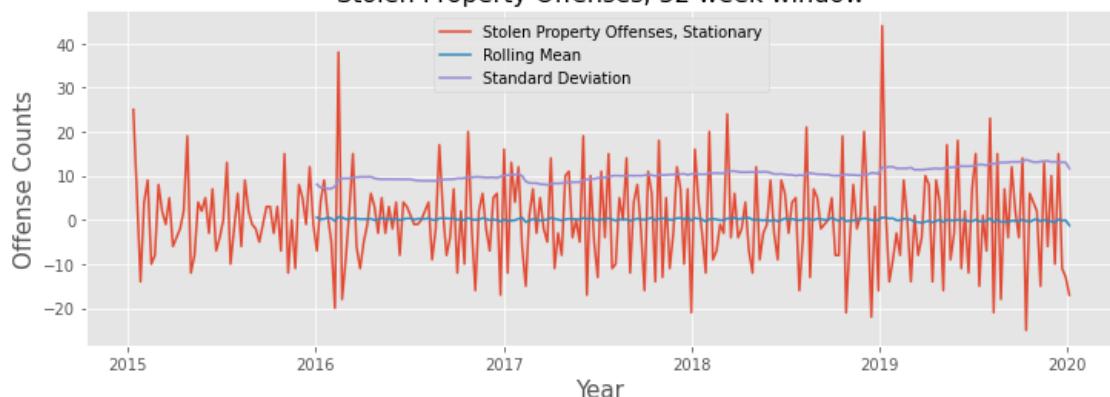
Destruction/Damage/Vandalism of Property, 52 week window

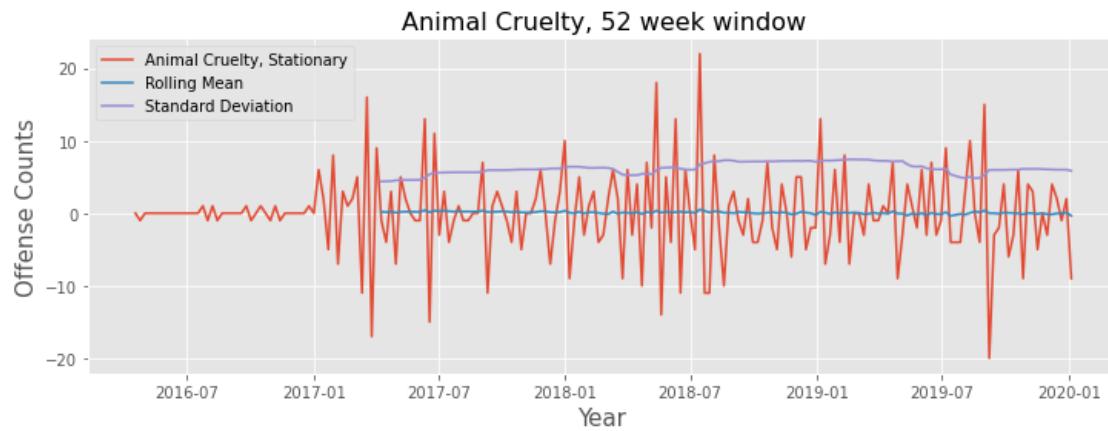
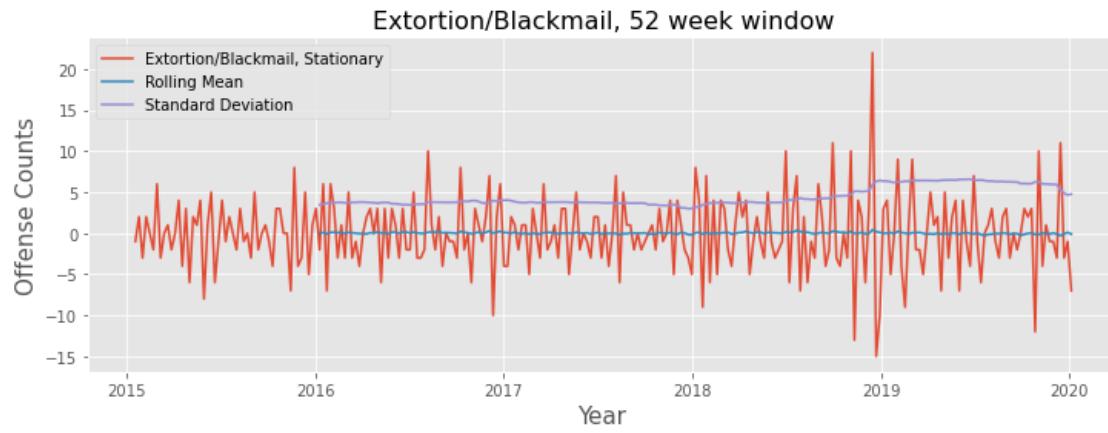


Sex Offenses, 52 week window



Stolen Property Offenses, 52 week window





```
[8]: df_results2
```

	Crime Category	Critical Value	P-value	\
Number				
1	Motor Vehicle Theft	-6.17315	6.72911e-08	
2	Burglary/Breaking & Entering	-12.8616	5.0966e-24	
3	Larceny/Theft Offenses	-11.1342	3.22534e-20	
4	Fraud Offenses	-6.08654	1.06105e-07	
5	Counterfeiting/Forgery	-10.6294	5.26217e-19	
6	Assault Offenses	-10.7223	3.12766e-19	
7	Destruction/Damage/Vandalism of Property	-12.0371	2.78743e-22	
8	Sex Offenses	-6.52936	9.95943e-09	
9	Stolen Property Offenses	-10.3858	2.08208e-18	
10	Extortion/Blackmail	-9.33958	8.87139e-16	
11	Animal Cruelty	-12.7603	8.16952e-24	

Number	Lags	Observations	Critical value, 1%	Critical value, 5%	\
1	7	253	-3.45646	-2.87303	
2	2	258	-3.45595	-2.87281	
3	3	257	-3.45605	-2.87285	
4	15	245	-3.45733	-2.87341	
5	5	255	-3.45626	-2.87294	
6	2	258	-3.45595	-2.87281	
7	3	257	-3.45605	-2.87285	
8	11	249	-3.45689	-2.87322	
9	5	255	-3.45626	-2.87294	
10	9	250	-3.45678	-2.87317	
11	2	192	-3.46488	-2.87671	

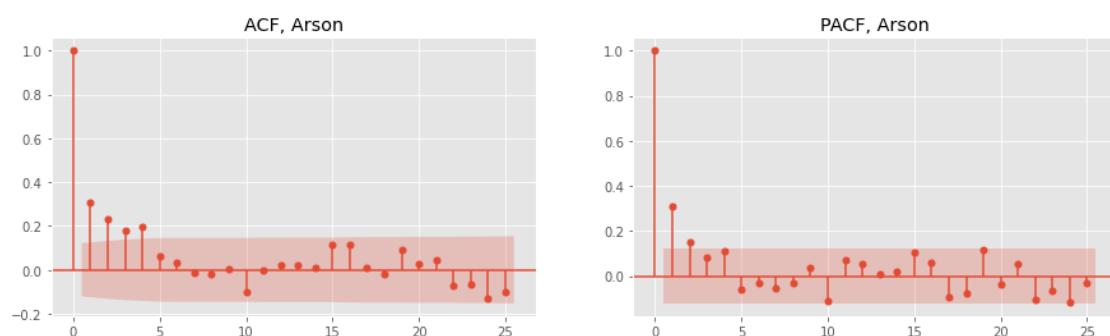
Critical value, 10% Stationary?

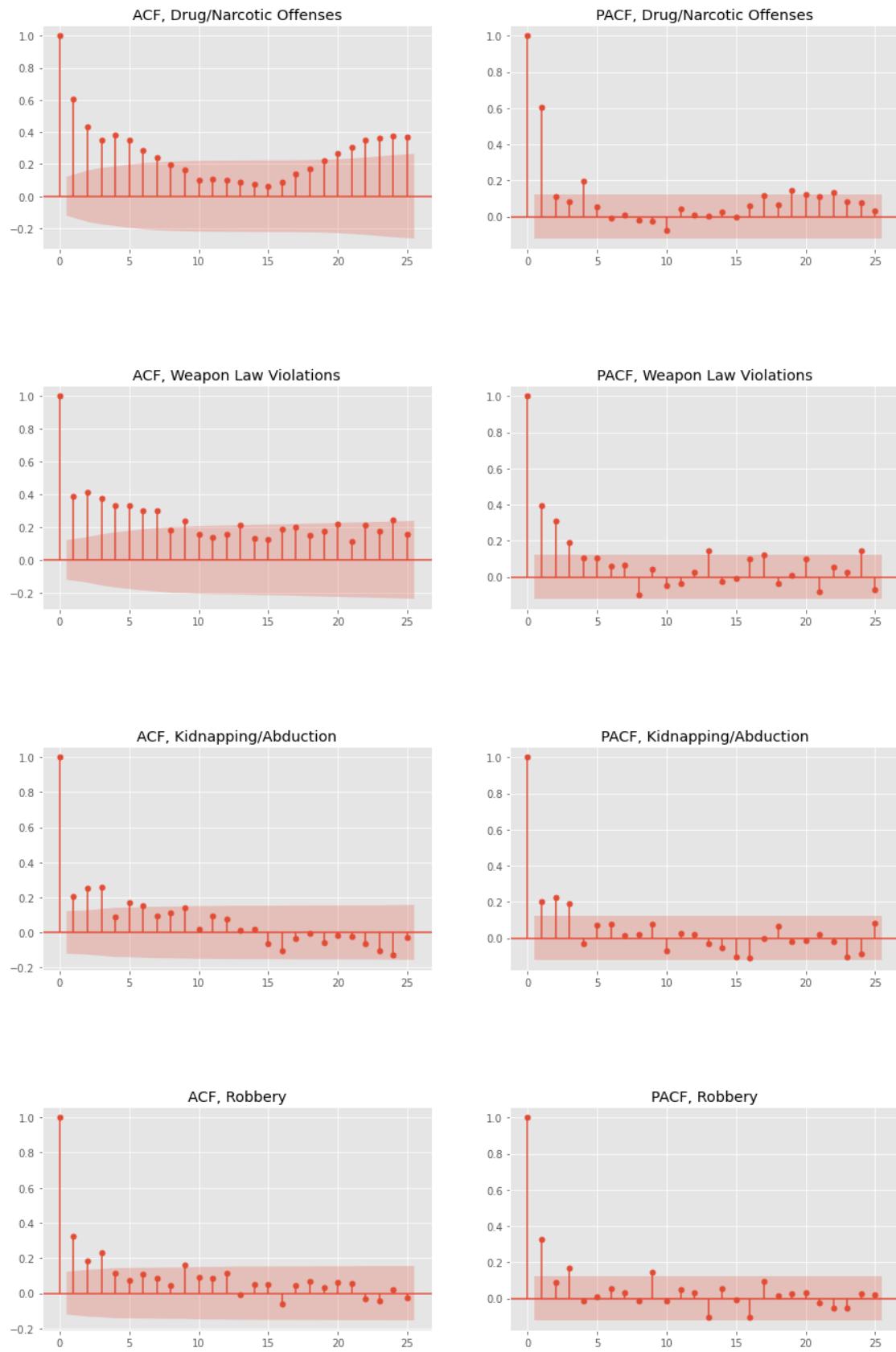
Number	Critical value, 10%	Stationary?
1	-2.57289	True
2	-2.57277	True
3	-2.5728	True
4	-2.5731	True
5	-2.57285	True
6	-2.57277	True
7	-2.5728	True
8	-2.57299	True
9	-2.57285	True
10	-2.57297	True
11	-2.57486	True

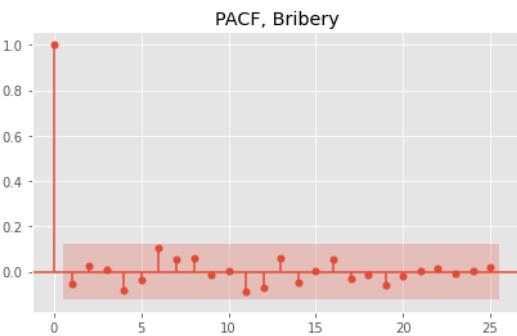
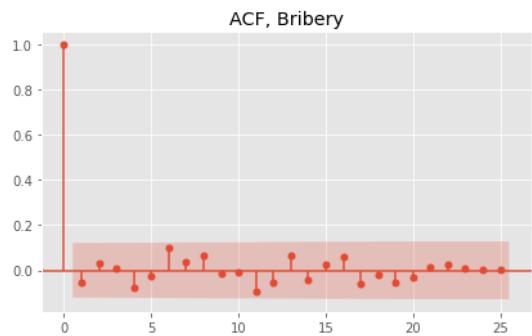
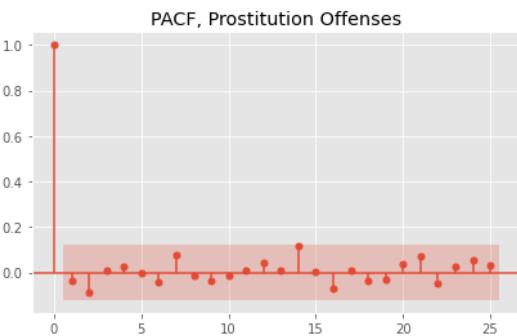
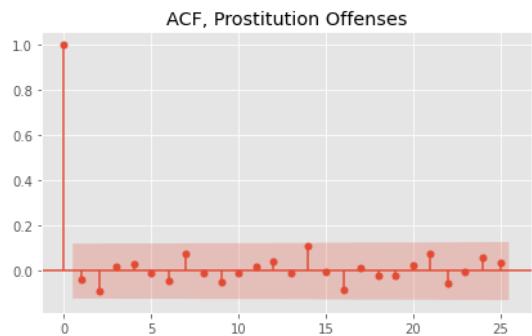
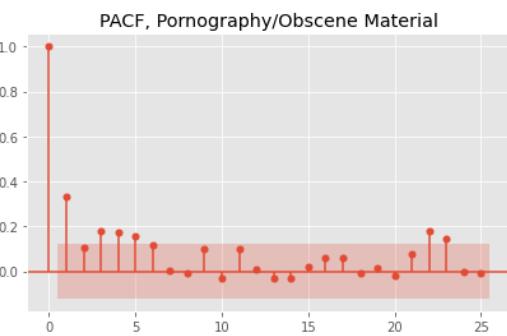
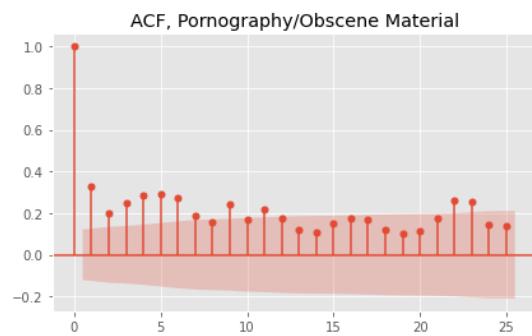
All 11 time-series got stationarized by the first differencing. There are two separate dictionaries for offenses categories: one with 12 original time-series, that were stationary from the get go and another one with 11 time-series that were pre-processed with the first differencing. The next step is to explore ACFs and PACFs of the timeframe and make a decision on the pdq and PDQs orders.

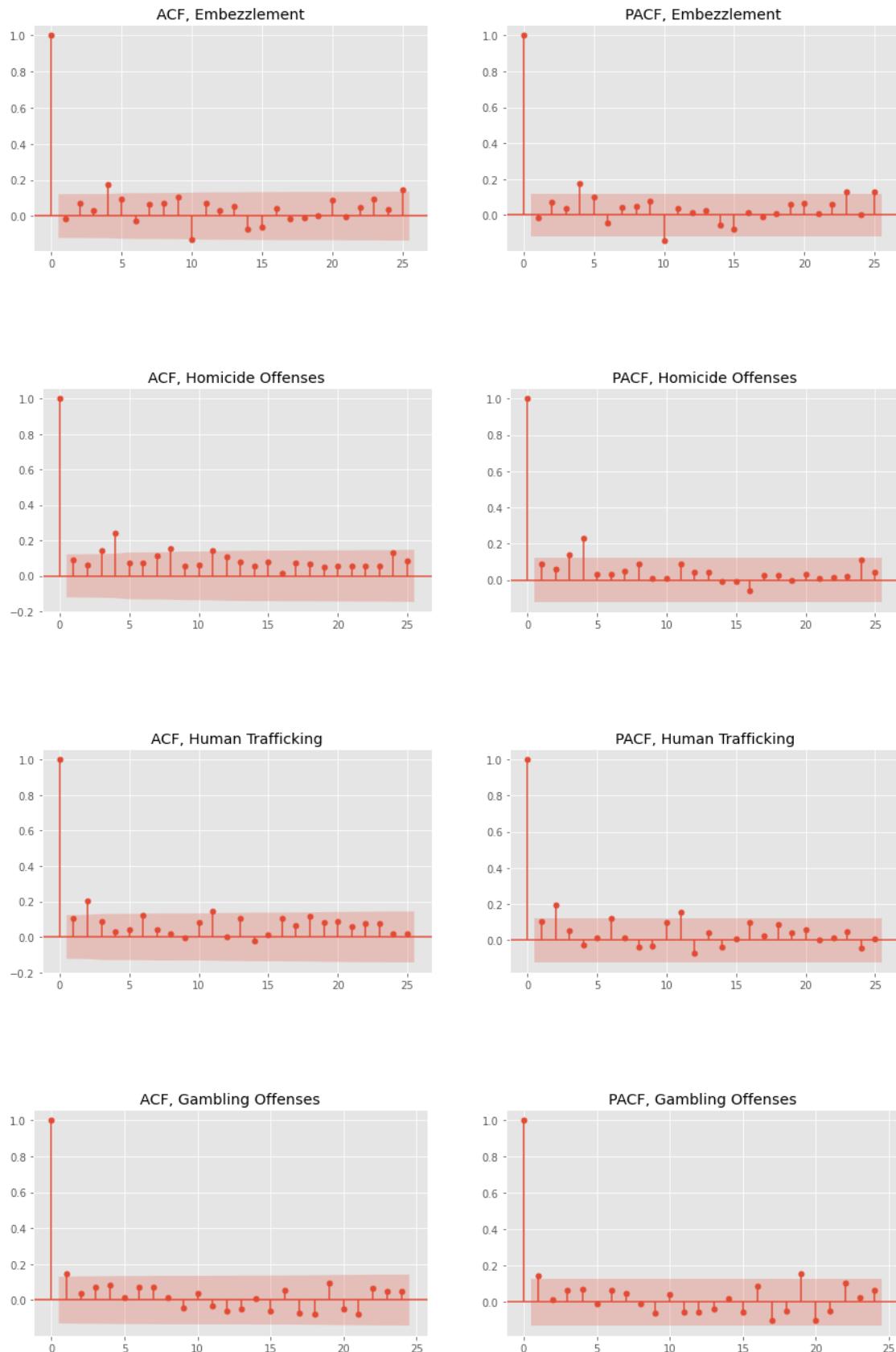
### Exploring ACFs and PACFs of the originally stationary time-series

[9]: `ACF_PACF_multiple(ts_stationary1);`

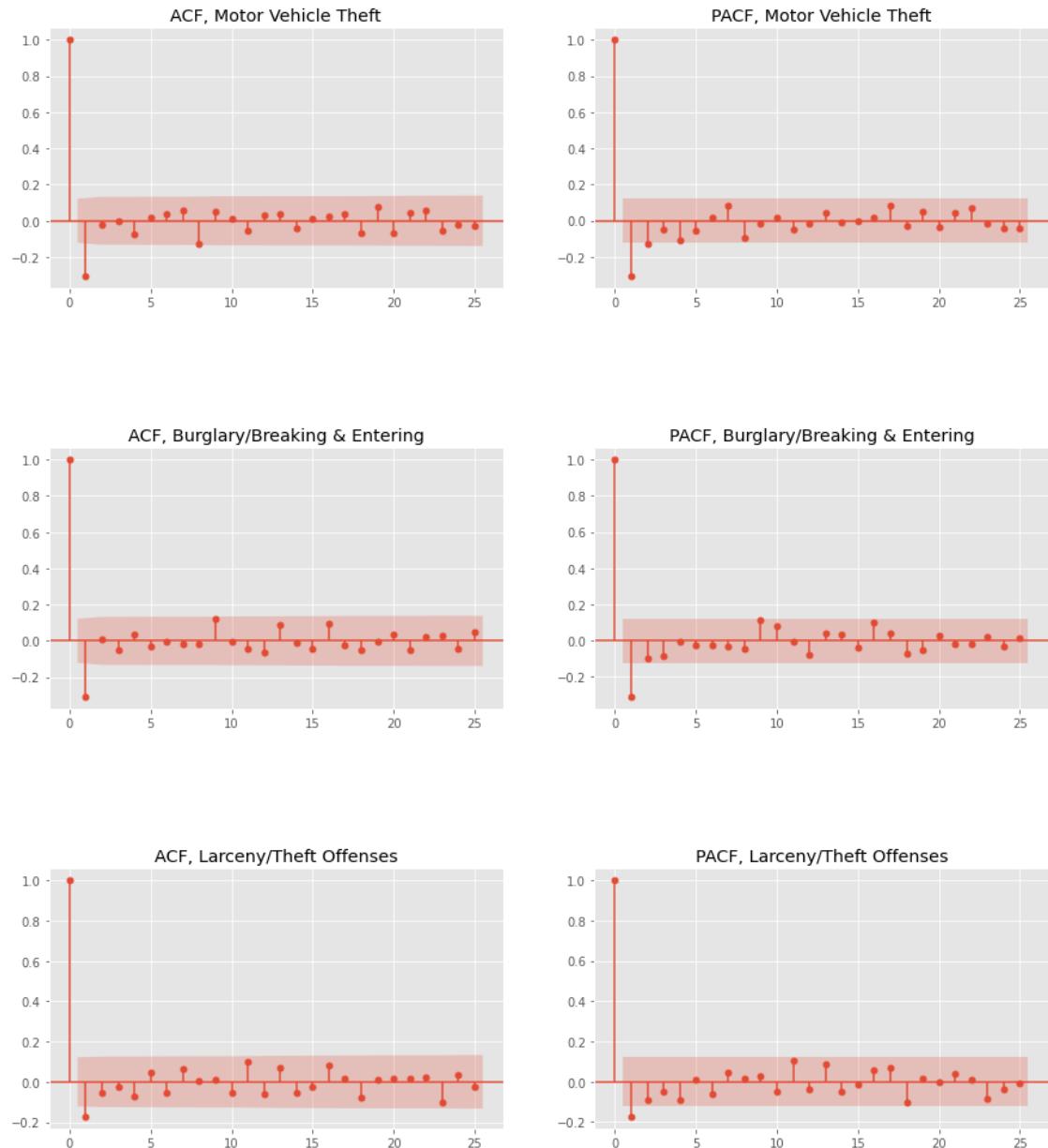


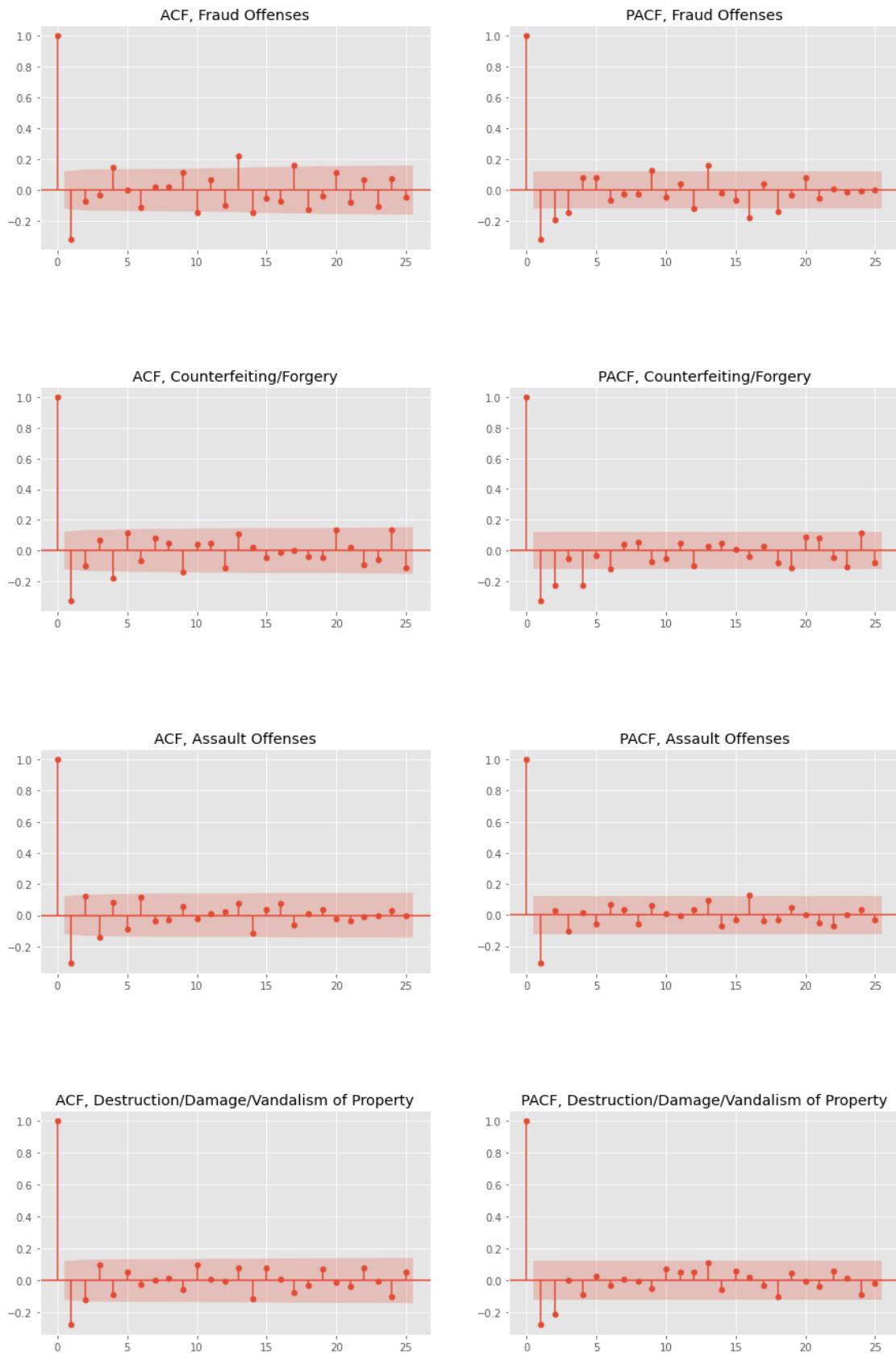


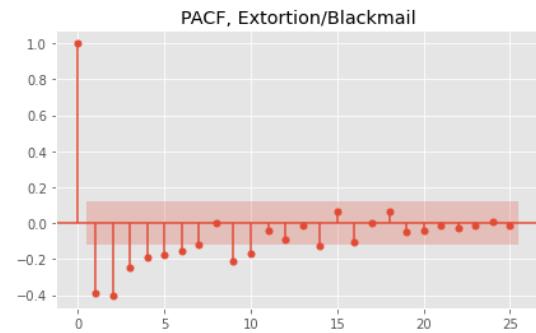
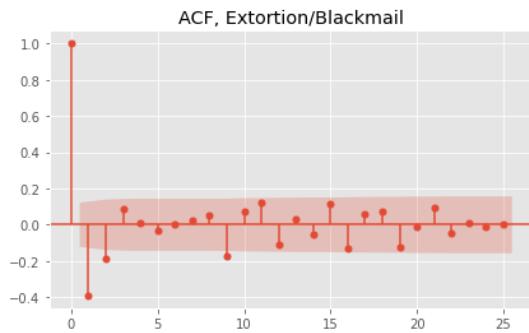
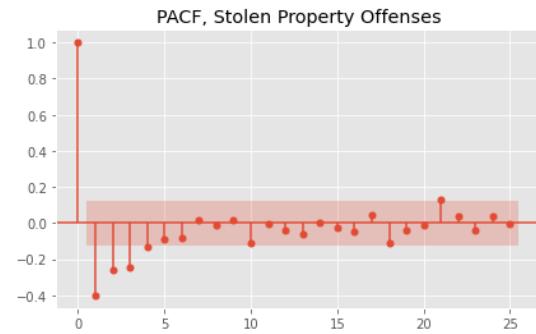
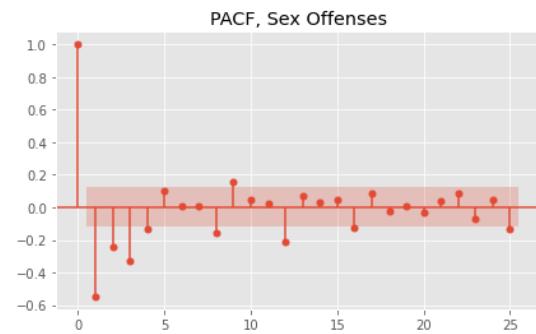
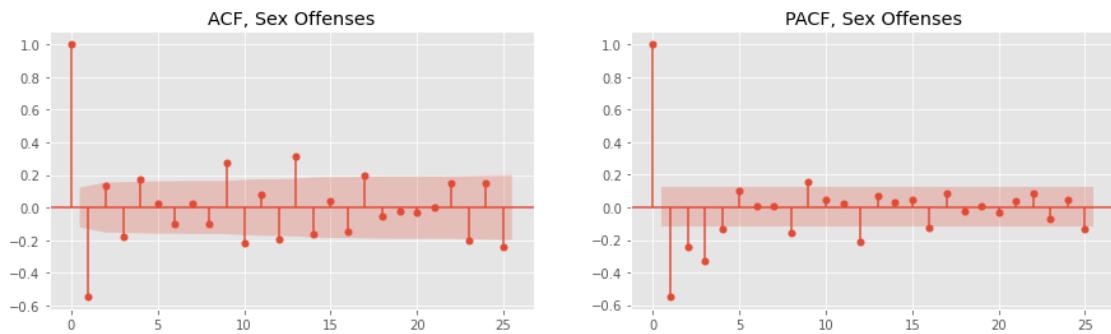


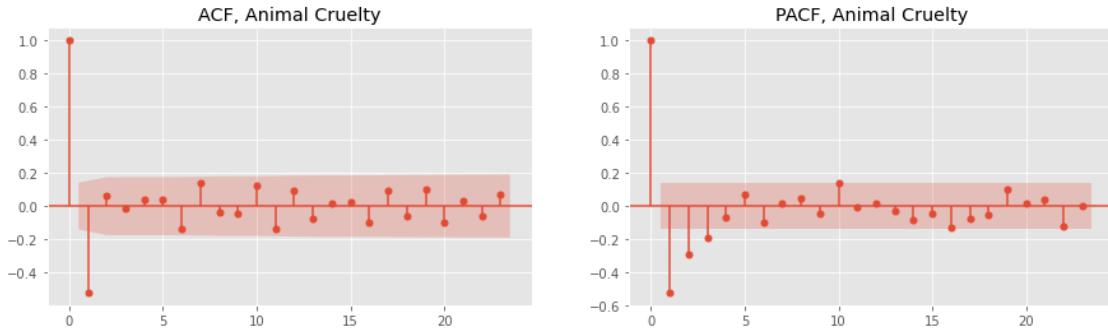


```
[10]: ACF_PACF_multiple(ts_stationary2);
```









### 3.2.3 Auto ARIMA for multiple categories of offenses

```
[11]: # RESULTS = []
# for crime, ts in TS_crime_category.items():
#     crime_categories_results = []

#     # Splitting it up
#     print('===='*20)
#     print('GRIDSEARCHING FOR {}'.format(crime))
#     train_size = round(len(ts) * 0.90)
#     ts_train, ts_test = ts[:train_size], ts[train_size:]

#     predictions_fig=display_figure_w_TSs(ts_train, ts_test, 'Training set', 'Test set',
#                                         'Training and Test Sets for Modeling {}'.format(crime), limit_=False)

#     #### Gridsearch

#     auto_model_train = pm.auto_arima(ts_train,
#                                     start_p=0,start_q=0, d=1,
#                                     start_P=1, start_Q=1, D=1,
#                                     max_p=2, max_q=2,
#                                     max_P=2, max_Q=2,
#                                     m=52, maxiter=150,
#                                     trace=False,verbose=True)

#     ## Fit SARIMAX with best parmas and compare forecast vs test
#     best_model = tsa.SARIMAX(ts_train,order=auto_model_train.order,
#                             seasonal_order = auto_model_train.
#                             seasonal_order,
#                             enforce_invertibility=False).fit()
```

```

#     ## Use diagnostics
#     diagnostics(best_model)

#     ## Prediction comparison
#     plt.style.use('ggplot')
#     y_hat_train=best_model.predict(typ='levels')
#     y_hat_test=best_model.predict(start=ts_test.index[0], end=ts_test.
#     ↪index[-1], typ='levels')

#     rmse = np.sqrt(mean_squared_error(ts_test, y_hat_test))
#     print('RMSE of the {} model for {}'.format(crime, round(rmse,2)))

#     predictions_fig=display_figure_w_TSs(ts_train, ts_test, 'Train set', ↪
#     'Test set',
#                         'Training and Test Sets Raw Values and ↪
#     ↪Predictions, {}'.format(crime),
#     n=4, ts3=y_hat_test,
#     ts4=y_hat_train, label3='Prediction for Test ↪
#     ↪set', label4='Prediction for Training set',
#     limit_=False)

#     print('\tFINAL MODEL:')

#     final_model = tsa.SARIMAX(ts, order=auto_model_train.order,
#     seasonal_order = auto_model_train.seasonal_order,
#     enforce_invertibility=False).fit()

#     ## Plot forecast
#     forecast_fig=plot_predictions(ts, final_model, 'Forecast For Two Years ↪
#     ↪Forward, {}'.format(crime),
#     steps=104, xmin='2015')

#     ## Fill in results and
#     crime_categories_results['final_model'] = final_model
#     crime_categories_results['predict_fig'] = predictions_fig
#     crime_categories_results['forecast_fig'] = forecast_fig

#     ## Saving results to RESULTS dict
#     RESULTS[crime] = crime_categories_results

#     print("\n\n")

```

[12]: # cropped\_RESULTS = {key:val for key, val in RESULTS.items() if ((key != 'Sex' ↪
 ↪Offenses')&(key != 'Weapon Law Violations'))}

```

[13]: # cropped_RESULTS.keys()

[14]: # with open('data/pickled_models/RESULTS1.pickle', 'wb') as f:
#       pickle.dump(cropped_RESULTS, f)

[15]: # TS_crime_category_to_rerun1={}
# TS_crime_category_to_rerun1['Sex Offenses']=TS_crime_category['Sex Offenses'].copy()
# TS_crime_category_to_rerun1['Weapon Law Violations']=TS_crime_category['Weapon Law Violations'].copy()

[16]: # RESULTS_second_run = {}
# for crime, ts in TS_crime_category_to_rerun1.items():
#     crime_categories_results = {}

#     # Splitting it up
#     print('===='*20)
#     print('GRIDSEARCHING FOR {}'.format(crime))
#     train_size = round(len(ts) * 0.90)
#     ts_train, ts_test = ts[:train_size], ts[train_size:]

#     predictions_fig=display_figure_w_TSs(ts_train, ts_test, 'Training set', 'Test set',
#                                         'Training and Test Sets for Modeling {}'.format(crime), limit_=False)

#     ##### Gridsearch
#     auto_model_train = pm.auto_arima(ts_train,
#                                     start_p=0,start_q=0, d=0,
#                                     start_P=0, start_Q=0, D=0,
#                                     max_p=2, max_q=2, max_d=1,
#                                     max_P=2, max_Q=2, max_D=1,
#                                     m=52, maxiter=300,
#                                     trace=False,verbose=True)

#     ## Fit SARIMAX with best parmas and compare forecast vs test
#     best_model = tsa.SARIMAX(ts_train,order=auto_model_train.order,
#                             seasonal_order = auto_model_train.
#                             seasonal_order,
#                             enforce_invertibility=False).fit()

#     ## Use diagnostics

```

```

#     diagnostics(best_model)

#     ## Prediction comparison
#     plt.style.use('ggplot')
#     y_hat_train=best_model.predict(typ='levels')
#     y_hat_test=best_model.predict(start=ts_test.index[0], end=ts_test.
#     ↪index[-1], typ='levels')

#     rmse = np.sqrt(mean_squared_error(ts_test, y_hat_test))
#     print('RMSE of the {} model for {}'.format(crime, round(rmse,2)))

#     predictions_fig=display_figure_w_TSs(ts_train, ts_test, 'Train set', ↪
#     ↪'Test set',
#                                         'Training and Test Sets Raw Values and ↪
#     ↪Predictions, {}'.format(crime),
#     #                                         n=4, ts3=y_hat_test,
#     #                                         ts4=y_hat_train, label3='Prediction for Test ↪
#     ↪set',
#     #                                         label4='Prediction for Training ↪
#     ↪set', limit_=False)

#     print('\tFINAL MODEL:')

#     final_model = tsa.SARIMAX(ts, order=auto_model_train.order,
#     seasonal_order = auto_model_train.seasonal_order,
#     enforce_invertibility=False).fit()

#     ## Plot forecast
#     forecast_fig=plot_predictions(ts, final_model, 'Forecast For Two Years ↪
#     ↪Forward, {}'.format(crime),
#     #                                         steps=104, xmin='2015')

#     ## Fill in results and
#     crime_categories_results['final_model'] = final_model
#     crime_categories_results['predict_fig'] = predictions_fig
#     crime_categories_results['forecast_fig'] = forecast_fig

#     ## Saving results to RESULTS dict
#     RESULTS_second_run[crime] = crime_categories_results

#     print("\n\n")

```

```
[17]: # with open('data/pickled_models/RESULTS2.pickle', 'wb') as f:
#     pickle.dump(RESULTS_second_run, f)
```

```
[18]: # def print_out_models(dictionary):
#       for crime, dict_ in dictionary.items():
#           print('OFFENSE CATEGORY: '+ crime)
#           for key, value in dict_.items():
#               if key=='final_model':
#                   print('\nTHE FINAL MODEL SUMMARY: \n')
#                   display(value.summary());
#                   display(value.plot_diagnostics(figsize=(15,7)));
#               elif key=='predict_fig':
#                   print('\nPREDICTION FOR TRAIN AND TEST sets: \n')
#                   display(value);
#               else:
#                   print('\nFORECAST: \n')
#                   display(value);
#       plt.close()
```

```
[19]: with open('data/pickled_models/RESULTS1.pickle', 'rb') as f:
    results1_back=pickle.load(f)
```

```
[20]: with open('data/pickled_models/RESULTS2.pickle', 'rb') as f:
    results2_back=pickle.load(f)
```

```
[21]: combined_results = {**results1_back, **results2_back}
```

```
[22]: print_out_models(combined_results)
```

\*\*\*\*\*

OFFENSE CATEGORY: Motor Vehicle Theft

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
"""

```

#### SARIMAX Results

Dep. Variable:	Motor Vehicle Theft	No. Observations:	262
Model:	SARIMAX(0, 1, 1)x(2, 1, [], 52)	Log Likelihood	-1087.379
Date:	Fri, 23 Jul 2021	AIC	2182.757
Time:	11:30:12	BIC	2196.126
Sample:	01-04-2015 - 01-05-2020	HQIC	2188.162

Covariance Type: opg

	coef	std err	z	P> z	[0.025	0.975]
ma.L1	-0.7592	0.059	-12.913	0.000	-0.874	-0.644
ar.S.L52	-0.5590	0.088	-6.333	0.000	-0.732	-0.386

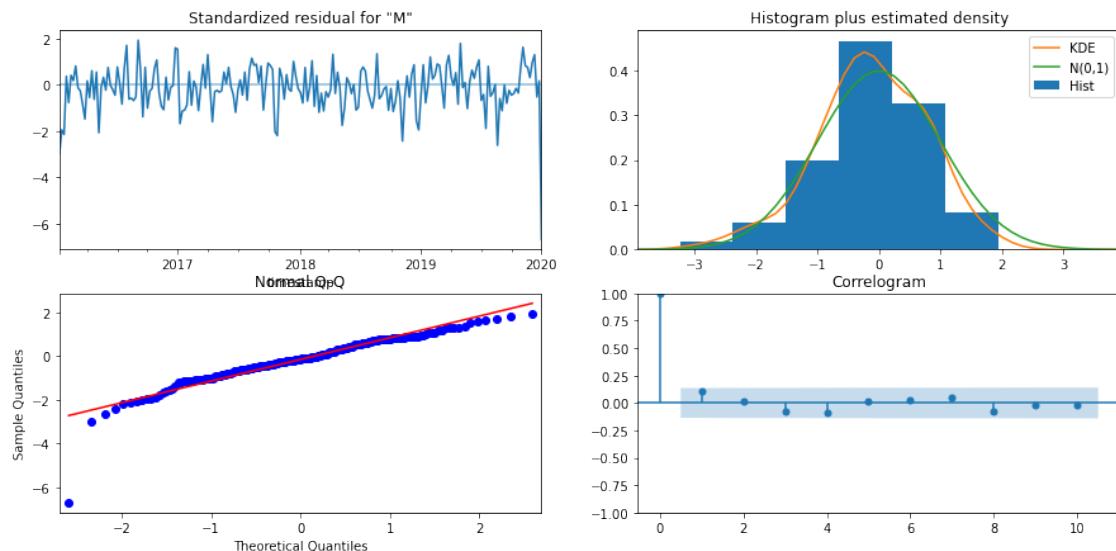
```

ar.S.L104      -0.2983      0.128     -2.327      0.020     -0.550     -0.047
sigma2       1748.7905    94.113     18.582      0.000    1564.332    1933.249
=====
Ljung-Box (L1) (Q):           2.41   Jarque-Bera (JB):        666.52
Prob(Q):                   0.12   Prob(JB):            0.00
Heteroskedasticity (H):      1.53   Skew:                  -1.56
Prob(H) (two-sided):         0.08   Kurtosis:             11.17
=====
```

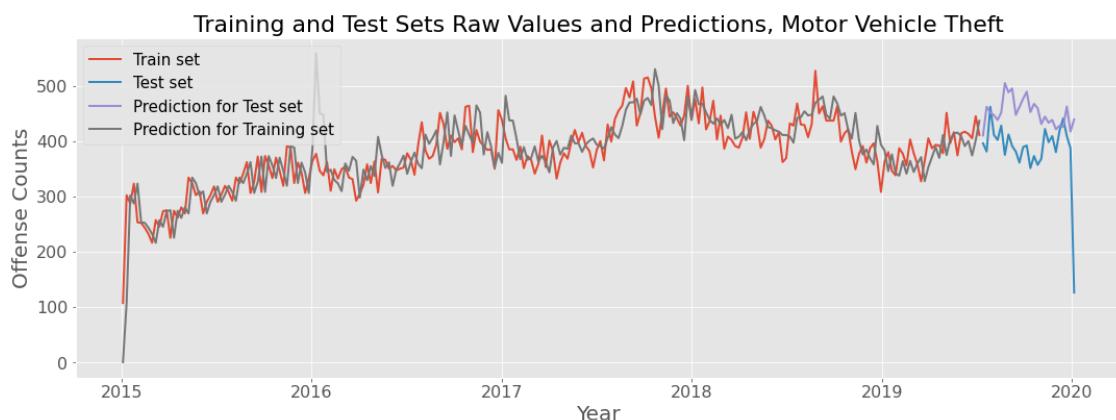
Warnings:

```
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

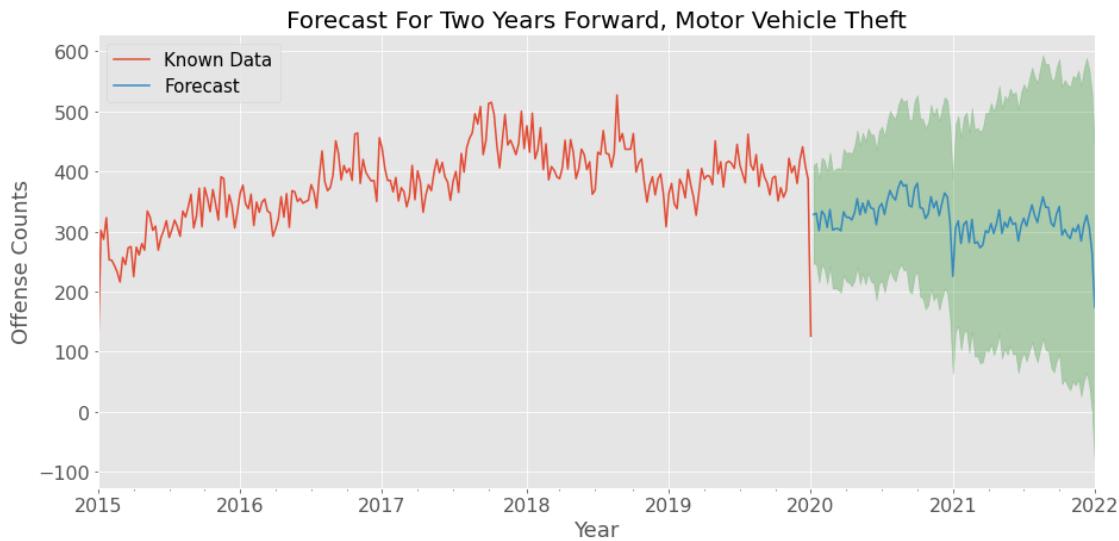
```



#### PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*
OFFENSE CATEGORY: Burglary/Breaking & Entering

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                                          SARIMAX Results
=====
Dep. Variable:          Burglary/Breaking & Entering    No. Observations:                  262
Model:                 SARIMAX(0, 1, 2)x(2, 1, [], 52)    Log Likelihood:                -1078.874
Date:                   Fri, 23 Jul 2021      AIC:                            2167.749
Time:                      11:30:12        BIC:                            2184.460
Sample:                 01-04-2015      HQIC:                           2174.505
                           - 01-05-2020
Covariance Type:                    opg
=====
            coef      std err           z      P>|z|      [0.025      0.975]
-----
ma.L1     -0.7629      0.073   -10.485      0.000     -0.906     -0.620
ma.L2     -0.1181      0.074    -1.594      0.111     -0.263      0.027
ar.S.L52   -0.4278      0.080    -5.334      0.000     -0.585     -0.271
ar.S.L104  -0.4115      0.113    -3.644      0.000     -0.633     -0.190
```

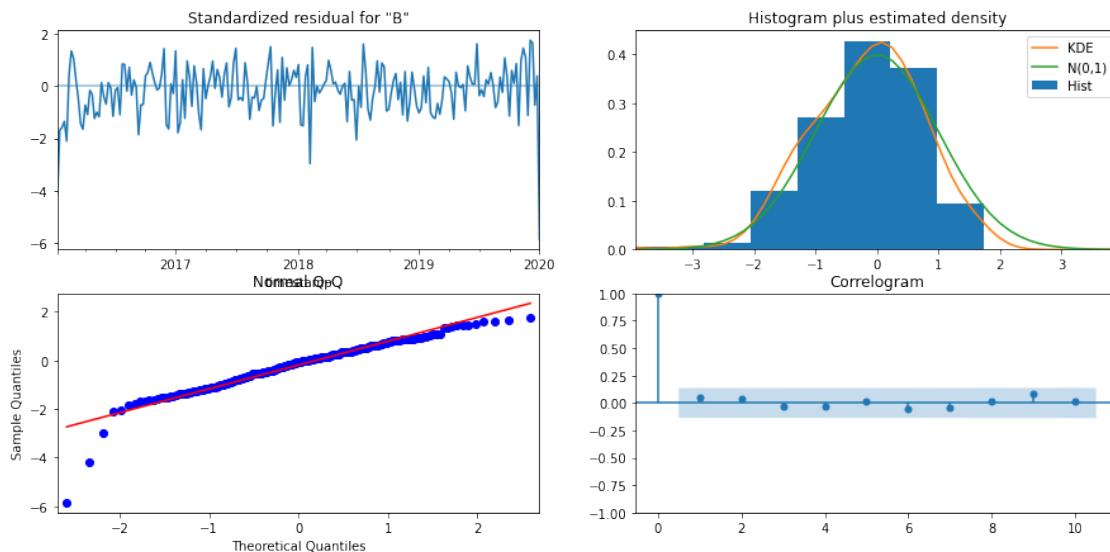
```

sigma2      1577.3598    156.099     10.105      0.000    1271.411    1883.309
=====
Ljung-Box (L1) (Q):           0.63  Jarque-Bera (JB):        291.53
Prob(Q):                   0.43  Prob(JB):            0.00
Heteroskedasticity (H):      0.99  Skew:                -1.27
Prob(H) (two-sided):         0.96  Kurtosis:             8.20
=====
```

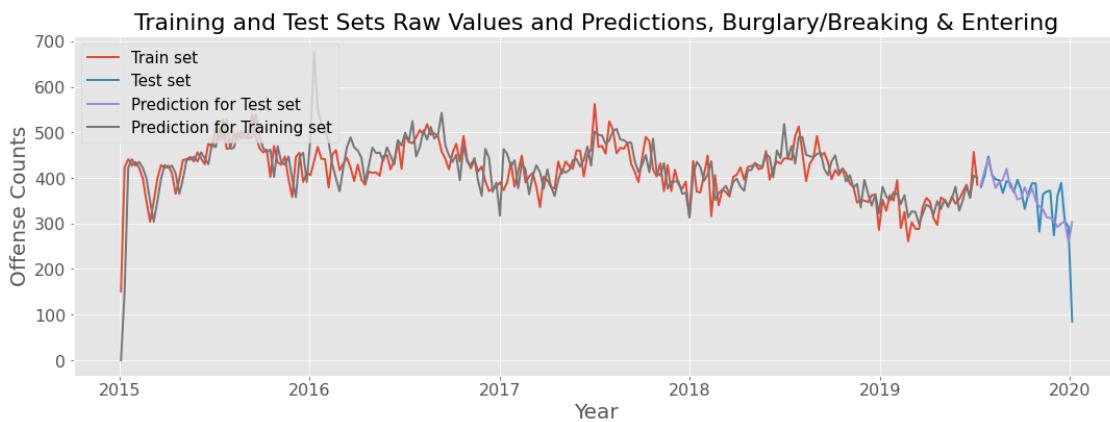
Warnings:

```
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

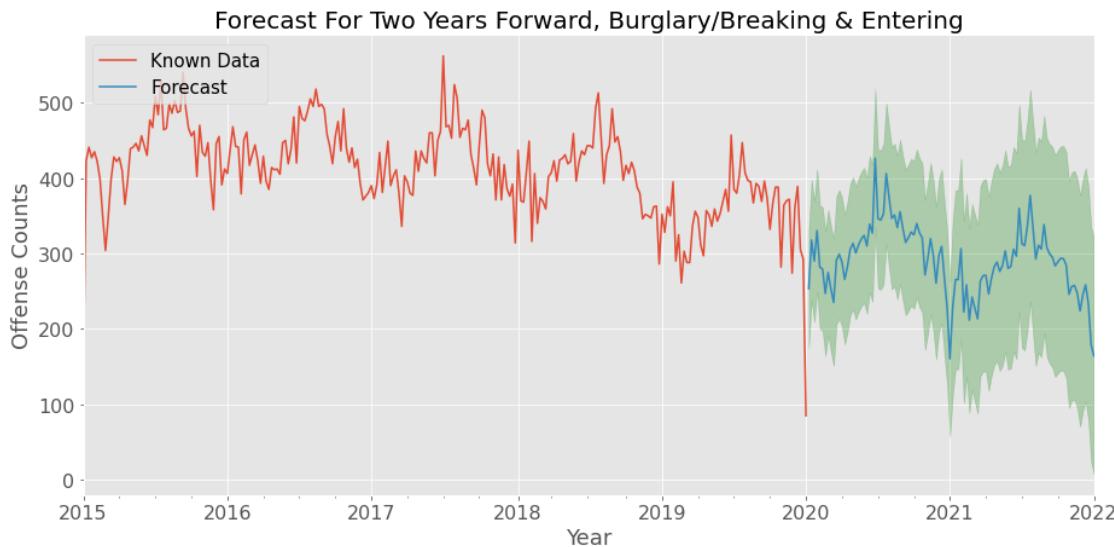
```



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*
OFFENSE CATEGORY: Larceny/Theft Offenses

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
=====
SARIMAX Results
=====
Dep. Variable:          Larceny/Theft Offenses    No. Observations:                 262
Model:                  SARIMAX(0, 1, 1)x(2, 1, []), 52    Log Likelihood:                -1381.281
Date:                   Fri, 23 Jul 2021            AIC:                            2770.561
Time:                   11:30:13                     BIC:                            2783.930
Sample:                 01-04-2015 - 01-05-2020      HQIC:                           2775.966
Covariance Type:        opg
=====
              coef    std err         z      P>|z|      [0.025      0.975]
-----
ma.L1       -0.8804    0.043   -20.302      0.000     -0.965     -0.795
ar.S.L52     -0.5155    0.091    -5.688      0.000     -0.693     -0.338
ar.S.L104    -0.3554    0.147    -2.411      0.016     -0.644     -0.066
```

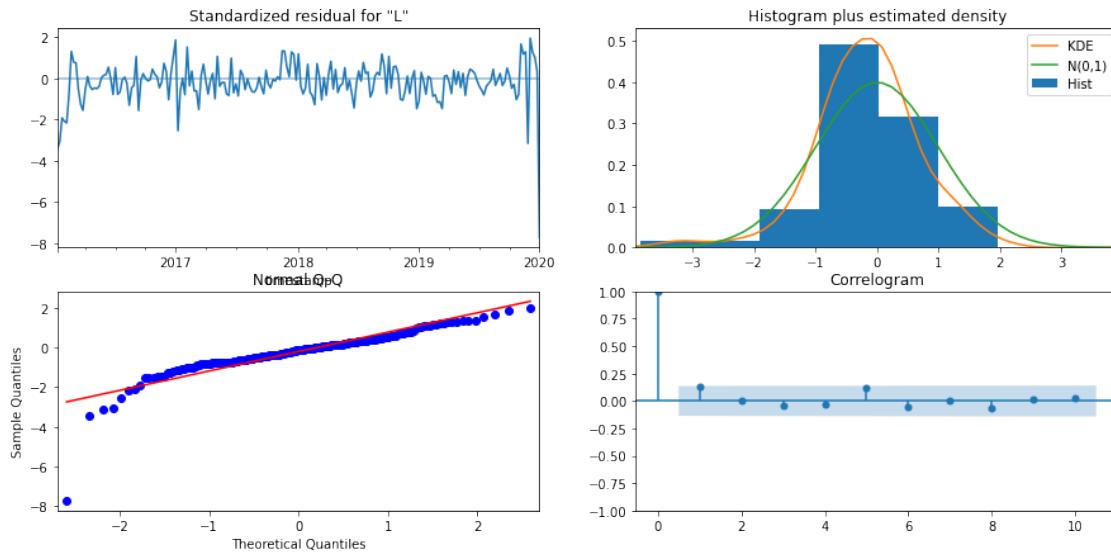
```

sigma2      2.886e+04   2762.625    10.446     0.000    2.34e+04   3.43e+04
=====
Ljung-Box (L1) (Q):           3.34   Jarque-Bera (JB):        2487.91
Prob(Q):                      0.07   Prob(JB):                  0.00
Heteroskedasticity (H):       1.44   Skew:                     -2.43
Prob(H) (two-sided):          0.13   Kurtosis:                 19.19
=====
```

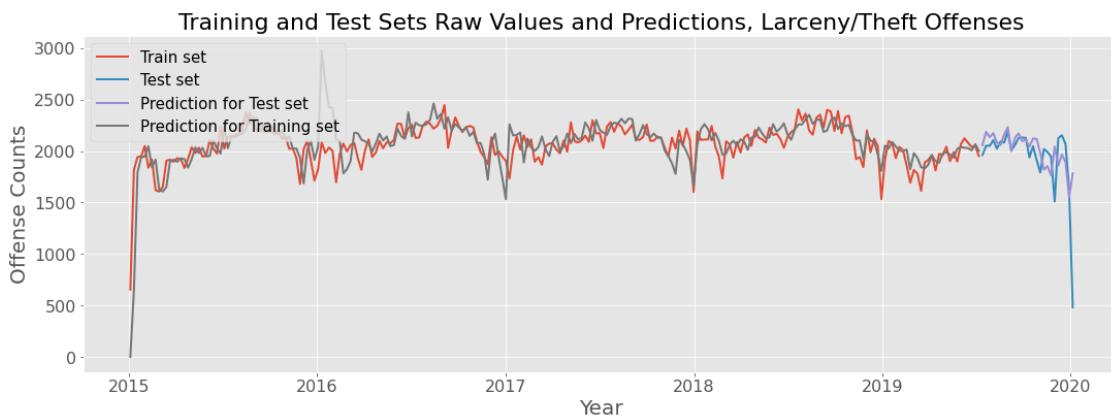
Warnings:

```
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

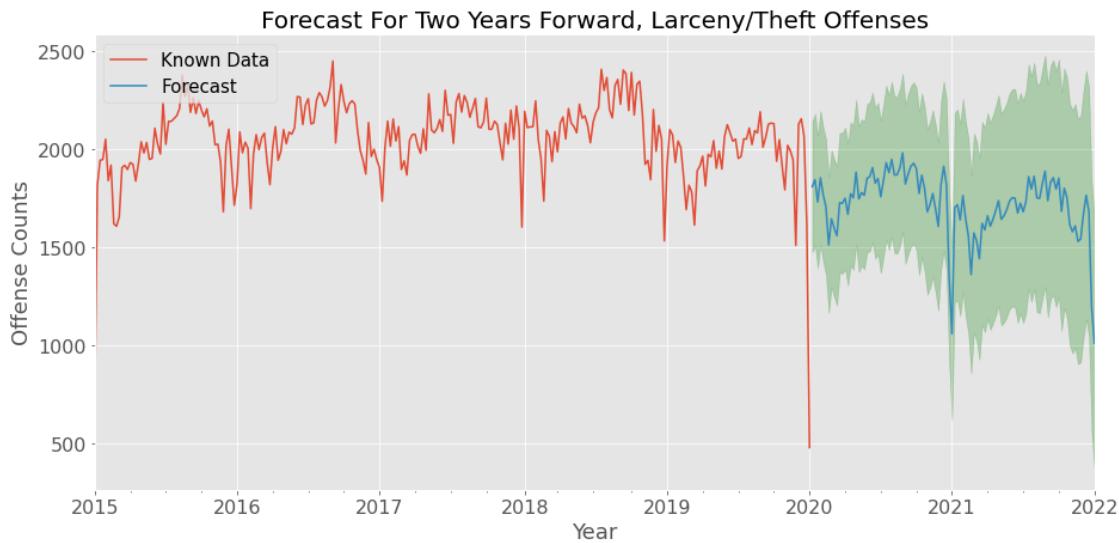
```



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*

OFFENSE CATEGORY: Fraud Offenses

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
=====
          SARIMAX Results
=====
Dep. Variable:                  Fraud Offenses    No. Observations:                   262
Model: SARIMAX(0, 1, 1)x(2, 1, 0, 52)    Log Likelihood:                -1138.743
Date: Fri, 23 Jul 2021            AIC:                            2285.485
Time: 11:30:14                     BIC:                            2298.854
Sample: 01-04-2015 - 01-05-2020    HQIC:                           2290.890
Covariance Type: opg
=====
              coef      std err      z      P>|z|      [0.025      0.975]
-----
ma.L1     -0.6526      0.050   -12.950      0.000     -0.751     -0.554
ar.S.L52  -0.4171      0.073    -5.698      0.000     -0.561     -0.274
ar.S.L104 -0.4076      0.072    -5.645      0.000     -0.549     -0.266
```

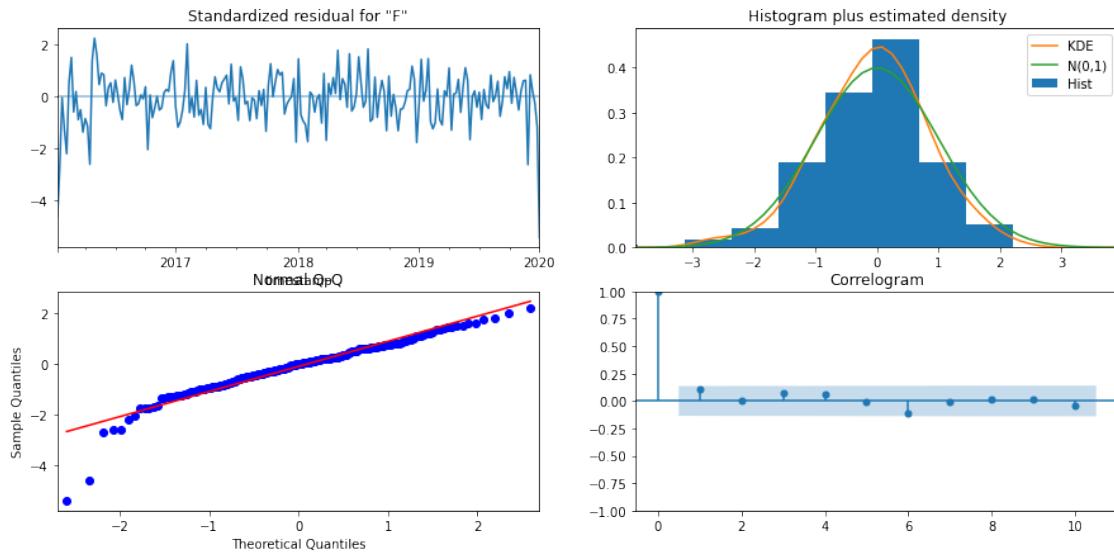
```

sigma2      2819.6525    226.429     12.453      0.000    2375.859    3263.446
=====
Ljung-Box (L1) (Q):           2.22  Jarque-Bera (JB):        258.78
Prob(Q):                   0.14  Prob(JB):            0.00
Heteroskedasticity (H):      0.84  Skew:                -1.23
Prob(H) (two-sided):         0.47  Kurtosis:             7.86
=====
```

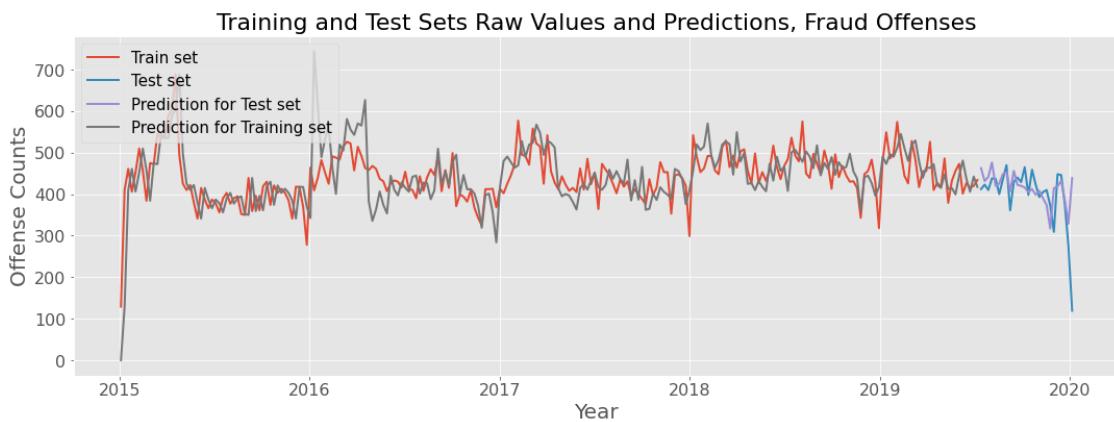
Warnings:

```
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

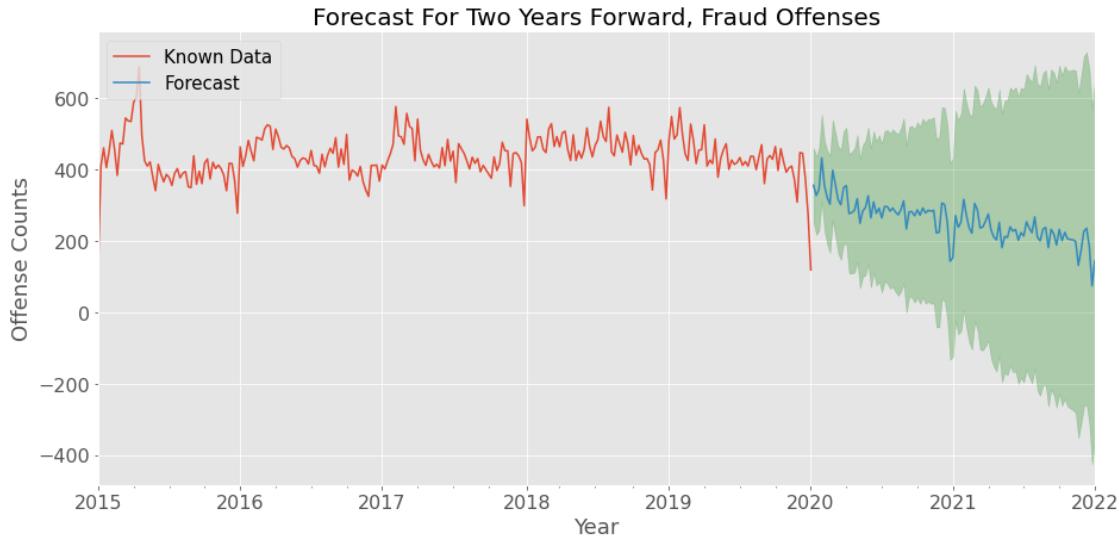
```



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*  
OFFENSE CATEGORY: Counterfeiting/Forgery

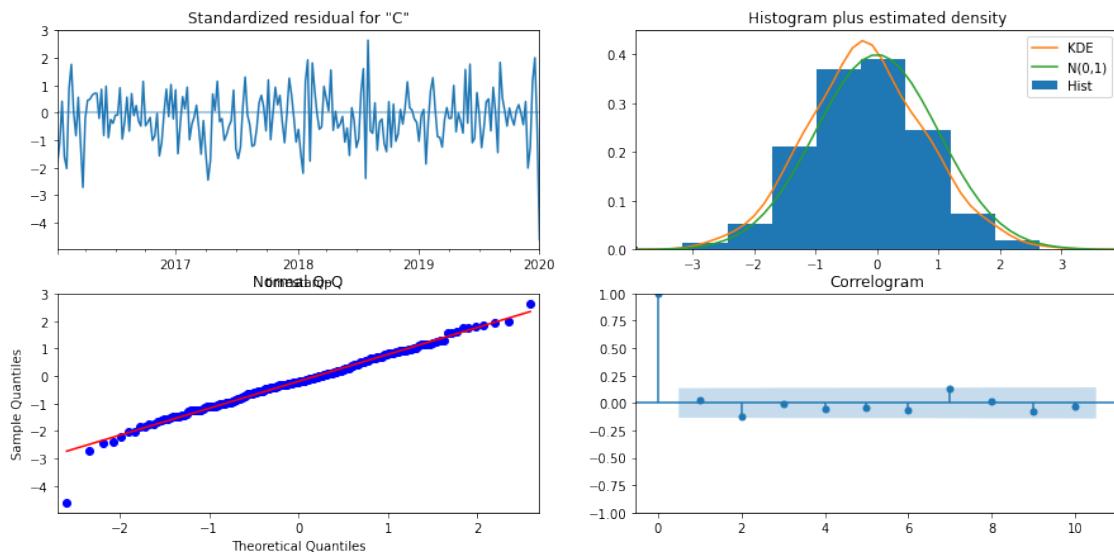
THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                                          SARIMAX Results
=====
Dep. Variable:          Counterfeiting/Forgery    No. Observations:                 262
Model:                  SARIMAX(0, 1, 1)x(2, 1, [], 52) Log Likelihood:            -871.182
Date:                   Fri, 23 Jul 2021      AIC:                            1750.364
Time:                   11:30:15             BIC:                            1763.734
Sample:                01-04-2015 - 01-05-2020 HQIC:                           1755.770
Covariance Type:        opg
=====
              coef    std err         z      P>|z|      [0.025      0.975]
-----
ma.L1       -0.8404     0.041   -20.468      0.000     -0.921     -0.760
ar.S.L52    -0.5933     0.089    -6.697      0.000     -0.767     -0.420
ar.S.L104   -0.3472     0.097    -3.563      0.000     -0.538     -0.156
sigma2      216.0399   16.310    13.246      0.000    184.073    248.007
```

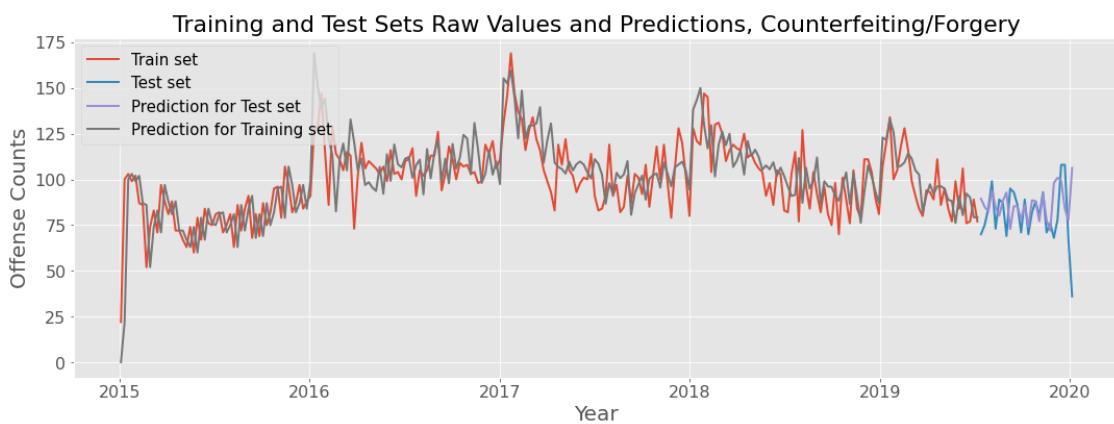
Ljung-Box (L1) (Q):	0.11	Jarque-Bera (JB):	21.25
Prob(Q):	0.74	Prob(JB):	0.00
Heteroskedasticity (H):	1.13	Skew:	-0.31
Prob(H) (two-sided):	0.61	Kurtosis:	4.44

Warnings:

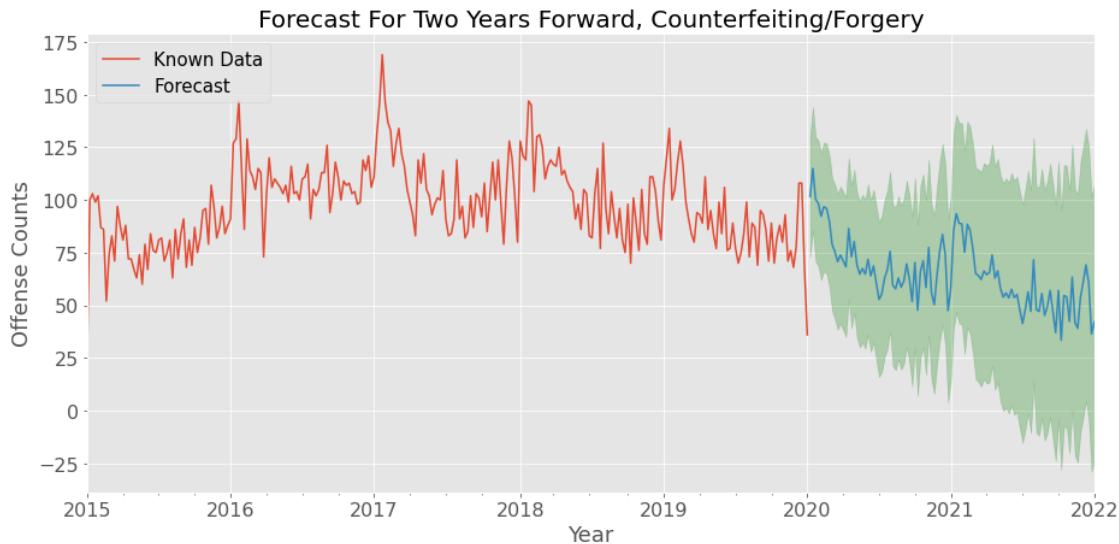
[1] Covariance matrix calculated using the outer product of gradients (complex-step).  
 """



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*

OFFENSE CATEGORY: Assault Offenses

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
=====
          SARIMAX Results
=====

Dep. Variable:           Assault Offenses    No. Observations:                 262
Model:             SARIMAX(2, 1, 1)x(2, 1, []), 52    Log Likelihood:                -1207.539
Date:            Fri, 23 Jul 2021    AIC:                            2427.078
Time:                         11:30:15    BIC:                            2447.132
Sample:                      01-04-2015    HQIC:                           2435.186
                               - 01-05-2020
Covariance Type:                  opg
=====

              coef      std err          z      P>|z|      [0.025      0.975]
-----  
ar.L1      0.1210      0.109      1.108      0.268     -0.093      0.335  
ar.L2      0.1233      0.111      1.113      0.266     -0.094      0.340  
ma.L1     -0.9078      0.063     -14.431      0.000     -1.031     -0.785  
ar.S.L52   -0.4029      0.101     -3.985      0.000     -0.601     -0.205
```

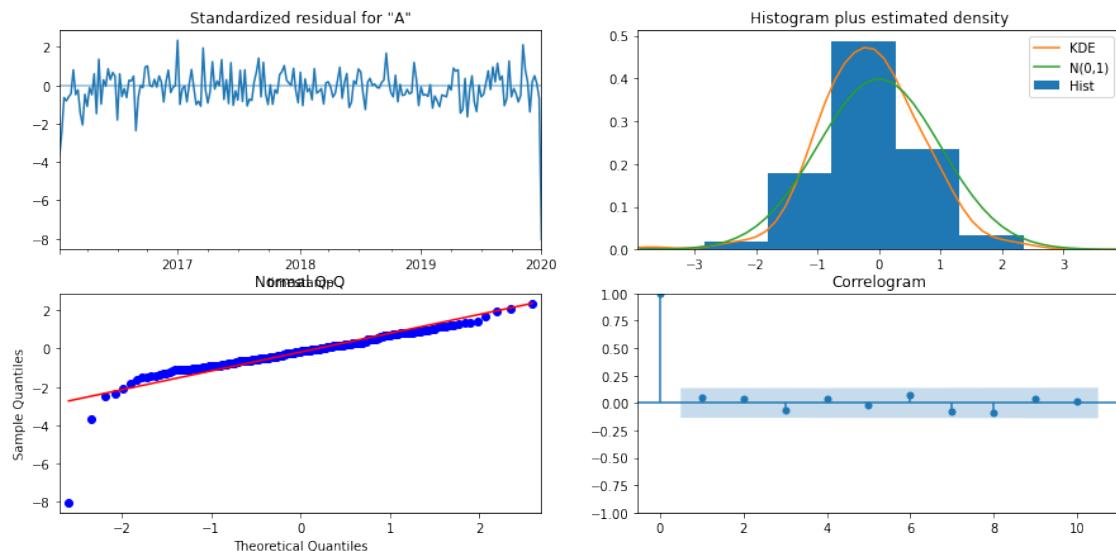
```

ar.S.L104      -0.3213      0.119      -2.700      0.007      -0.555      -0.088
sigma2       5617.1717    295.661     18.999      0.000     5037.687    6196.656
=====
Ljung-Box (L1) (Q):                  0.50   Jarque-Bera (JB):            3272.61
Prob(Q):                           0.48   Prob(JB):                   0.00
Heteroskedasticity (H):             1.53   Skew:                      -2.49
Prob(H) (two-sided):                0.08   Kurtosis:                 21.73
=====
```

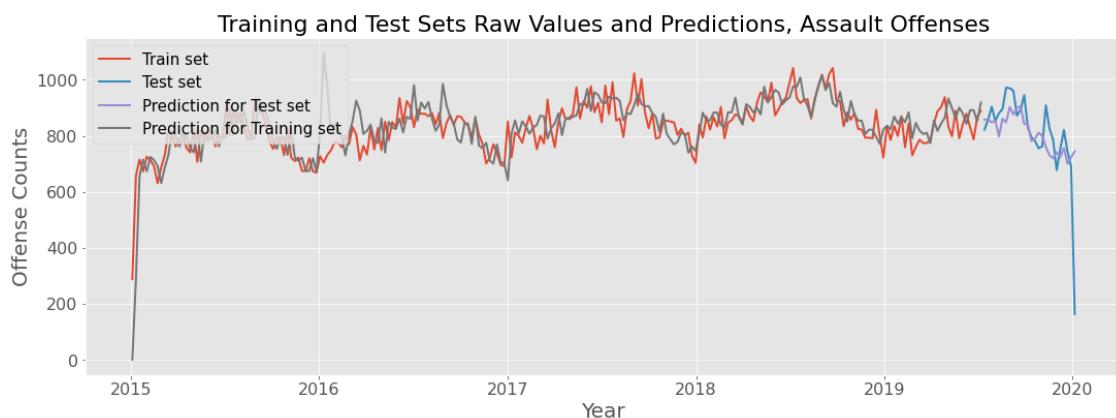
Warnings:

```
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

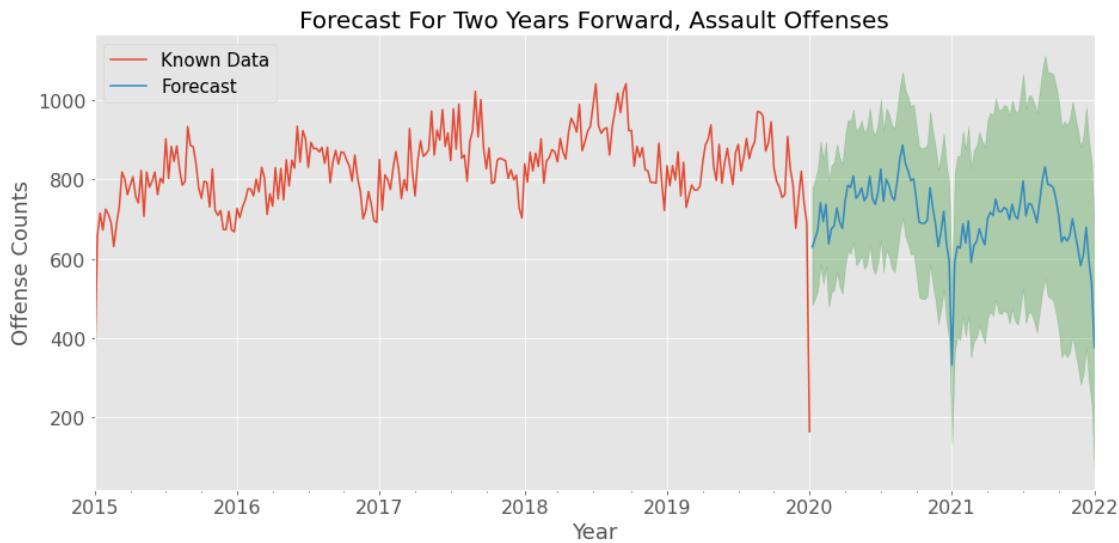
```



#### PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*  
OFFENSE CATEGORY: Destruction/Damage/Vandalism of Property

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
=====
          SARIMAX Results
=====
Dep. Variable:      Destruction/Damage/Vandalism of Property    No. Observations:      -124
Model:                  SARIMAX(1, 1, 2)x(2, 1, [], 52)    Log Likelihood:        248
Date:                      Fri, 23 Jul 2021    AIC:                  256
Time:                          11:30:16    BIC:                  256
Sample:                      01-04-2015    HQIC:                 256
                           - 01-05-2020
Covariance Type:             opg
=====
              coef    std err        z     P>|z|    [0.025    0.975]
-----
ar.L1       -0.4574    0.234   -1.954     0.051    -0.916     0.001
ma.L1       -0.2473    0.229   -1.078     0.281    -0.697     0.202
ma.L2       -0.6048    0.200   -3.030     0.002    -0.996    -0.214
```

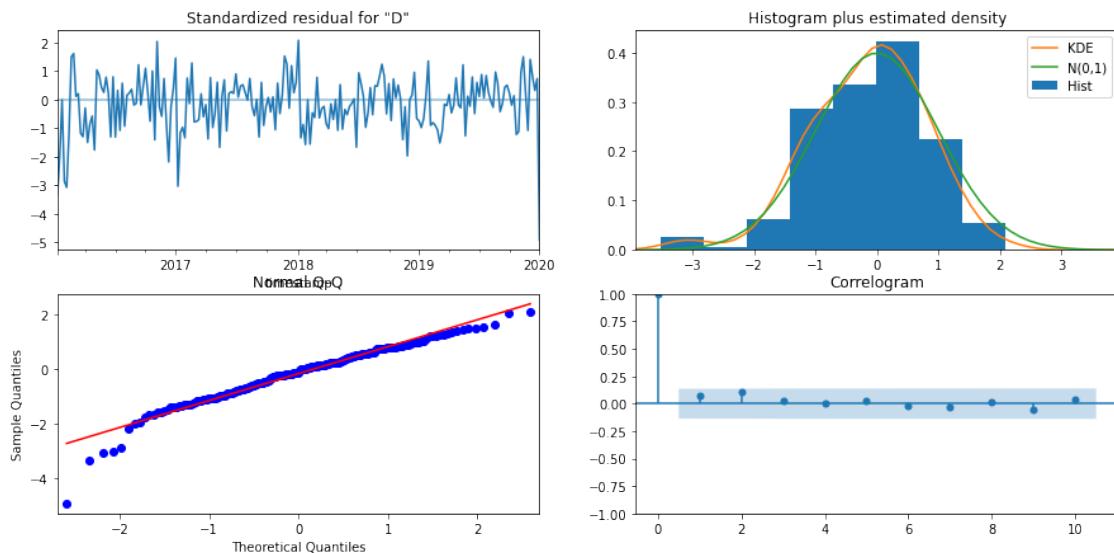
```

ar.S.L52      -0.5324      0.084      -6.323      0.000      -0.697      -0.367
ar.S.L104     -0.3604      0.092      -3.904      0.000      -0.541      -0.179
sigma2       7448.8908    862.754      8.634      0.000    5757.925    9139.857
=====
Ljung-Box (L1) (Q):                      0.98   Jarque-Bera (JB):        78.67
Prob(Q):                                0.32   Prob(JB):            0.00
Heteroskedasticity (H):                  0.67   Skew:                 -0.88
Prob(H) (two-sided):                    0.10   Kurtosis:           5.44
=====
```

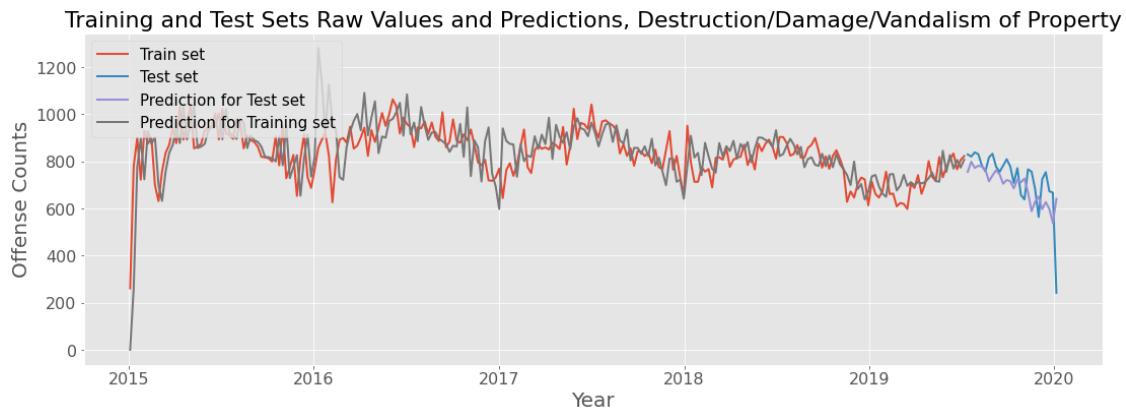
Warnings:

```
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

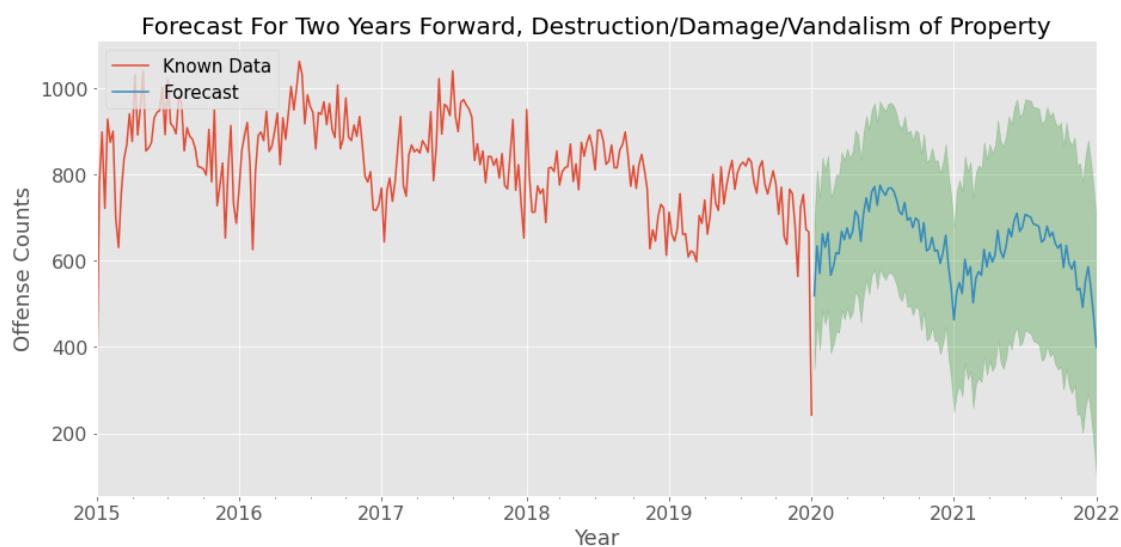
```



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*

OFFENSE CATEGORY: Arson

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
```

```
"""
```

SARIMAX Results

```
=====
```

Dep. Variable:

Arson No. Observations:

262

```

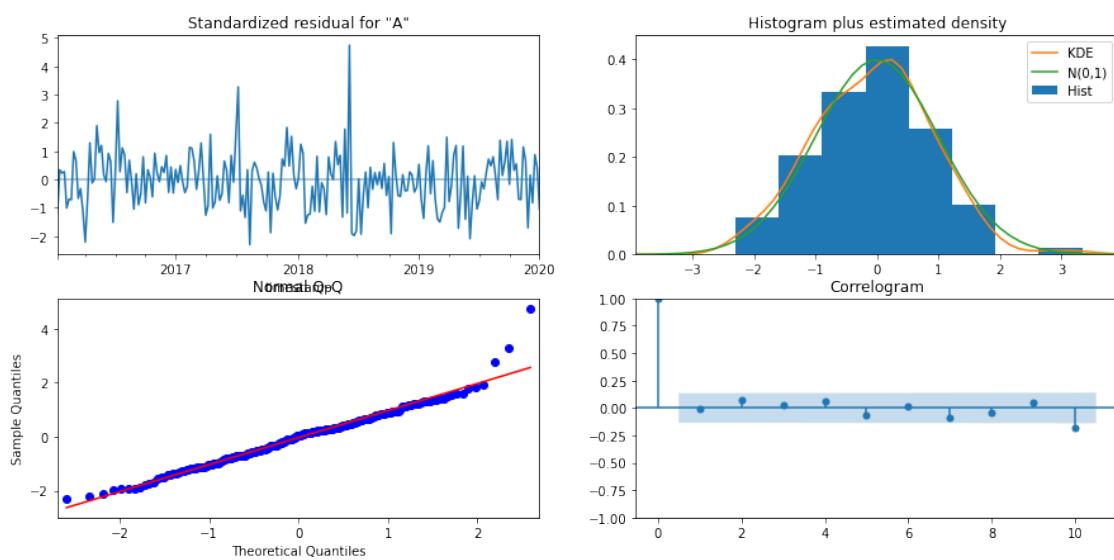
Model: SARIMAX(1, 1, 1)x(2, 1, []) , 52 Log Likelihood      -722.935
Date: Fri, 23 Jul 2021 AIC                         1455.870
Time: 11:30:17 BIC                         1472.582
Sample: 01-04-2015 HQIC                        1462.627
        - 01-05-2020
Covariance Type: opg
=====

            coef    std err       z   P>|z|    [0.025    0.975]
-----
ar.L1      0.1322    0.067    1.974    0.048    0.001    0.264
ma.L1     -0.9588    0.028   -33.989   0.000   -1.014   -0.904
ar.S.L52   -0.5102    0.070    -7.311   0.000   -0.647   -0.373
ar.S.L104  -0.3924    0.087   -4.493   0.000   -0.564   -0.221
sigma2     51.9199    3.810   13.626   0.000   44.452   59.388
=====

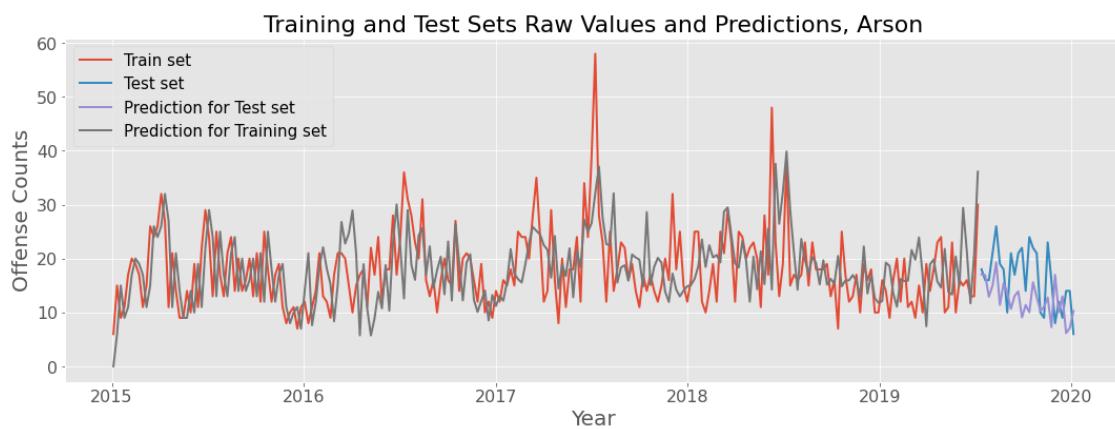
Ljung-Box (L1) (Q):          0.03 Jarque-Bera (JB):      47.51
Prob(Q):                   0.86 Prob(JB):           0.00
Heteroskedasticity (H):     1.04 Skew:                  0.57
Prob(H) (two-sided):        0.86 Kurtosis:             5.04
=====

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

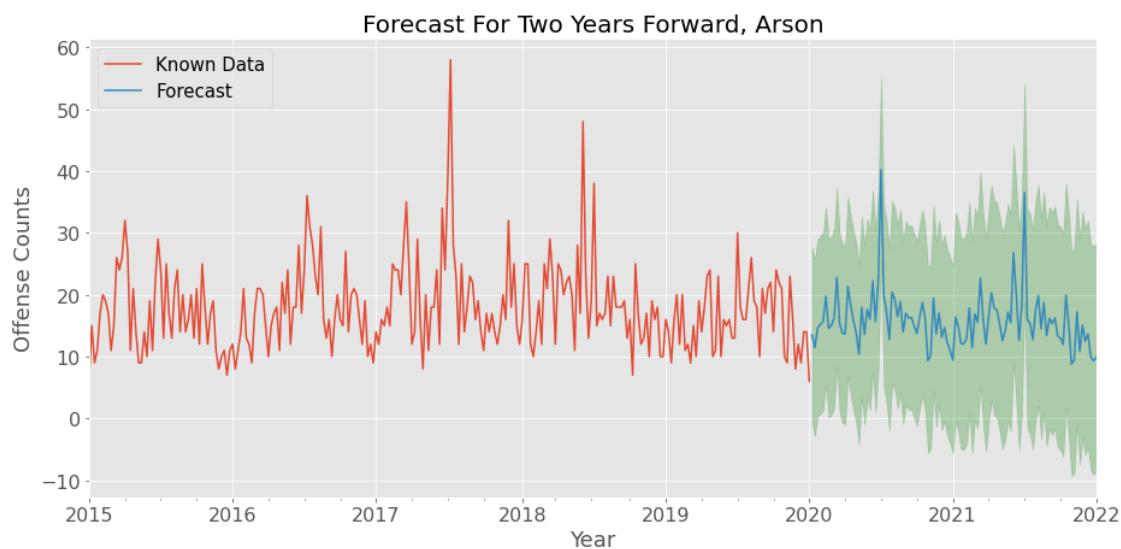
```



PREDICTION FOR TRAIN AND TEST sets:



**FORECAST:**



\*\*\*\*\*

OFFENSE CATEGORY: Drug/Narcotic Offenses

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
"""

```

#### SARIMAX Results

=====  
Dep. Variable:

Drug/Narcotic Offenses

No. Observations:

262

```

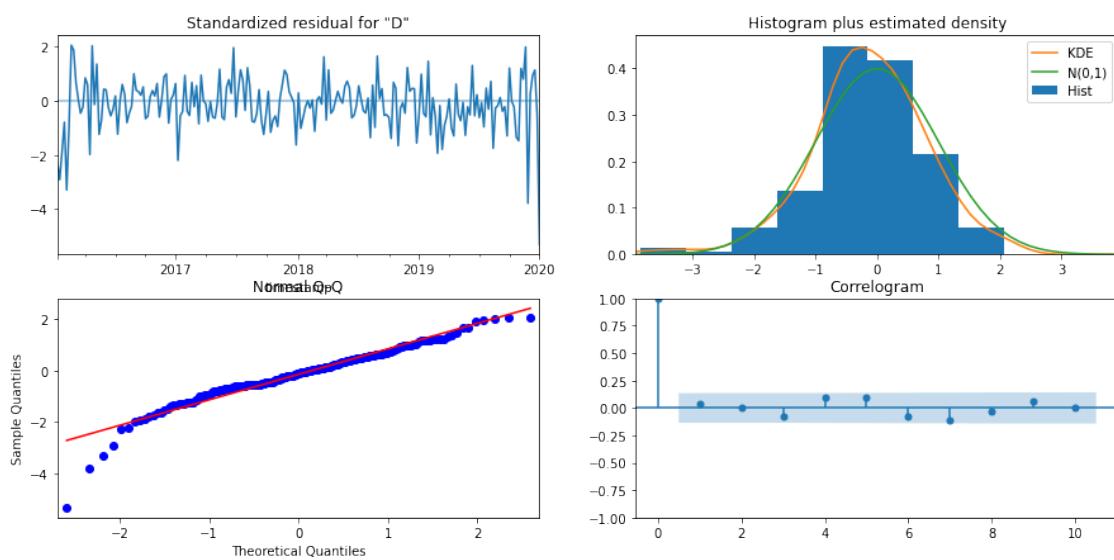
Model: SARIMAX(1, 1, 1)x(2, 1, []) , 52 Log Likelihood           -1184.394
Date: Fri, 23 Jul 2021 AIC                                2378.788
Time: 11:30:18 BIC                                2395.500
Sample: 01-04-2015 HQIC                               2385.545
        - 01-05-2020
Covariance Type: opg
=====

            coef    std err      z   P>|z|    [0.025    0.975]
-----
ar.L1      0.1509    0.076   1.994    0.046    0.003    0.299
ma.L1     -0.8906    0.047 -18.944    0.000   -0.983   -0.798
ar.S.L52   -0.4894    0.099  -4.934    0.000   -0.684   -0.295
ar.S.L104  -0.2756    0.104  -2.642    0.008   -0.480   -0.071
sigma2    4502.3816  326.682 13.782    0.000 3862.097 5142.666
=====

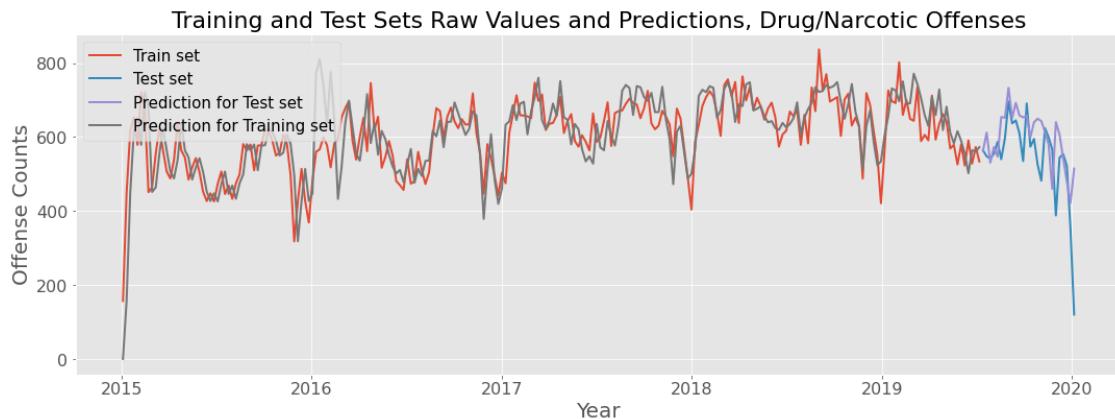
Ljung-Box (L1) (Q):          0.29 Jarque-Bera (JB):       162.75
Prob(Q):                   0.59 Prob(JB):                  0.00
Heteroskedasticity (H):     1.36 Skew:                      -0.99
Prob(H) (two-sided):        0.20 Kurtosis:                 6.85
=====

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

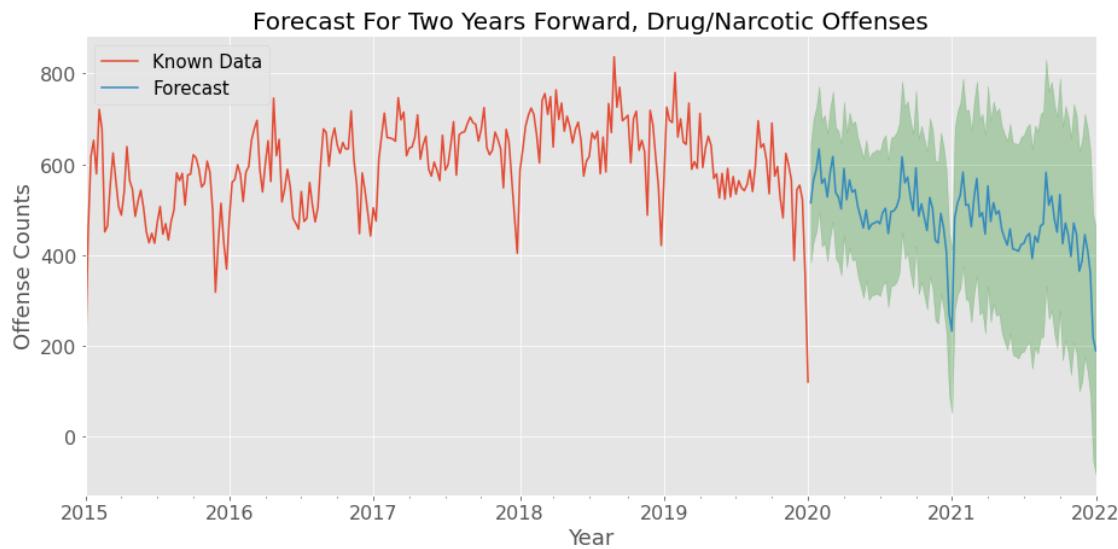
```



PREDICTION FOR TRAIN AND TEST sets:



**FORECAST:**



\*\*\*\*\*
OFFENSE CATEGORY: Stolen Property Offenses

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
"""

```

#### SARIMAX Results

```
=====
Dep. Variable:          Stolen Property Offenses    No. Observations:      262
```

```

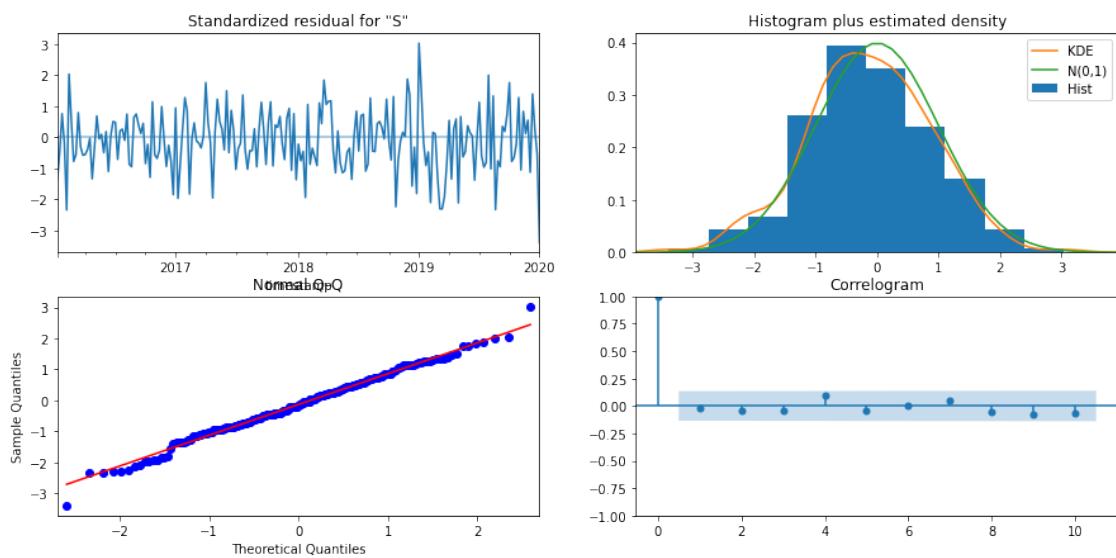
Model: SARIMAX(0, 1, 2)x(2, 1, [], 52) Log Likelihood           -787.419
Date:                     Fri, 23 Jul 2021      AIC                  1584.838
Time:                         11:30:18        BIC                  1601.550
Sample:                      01-04-2015    HQIC                1591.595
                             - 01-05-2020
Covariance Type:          opg
=====

              coef   std err      z   P>|z|   [0.025   0.975]
-----
ma.L1      -0.7840   0.065  -11.977   0.000   -0.912   -0.656
ma.L2      -0.0757   0.068  -1.116   0.264   -0.209   0.057
ar.S.L52    -0.7599   0.069  -11.050   0.000   -0.895   -0.625
ar.S.L104   -0.4050   0.080  -5.093   0.000   -0.561   -0.249
sigma2     91.4605  9.984   9.161   0.000   71.892  111.029
=====

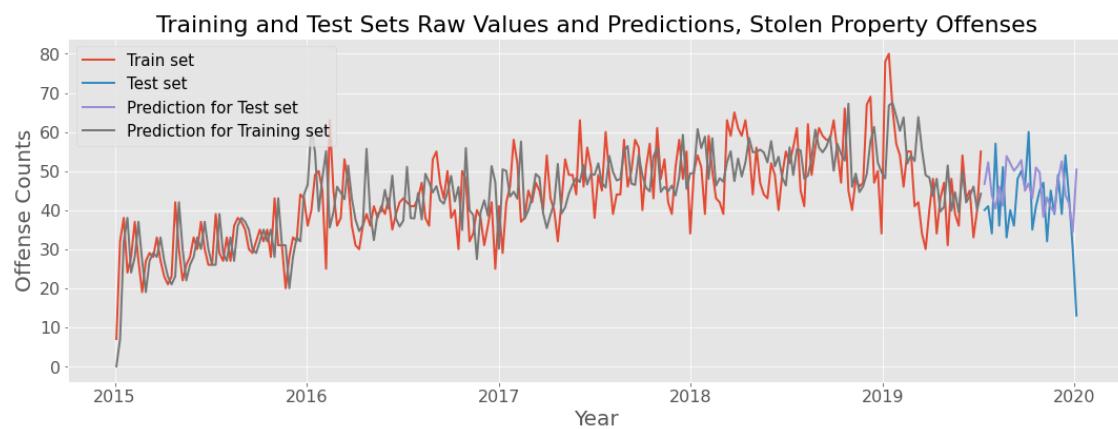
Ljung-Box (L1) (Q):            0.05  Jarque-Bera (JB):          0.86
Prob(Q):                      0.82  Prob(JB):                 0.65
Heteroskedasticity (H):       1.93  Skew:                   -0.10
Prob(H) (two-sided):          0.01  Kurtosis:                3.25
=====

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

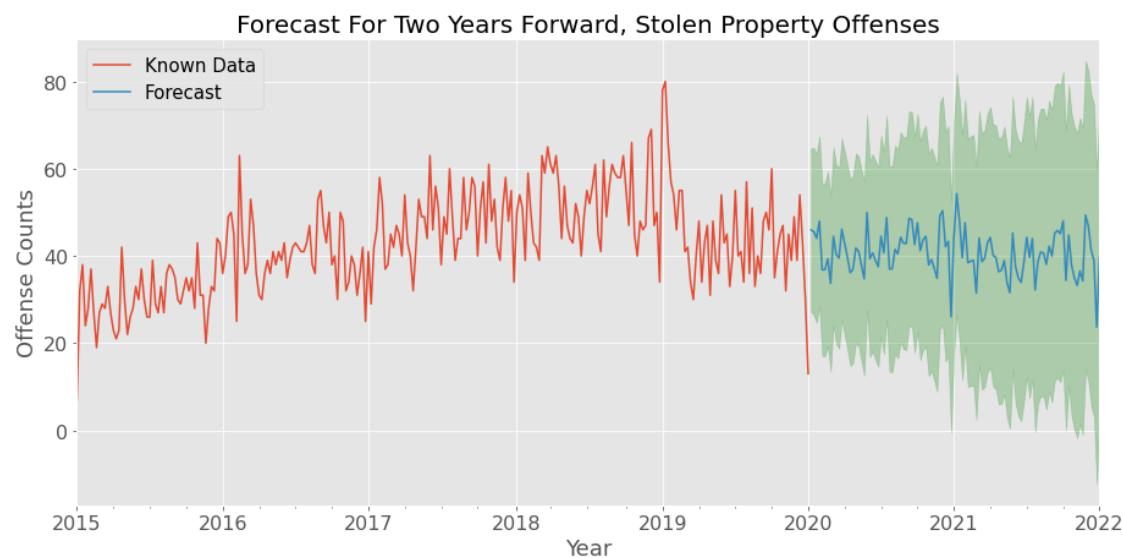
```



PREDICTION FOR TRAIN AND TEST sets:



**FORECAST:**



\*\*\*\*\*

OFFENSE CATEGORY: Kidnapping/Abduction

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
"""

```

#### SARIMAX Results

```
=====
Dep. Variable: Kidnapping/Abduction No. Observations: 262
=====
```

```

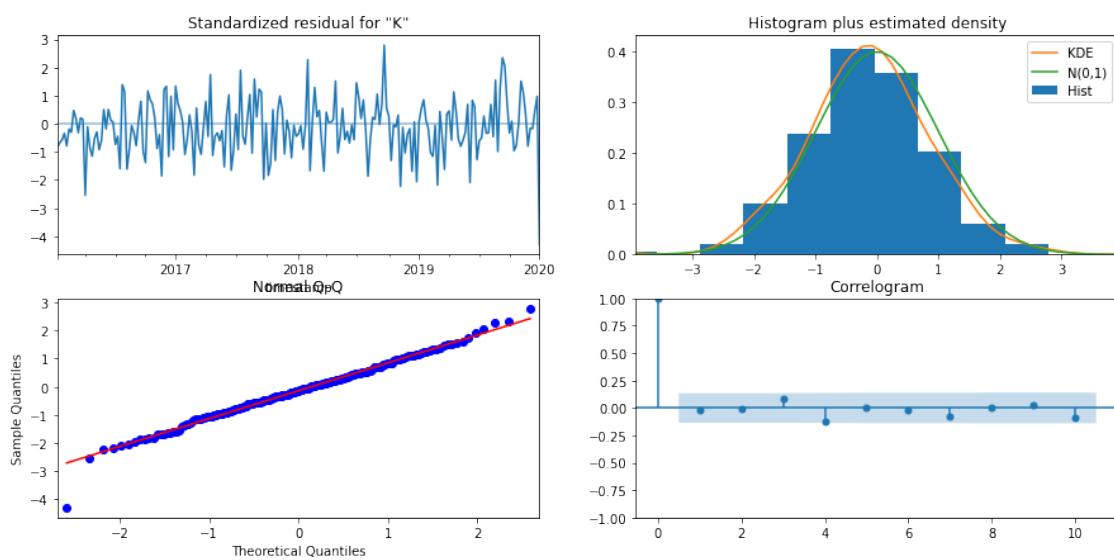
Model: SARIMAX(1, 1, 1)x(2, 1, []) , 52 Log Likelihood      -726.762
Date: Fri, 23 Jul 2021 AIC                         1463.525
Time: 11:30:19 BIC                         1480.236
Sample: 01-04-2015 HQIC                        1470.281
- 01-05-2020
Covariance Type: opg
=====

            coef    std err       z   P>|z|    [0.025    0.975]
-----
ar.L1     -0.1379    0.082  -1.687    0.092   -0.298    0.022
ma.L1     -0.9205    0.035 -26.484    0.000   -0.989   -0.852
ar.S.L52   -0.6328    0.076  -8.311    0.000   -0.782   -0.484
ar.S.L104  -0.1894    0.112  -1.688    0.091   -0.409    0.030
sigma2    54.9004    4.521  12.144    0.000   46.040  63.761
=====

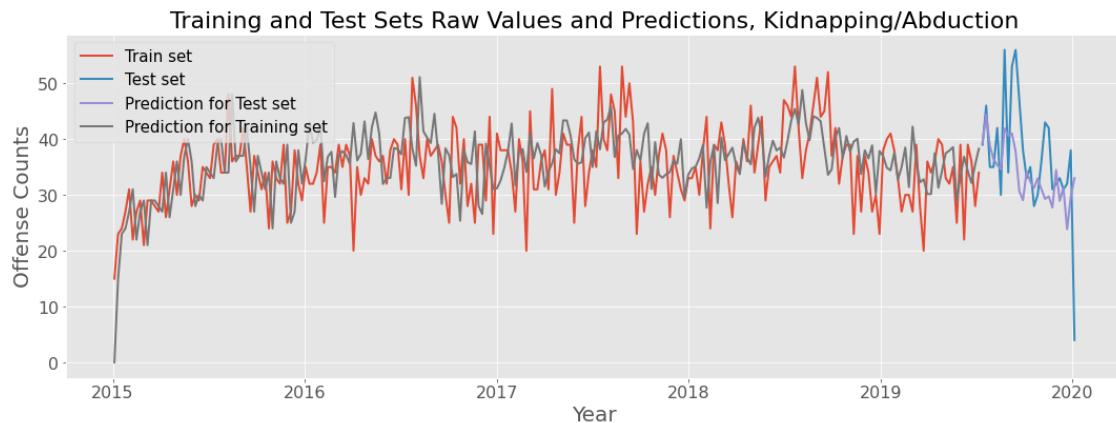
Ljung-Box (L1) (Q):          0.08 Jarque-Bera (JB):        10.95
Prob(Q):                   0.78 Prob(JB):                  0.00
Heteroskedasticity (H):     1.58 Skew:                      -0.19
Prob(H) (two-sided):        0.06 Kurtosis:                 4.05
=====

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

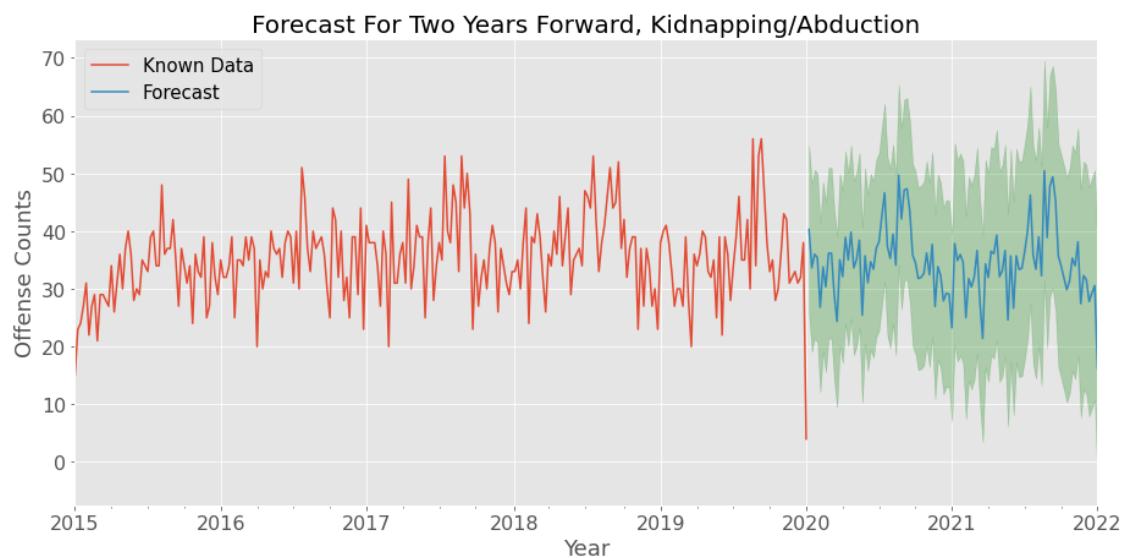
```



PREDICTION FOR TRAIN AND TEST sets:



**FORECAST:**



\*\*\*\*\*

**OFFENSE CATEGORY: Robbery**

**THE FINAL MODEL SUMMARY:**

```
<class 'statsmodels.iolib.summary.Summary'>
"""

```

**SARIMAX Results**

Dep. Variable:

Robbery No. Observations:

262

```

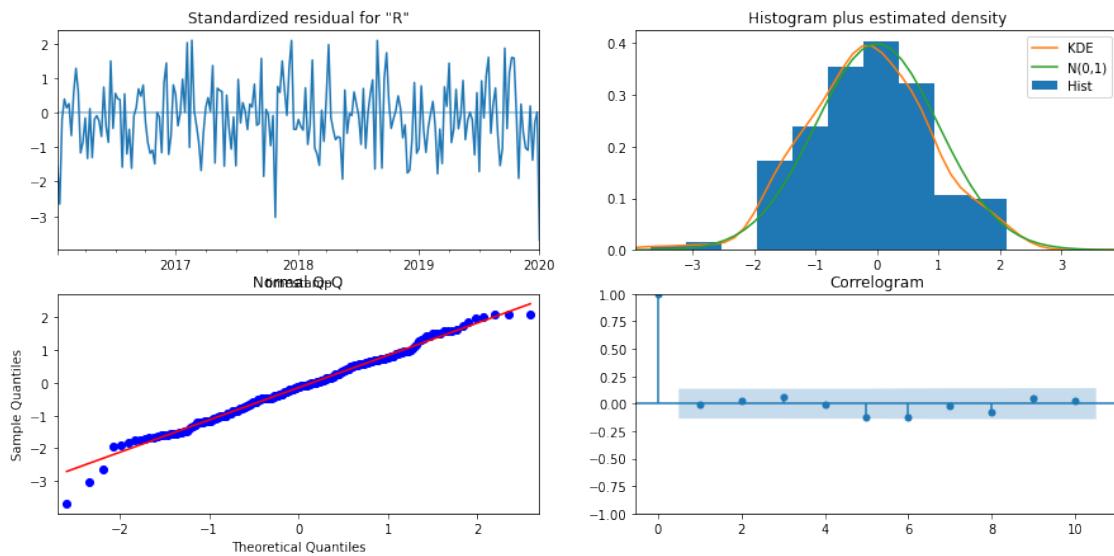
Model: SARIMAX(1, 1, 1)x(1, 1, 0, 52) Log Likelihood      -835.654
Date:             Fri, 23 Jul 2021   AIC                  1679.309
Time:                      11:30:20   BIC                  1692.678
Sample:            01-04-2015   HQIC                 1684.714
                   - 01-05-2020
Covariance Type: opg
=====

              coef    std err      z   P>|z|    [0.025    0.975]
-----
ar.L1        0.1493    0.086    1.738    0.082   -0.019    0.318
ma.L1       -0.9293    0.036   -25.568    0.000   -1.000   -0.858
ar.S.L52     -0.4793    0.065   -7.334    0.000   -0.607   -0.351
sigma2      161.6784   14.925   10.833    0.000  132.425  190.931
=====

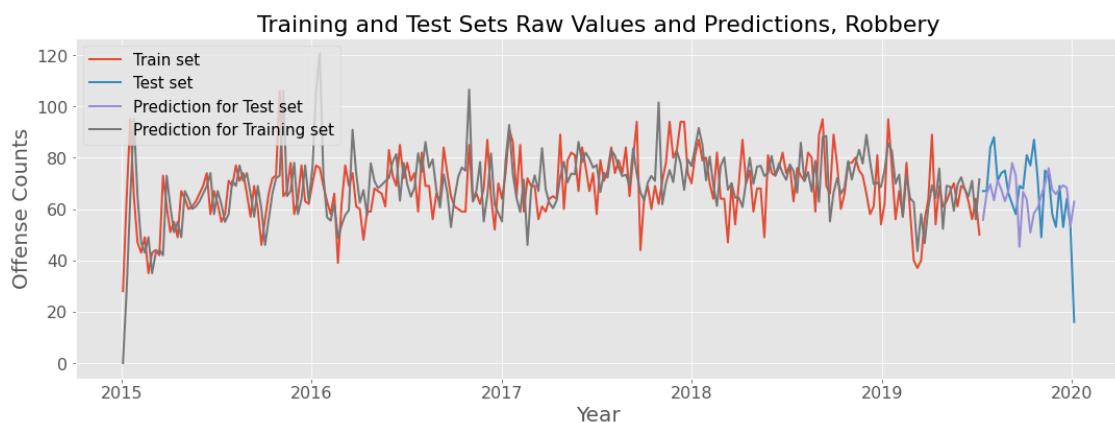
Ljung-Box (L1) (Q):          0.02   Jarque-Bera (JB):      1.50
Prob(Q):                    0.89   Prob(JB):           0.47
Heteroskedasticity (H):     1.23   Skew:                -0.13
Prob(H) (two-sided):        0.40   Kurtosis:            3.32
=====

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

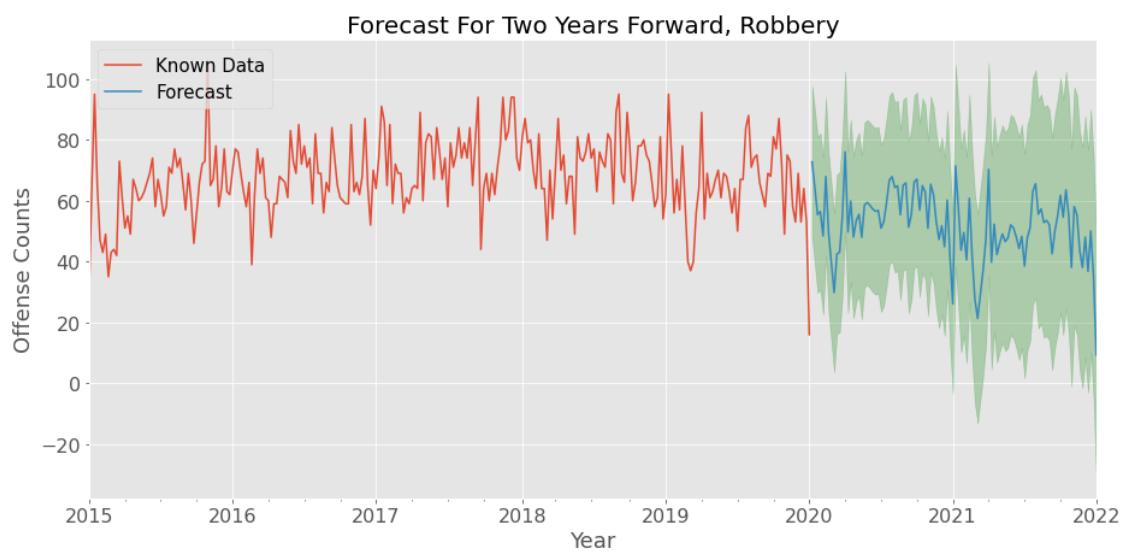
```



PREDICTION FOR TRAIN AND TEST sets:



**FORECAST:**



\*\*\*\*\*

OFFENSE CATEGORY: Extortion/Blackmail

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
"""

```

#### SARIMAX Results

```
=====
Dep. Variable: Extortion/Blackmail No. Observations: 261
```

```

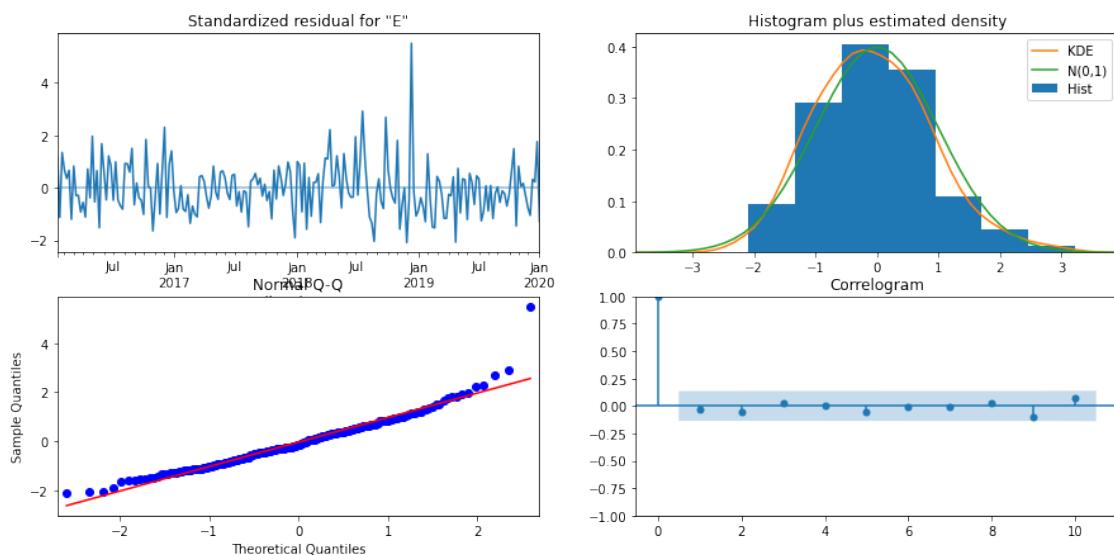
Model: SARIMAX(1, 1, 2)x(2, 1, []) , 52 Log Likelihood      -586.725
Date: Fri, 23 Jul 2021 AIC                         1185.449
Time: 11:30:21 BIC                         1205.474
Sample: 01-11-2015 HQIC                      1193.546
        - 01-05-2020
Covariance Type: opg
=====

            coef    std err       z   P>|z|    [0.025    0.975]
-----
ar.L1     -0.6409    0.214   -2.992    0.003   -1.061   -0.221
ma.L1     -0.1107    0.174   -0.635    0.526   -0.452    0.231
ma.L2     -0.7017    0.156   -4.488    0.000   -1.008   -0.395
ar.S.L52   -0.6926    0.095   -7.254    0.000   -0.880   -0.505
ar.S.L104  -0.3277    0.078   -4.223    0.000   -0.480   -0.176
sigma2    14.2969    0.938   15.246    0.000   12.459   16.135
=====

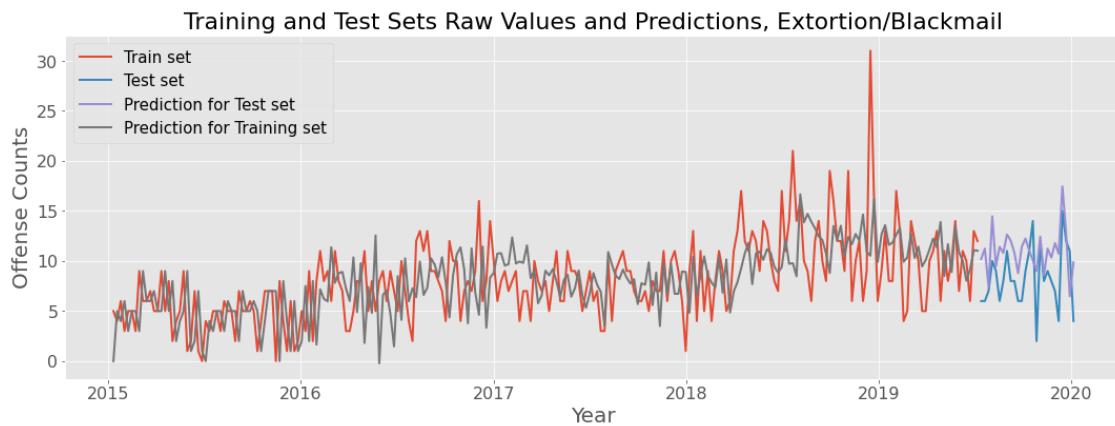
Ljung-Box (L1) (Q):          0.16   Jarque-Bera (JB):      159.88
Prob(Q):                   0.69   Prob(JB):                  0.00
Heteroskedasticity (H):     1.52   Skew:                     1.04
Prob(H) (two-sided):        0.08   Kurtosis:                 6.76
=====

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

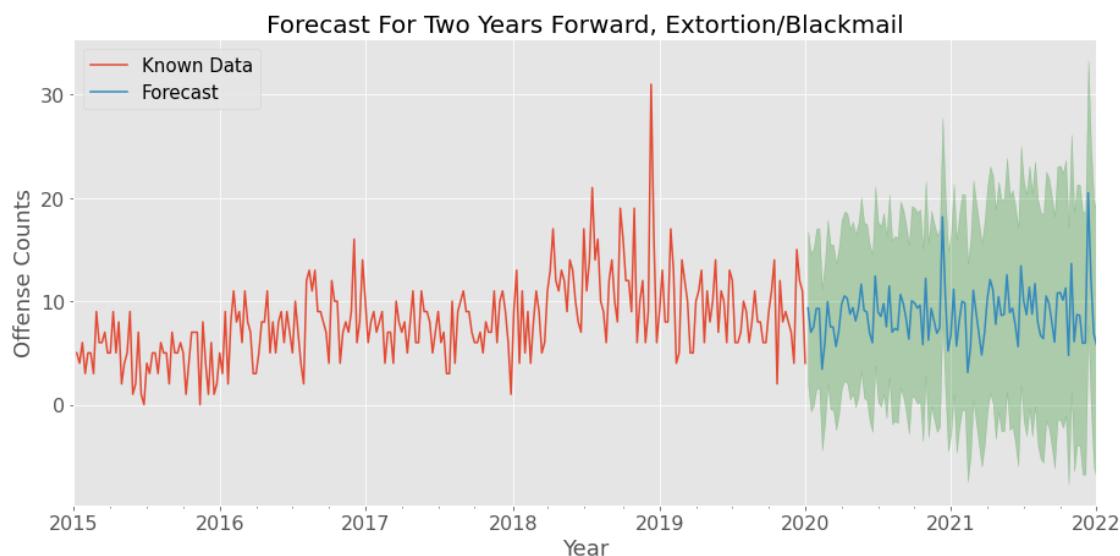
```



PREDICTION FOR TRAIN AND TEST sets:



**FORECAST:**



\*\*\*\*\*

OFFENSE CATEGORY: Pornography/Obscene Material

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
SARIMAX Results
```

```

=====
Dep. Variable: Pornography/Obscene Material No. Observations: 262
Model: SARIMAX(2, 1, 0)x(1, 1, 0, 52) Log Likelihood -670.395
Date: Fri, 23 Jul 2021 AIC 1348.789
Time: 11:30:22 BIC 1362.159
Sample: 01-04-2015 HQIC 1354.195
- 01-05-2020
Covariance Type: opg
=====

```

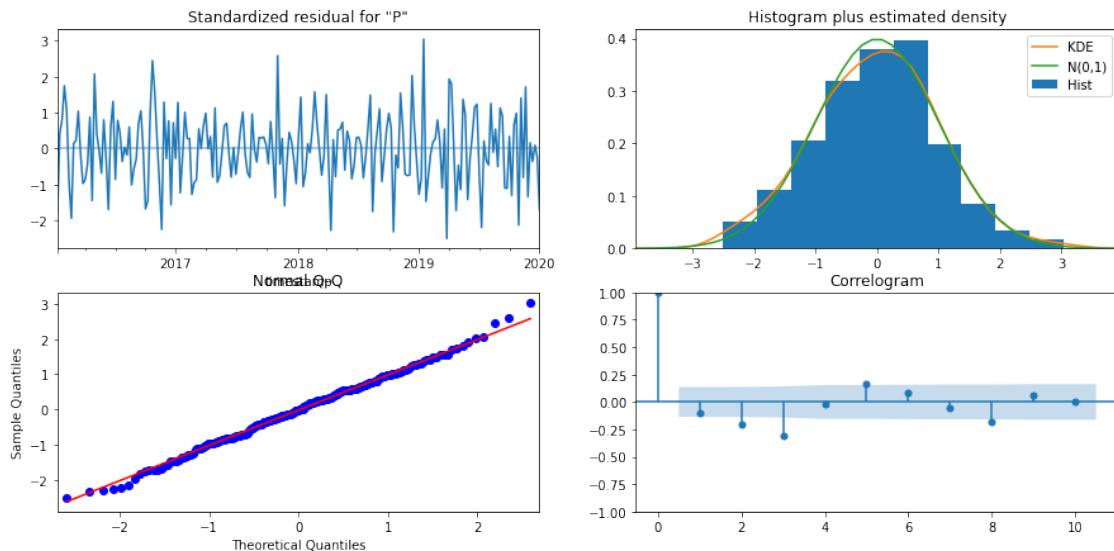
	coef	std err	z	P> z	[0.025	0.975]
ar.L1	-0.5977	0.065	-9.236	0.000	-0.724	-0.471
ar.L2	-0.3678	0.072	-5.127	0.000	-0.508	-0.227
ar.S.L52	-0.4428	0.077	-5.737	0.000	-0.594	-0.292
sigma2	33.8076	3.454	9.789	0.000	27.039	40.577

```

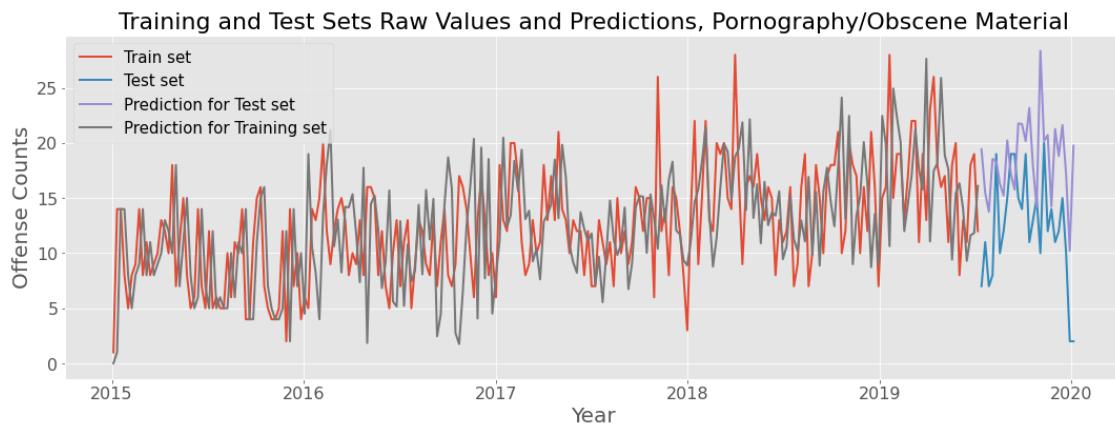
Ljung-Box (L1) (Q): 1.92 Jarque-Bera (JB): 0.01
Prob(Q): 0.17 Prob(JB): 0.99
Heteroskedasticity (H): 1.26 Skew: 0.02
Prob(H) (two-sided): 0.34 Kurtosis: 2.99
=====
```

#### Warnings:

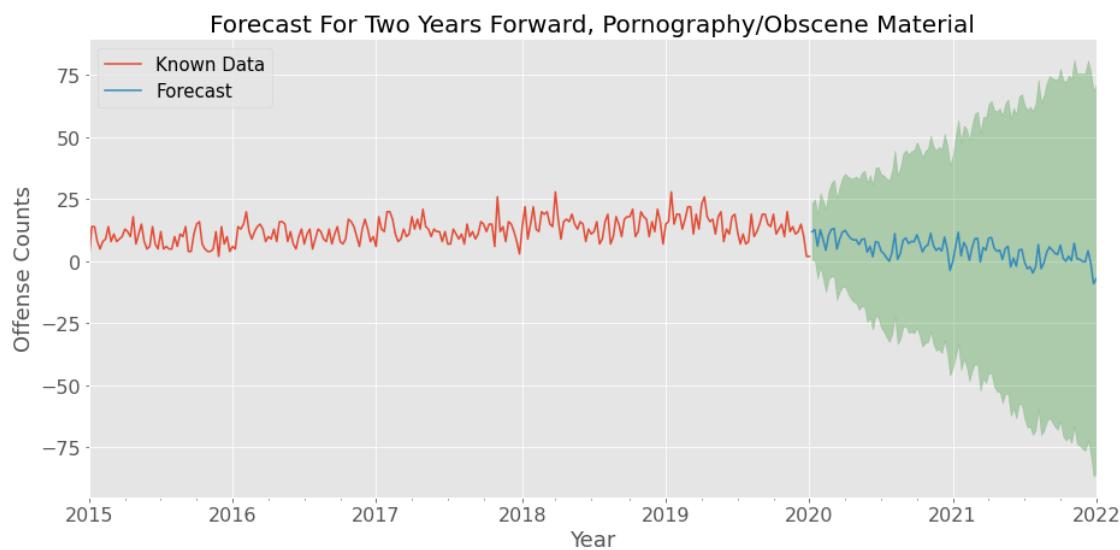
[1] Covariance matrix calculated using the outer product of gradients (complex-step).  
 """



PREDICTION FOR TRAIN AND TEST sets:



**FORECAST:**



\*\*\*\*\*

**OFFENSE CATEGORY: Prostitution Offenses**

**THE FINAL MODEL SUMMARY:**

```
<class 'statsmodels.iolib.summary.Summary'>
"""
SARIMAX Results
```

```

=====
Dep. Variable: Prostitution Offenses No. Observations: 261
Model: SARIMAX(2, 1, 2)x(2, 1, [], 52) Log Likelihood -768.793
Date: Fri, 23 Jul 2021 AIC 1551.586
Time: 11:30:22 BIC 1574.949
Sample: 01-04-2015 HQIC 1561.033
- 12-29-2019
Covariance Type: opg
=====

```

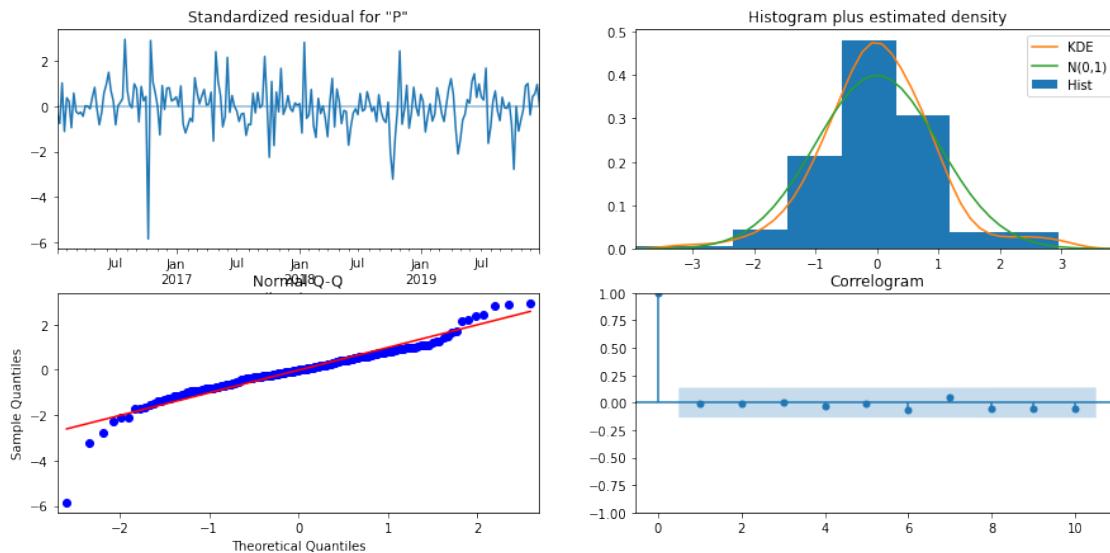
	coef	std err	z	P> z	[0.025	0.975]
ar.L1	0.0872	0.378	0.230	0.818	-0.654	0.829
ar.L2	-0.1269	0.122	-1.041	0.298	-0.366	0.112
ma.L1	-1.2842	0.375	-3.426	0.001	-2.019	-0.550
ma.L2	0.3174	0.367	0.864	0.388	-0.403	1.038
ar.S.L52	-0.5900	0.050	-11.911	0.000	-0.687	-0.493
ar.S.L104	-0.4231	0.048	-8.855	0.000	-0.517	-0.329
sigma2	80.8415	5.606	14.420	0.000	69.854	91.829

```

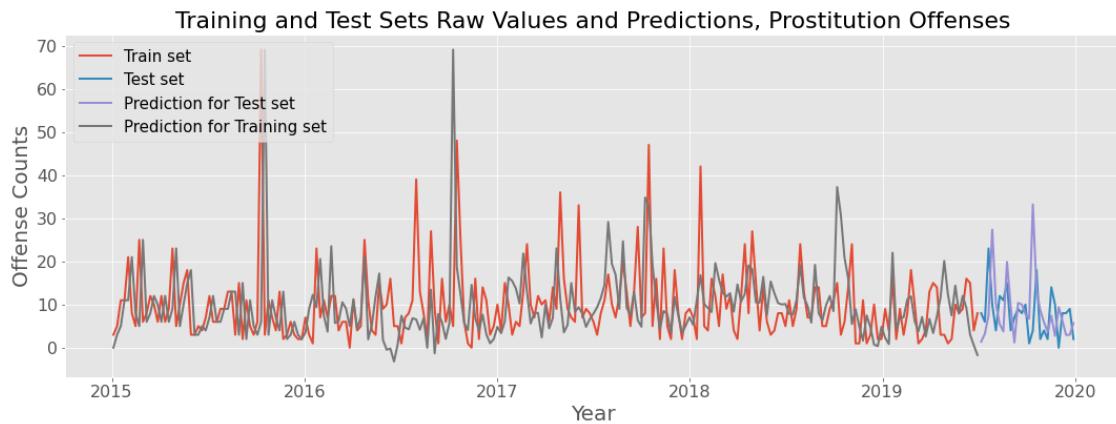
Ljung-Box (L1) (Q): 0.00 Jarque-Bera (JB): 319.98
Prob(Q): 0.96 Prob(JB): 0.00
Heteroskedasticity (H): 0.76 Skew: -0.80
Prob(H) (two-sided): 0.27 Kurtosis: 8.86
=====
```

#### Warnings:

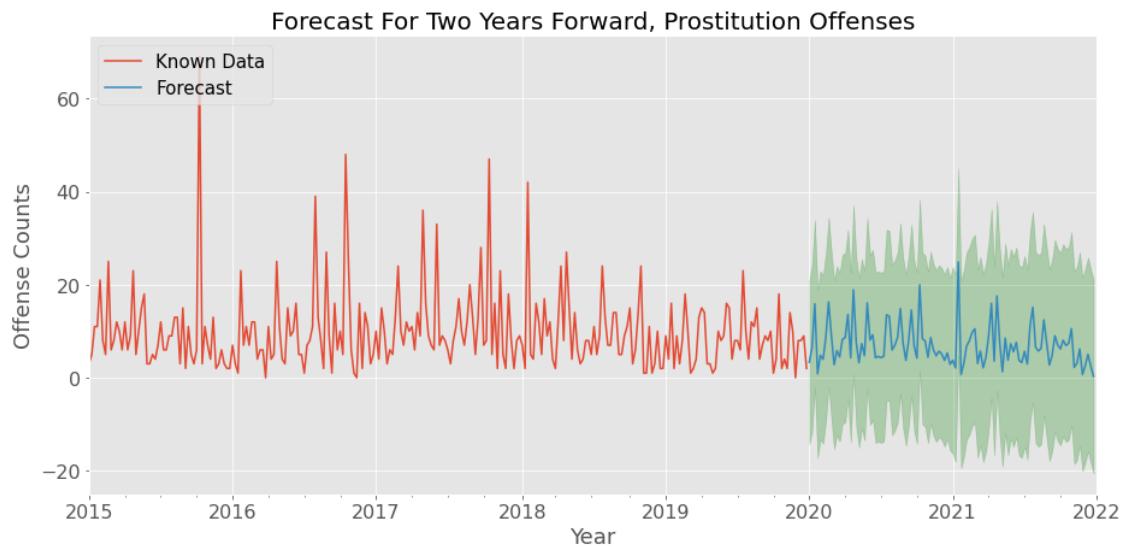
[1] Covariance matrix calculated using the outer product of gradients (complex-step).  
 """



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*

OFFENSE CATEGORY: Bribery

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
```

====

### SARIMAX Results

```
=====
Dep. Variable:                   Bribery    No. Observations:             262
Model: SARIMAX(1, 1, 0)x(2, 1, 0, 52) Log Likelihood:        -498.722
Date:   Fri, 23 Jul 2021      AIC:                  1005.443
Time:   11:30:23            BIC:                  1018.813
Sample: 01-04-2015 - 01-05-2020 HQIC:                  1010.849
Covariance Type:                opg
=====
```

	coef	std err	z	P> z	[0.025	0.975]
<hr/>						
ar.L1	-0.5278	0.055	-9.665	0.000	-0.635	-0.421
ar.S.L52	-0.6081	0.087	-6.976	0.000	-0.779	-0.437
ar.S.L104	-0.3715	0.084	-4.423	0.000	-0.536	-0.207
sigma2	6.0779	0.461	13.197	0.000	5.175	6.981

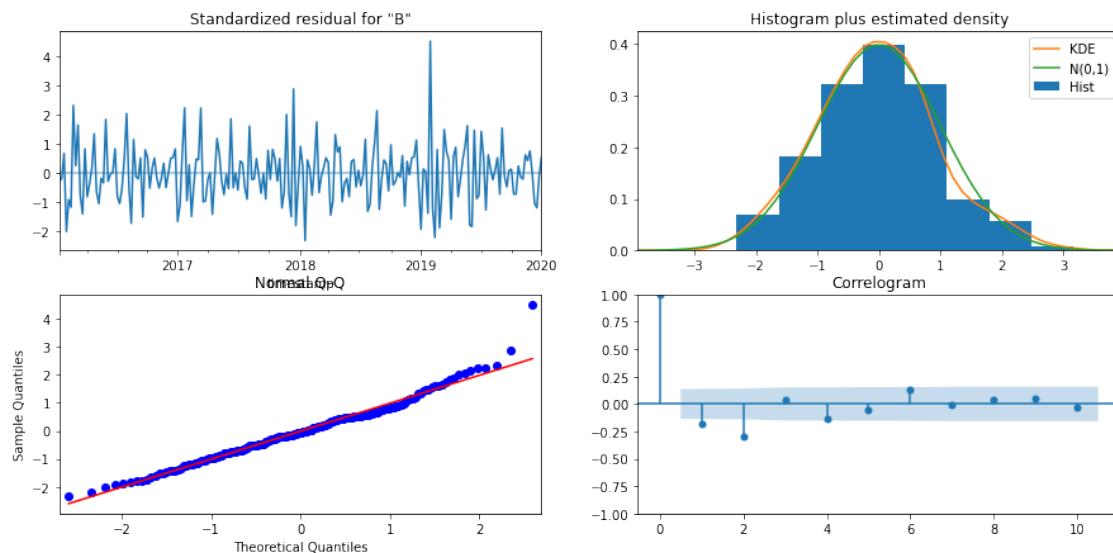
---

```
Ljung-Box (L1) (Q):           7.09    Jarque-Bera (JB):       32.28
Prob(Q):                      0.01    Prob(JB):                 0.00
Heteroskedasticity (H):        1.14    Skew:                     0.58
Prob(H) (two-sided):          0.59    Kurtosis:                 4.53
=====
```

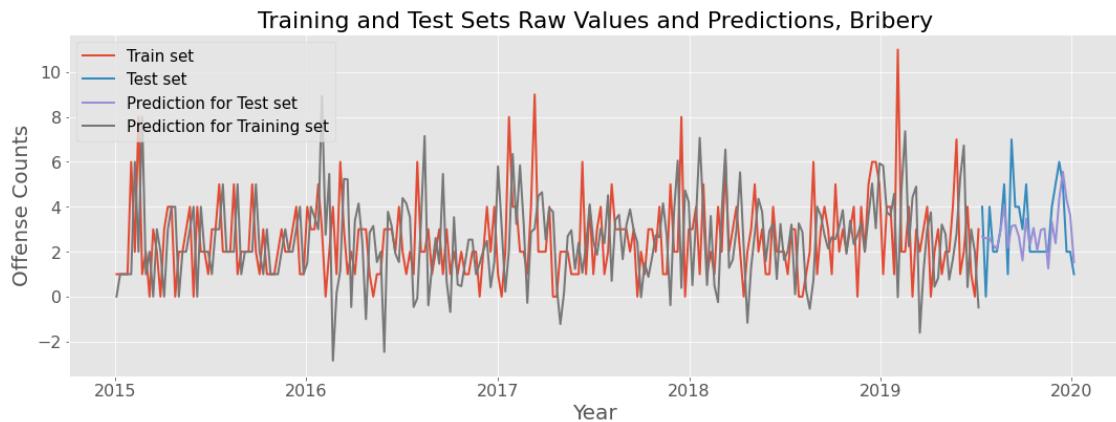
#### Warnings:

[1] Covariance matrix calculated using the outer product of gradients (complex-step).

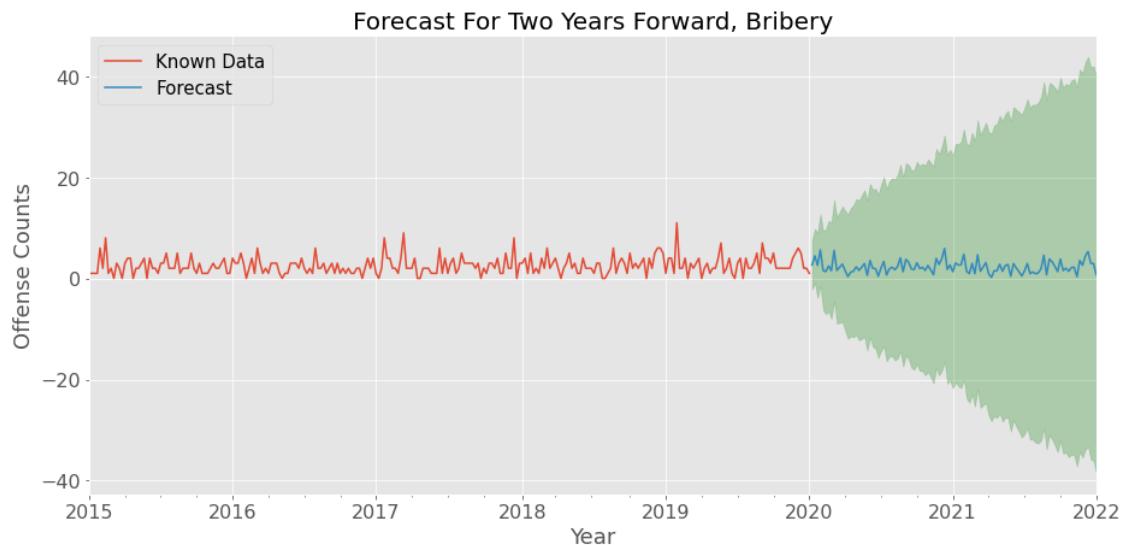
====



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*

OFFENSE CATEGORY: Embezzlement

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
```

====

### SARIMAX Results

```
=====
Dep. Variable: Embezzlement    No. Observations: 262
Model: SARIMAX(0, 1, 1)x(2, 1, [])  Log Likelihood -582.761
Date: Fri, 23 Jul 2021   AIC 1173.522
Time: 11:30:24   BIC 1186.892
Sample: 01-04-2015 - 01-05-2020   HQIC 1178.928
Covariance Type: opg
=====
```

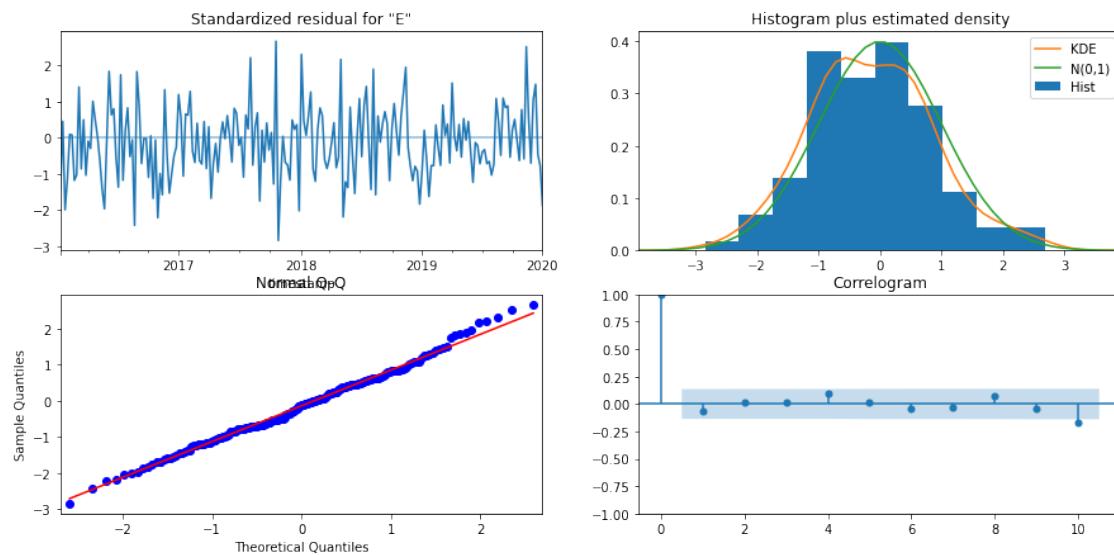
	coef	std err	z	P> z	[0.025	0.975]
ma.L1	-1.0684	0.036	-29.657	0.000	-1.139	-0.998
ar.S.L52	-0.7387	0.077	-9.546	0.000	-0.890	-0.587
ar.S.L104	-0.3269	0.088	-3.707	0.000	-0.500	-0.154
sigma2	11.5611	1.365	8.468	0.000	8.885	14.237

```
Ljung-Box (L1) (Q): 0.95 Jarque-Bera (JB): 1.28
Prob(Q): 0.33 Prob(JB): 0.53
Heteroskedasticity (H): 0.71 Skew: 0.19
Prob(H) (two-sided): 0.16 Kurtosis: 3.03
=====
```

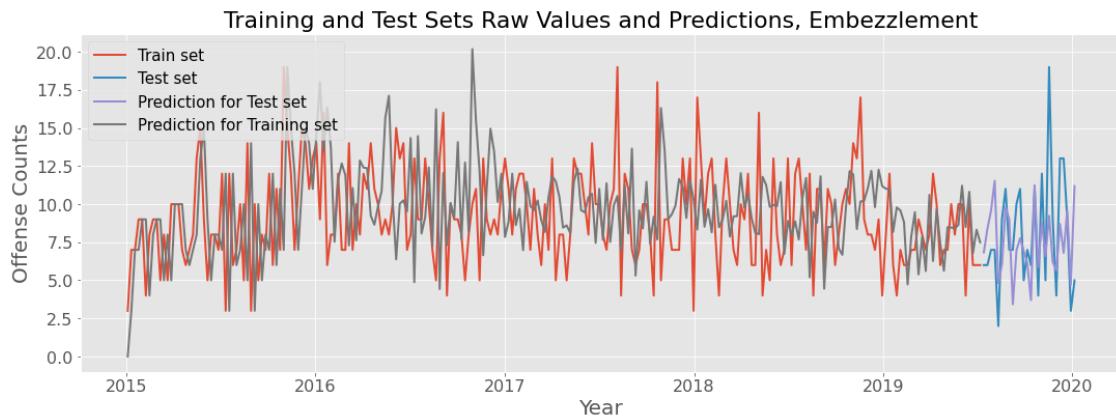
#### Warnings:

[1] Covariance matrix calculated using the outer product of gradients (complex-step).

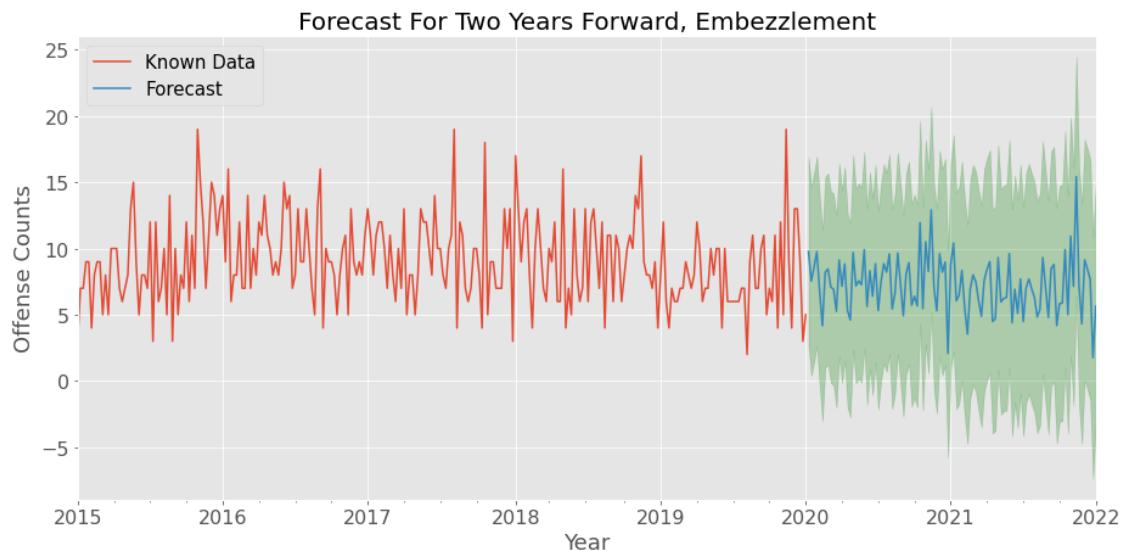
====



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*

OFFENSE CATEGORY: Homicide Offenses

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
```

====

### SARIMAX Results

```
=====
Dep. Variable: Homicide Offenses No. Observations: 262
Model: SARIMAX(0, 1, 1)x(2, 1, [], 52) Log Likelihood -488.621
Date: Fri, 23 Jul 2021 AIC 985.242
Time: 11:30:25 BIC 998.611
Sample: 01-04-2015 HQIC 990.647
          - 01-05-2020
Covariance Type: opg
=====
```

	coef	std err	z	P> z	[0.025	0.975]
ma.L1	-1.0235	0.020	-49.946	0.000	-1.064	-0.983
ar.S.L52	-0.7096	0.063	-11.268	0.000	-0.833	-0.586
ar.S.L104	-0.3780	0.092	-4.130	0.000	-0.557	-0.199
sigma2	5.0587	0.457	11.060	0.000	4.162	5.955

=====

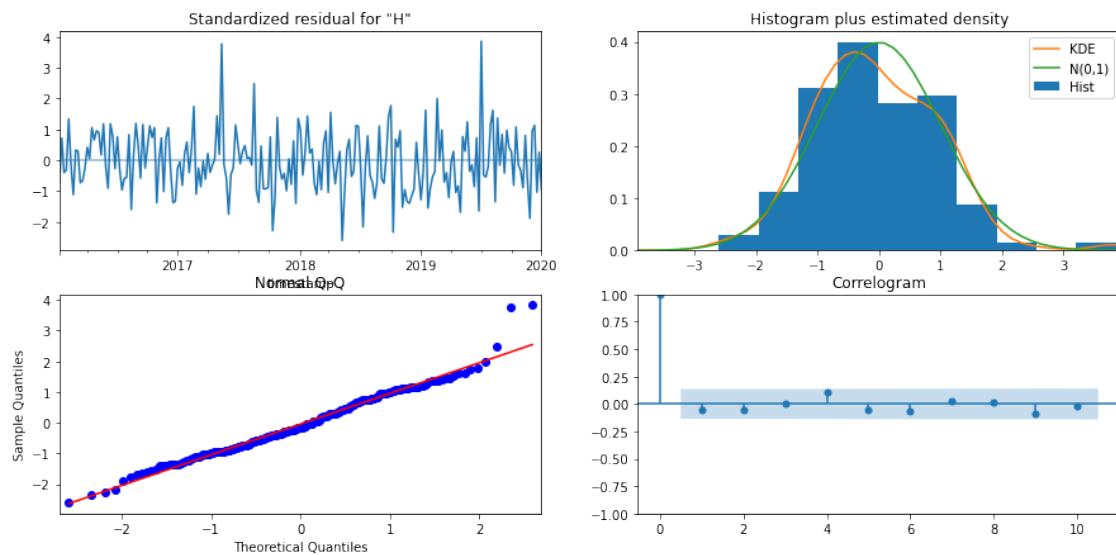
Ljung-Box (L1) (Q):	0.68	Jarque-Bera (JB):	17.33
Prob(Q):	0.41	Prob(JB):	0.00
Heteroskedasticity (H):	1.97	Skew:	0.47
Prob(H) (two-sided):	0.01	Kurtosis:	4.05

=====

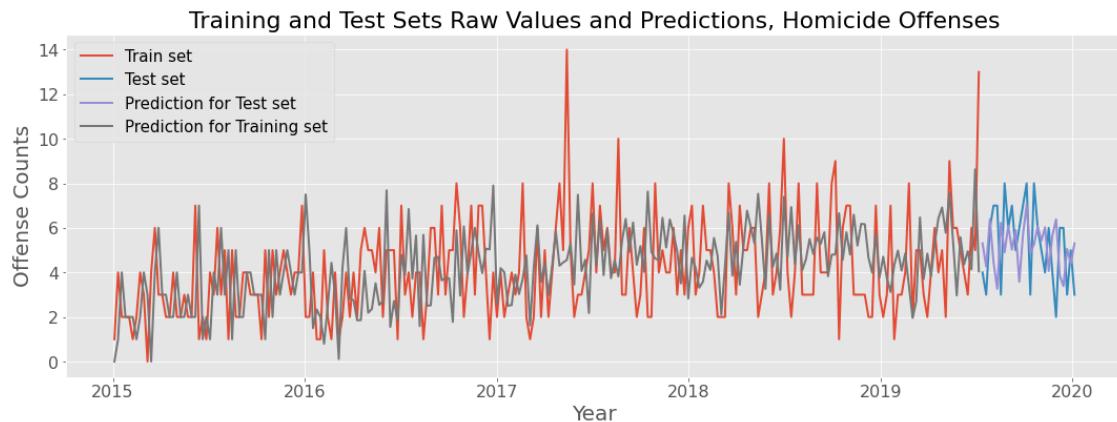
#### Warnings:

[1] Covariance matrix calculated using the outer product of gradients (complex-step).

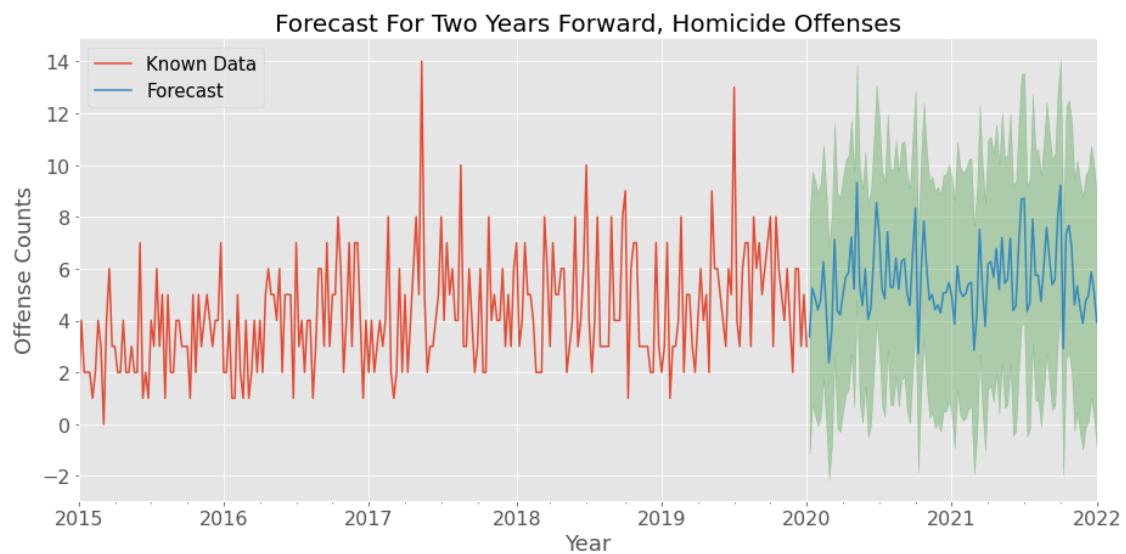
====



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*

OFFENSE CATEGORY: Human Trafficking

THE FINAL MODEL SUMMARY:

```
<class 'statsmodels.iolib.summary.Summary'>
```

"""

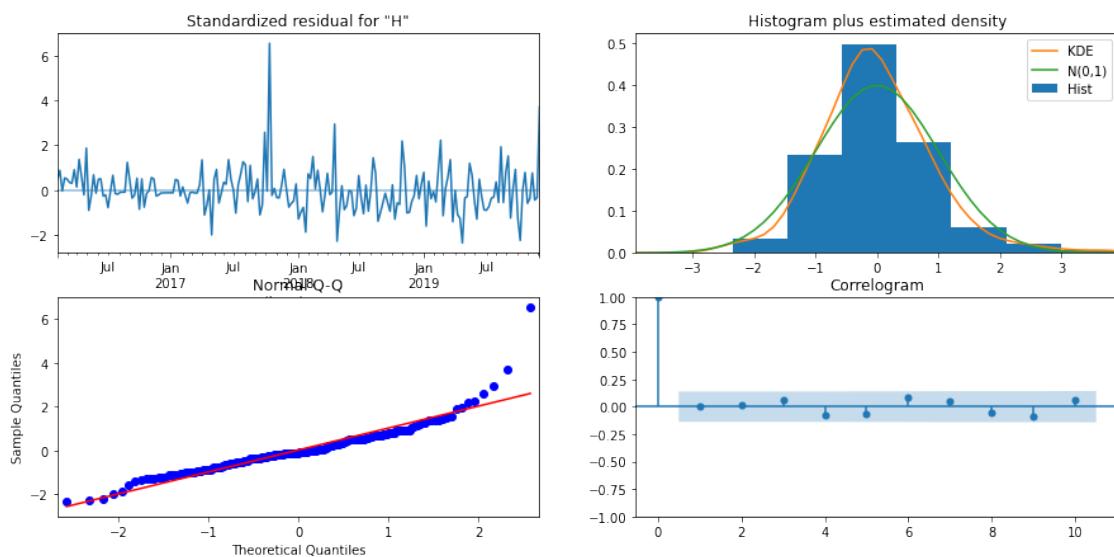
### SARIMAX Results

Dep. Variable:	Human Trafficking	No. Observations:	254			
Model:	SARIMAX(2, 1, 1)x(2, 1, 0, 52)	Log Likelihood	-329.007			
Date:	Fri, 23 Jul 2021	AIC	670.015			
Time:	11:30:25	BIC	689.834			
Sample:	02-01-2015 - 12-08-2019	HQIC	678.035			
Covariance Type:	opg					
			=====			
	coef	std err	z	P> z	[0.025	0.975]
ar.L1	0.0605	0.089	0.680	0.496	-0.114	0.235
ar.L2	0.1227	0.089	1.378	0.168	-0.052	0.297
ma.L1	-0.9674	0.030	-32.027	0.000	-1.027	-0.908
ar.S.L52	-0.7577	0.050	-15.241	0.000	-0.855	-0.660
ar.S.L104	-0.5915	0.048	-12.239	0.000	-0.686	-0.497
sigma2	1.1424	0.107	10.668	0.000	0.933	1.352
Ljung-Box (L1) (Q):	0.00	Jarque-Bera (JB):	778.67			
Prob(Q):	0.99	Prob(JB):	0.00			
Heteroskedasticity (H):	2.96	Skew:	1.72			
Prob(H) (two-sided):	0.00	Kurtosis:	12.01			
			=====			

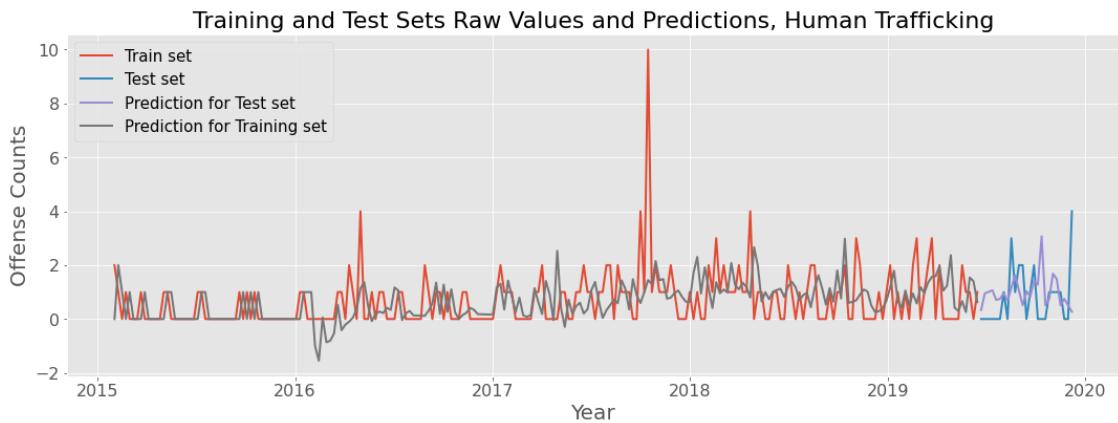
### Warnings:

[1] Covariance matrix calculated using the outer product of gradients (complex-step).

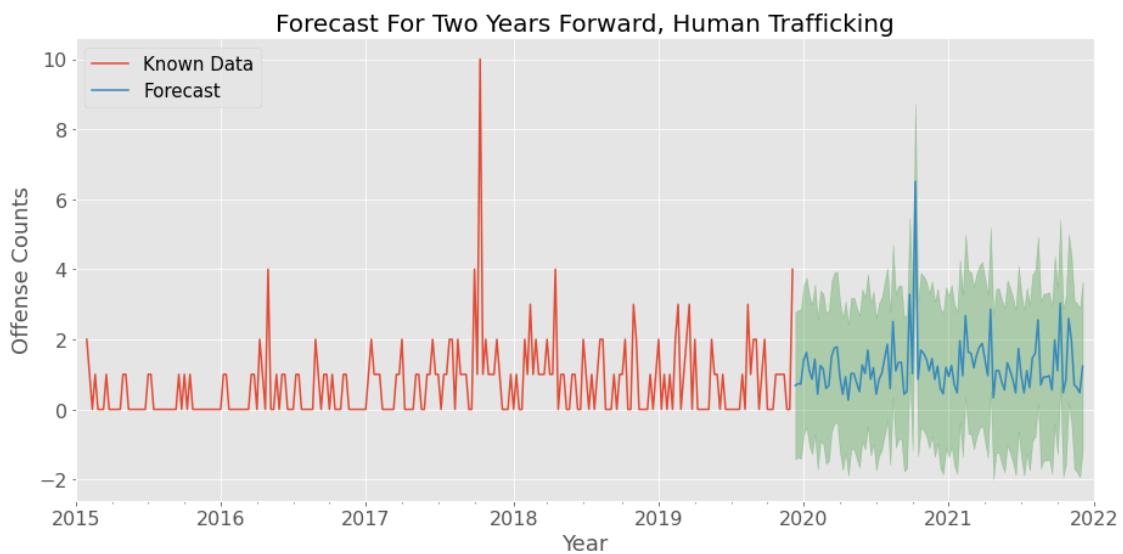
"""



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*

OFFENSE CATEGORY: Gambling Offenses

THE FINAL MODEL SUMMARY:

```

<class 'statsmodels.iolib.summary.Summary'>
"""
=====
              SARIMAX Results
=====

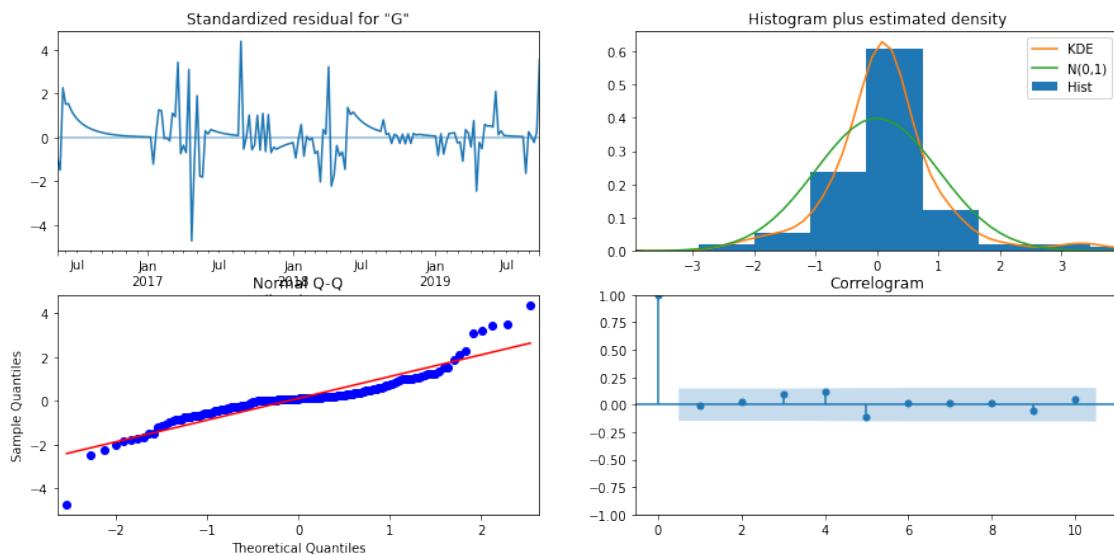
Dep. Variable:          Gambling Offenses    No. Observations:                  230
Model:                 SARIMAX(2, 1, 1)x(2, 1, 0, 52)    Log Likelihood:                -184.117
Date:                  Fri, 23 Jul 2021      AIC:                            380.234
Time:                  11:30:26             BIC:                            399.291
Sample:                05-10-2015 - 09-29-2019      HQIC:                           387.962
Covariance Type:        opg

=====

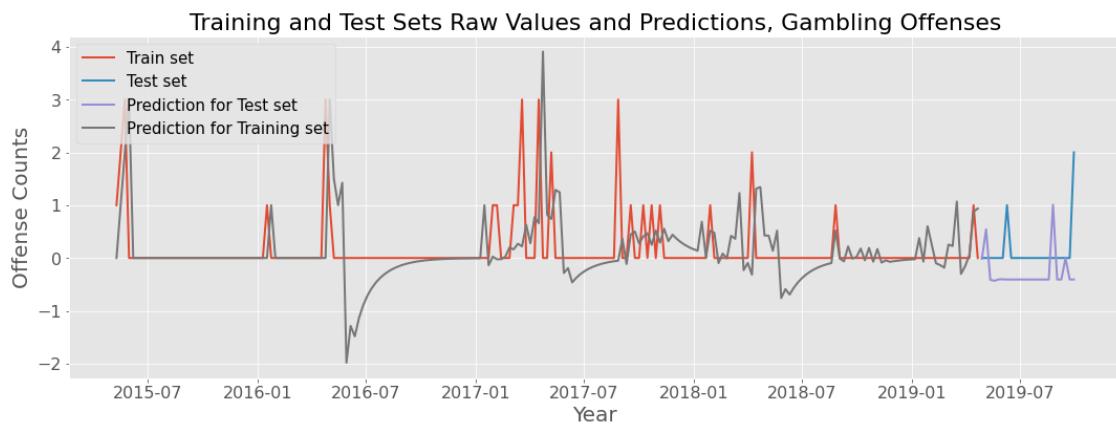
            coef      std err           z      P>|z|      [0.025      0.975]
-----
ar.L1       0.0104      0.070     0.149      0.881     -0.126      0.147
ar.L2      -0.1026      0.072    -1.418      0.156     -0.244      0.039
ma.L1      -0.8722      0.037   -23.807      0.000     -0.944     -0.800
ar.S.L52    -0.7778      0.071   -10.981      0.000     -0.917     -0.639
ar.S.L104   -0.5218      0.048   -10.976      0.000     -0.615     -0.429
sigma2      0.3527      0.029    12.315      0.000      0.297      0.409
Ljung-Box (L1) (Q):      0.01    Jarque-Bera (JB):               266.41
Prob(Q):            0.93    Prob(JB):                     0.00
Heteroskedasticity (H):  0.39    Skew:                         0.28
Prob(H) (two-sided):    0.00    Kurtosis:                   8.98
=====

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

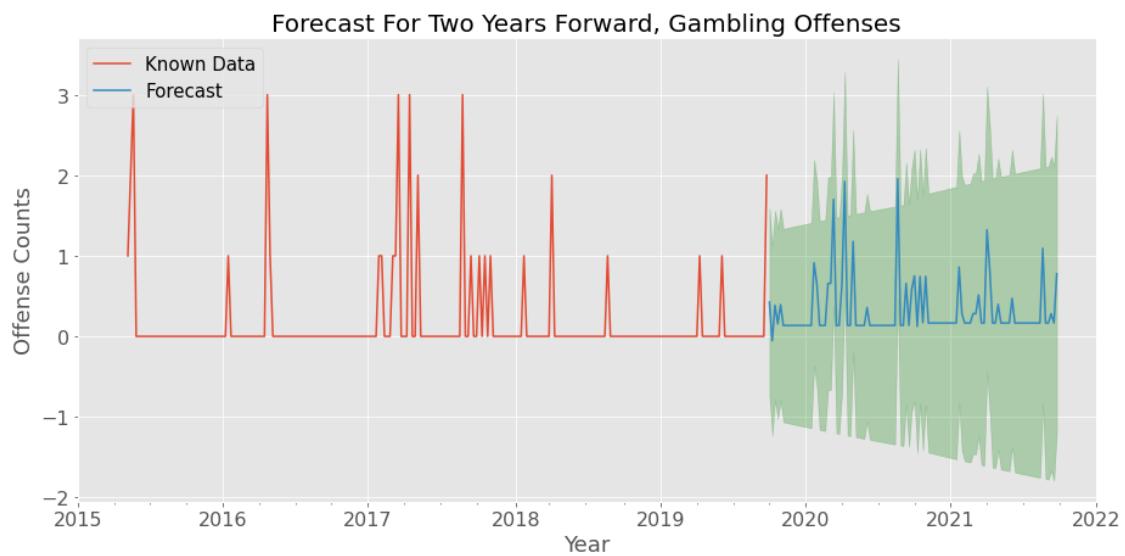
```



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*

OFFENSE CATEGORY: Animal Cruelty

THE FINAL MODEL SUMMARY:

```

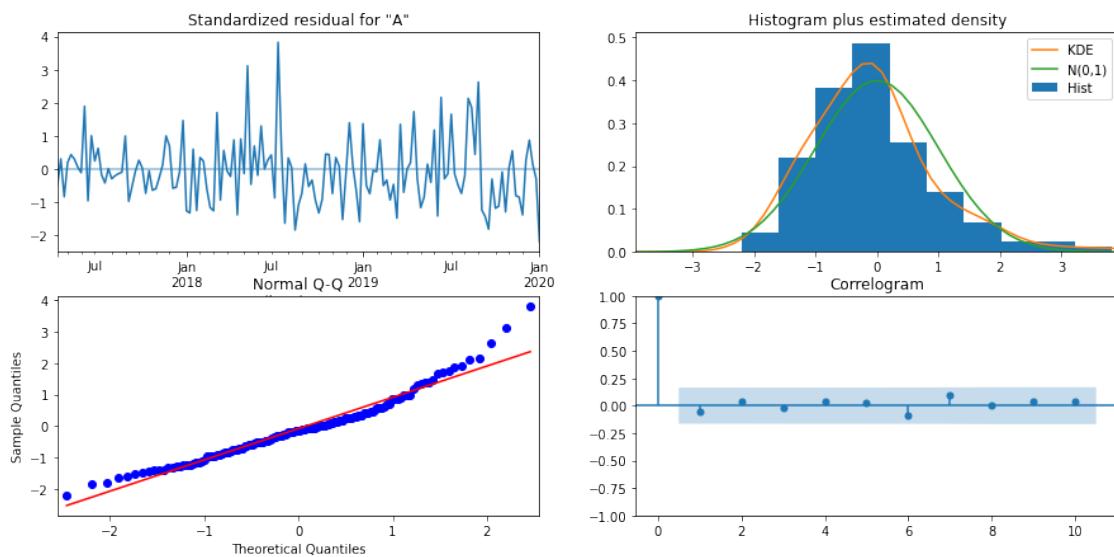
<class 'statsmodels.iolib.summary.Summary'>
"""
=====
SARIMAX Results
=====
Dep. Variable: Animal Cruelty No. Observations: 196
Model: SARIMAX(0, 1, 1)x(2, 1, [], 52) Log Likelihood -450.562
Date: Fri, 23 Jul 2021 AIC 909.124
Time: 11:30:27 BIC 920.976
Sample: 04-10-2016 HQIC 913.940
- 01-05-2020
Covariance Type: opg
=====
              coef    std err      z   P>|z|    [0.025    0.975]
-----
ma.L1     -0.6934    0.063 -10.953    0.000   -0.817   -0.569
ar.S.L52  -0.8118    0.130   -6.230    0.000   -1.067   -0.556
ar.S.L104 -0.3824    0.147   -2.597    0.009   -0.671   -0.094
sigma2    24.2980    3.551    6.843    0.000   17.339   31.257
-----
Ljung-Box (L1) (Q): 0.45 Jarque-Bera (JB): 32.54
Prob(Q): 0.50 Prob(JB): 0.00
Heteroskedasticity (H): 2.19 Skew: 0.89
Prob(H) (two-sided): 0.01 Kurtosis: 4.52
=====

```

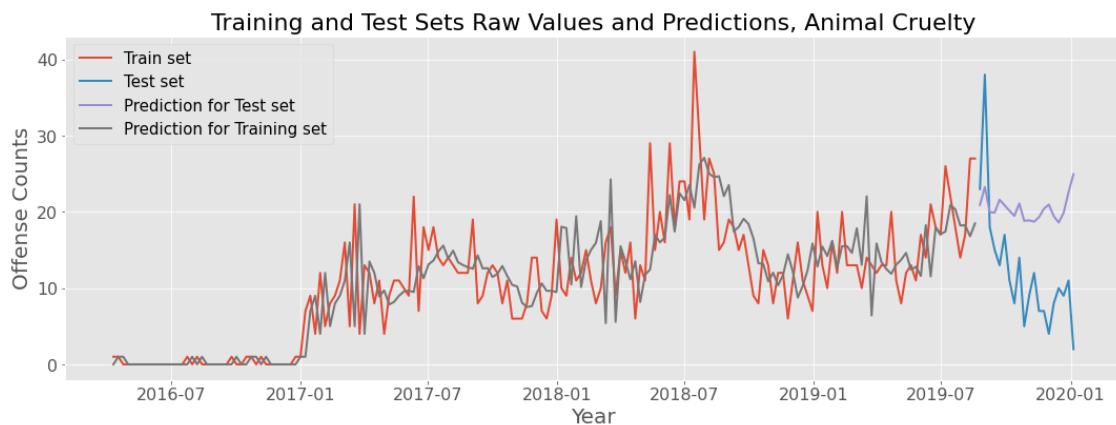
#### Warnings:

[1] Covariance matrix calculated using the outer product of gradients (complex-step).

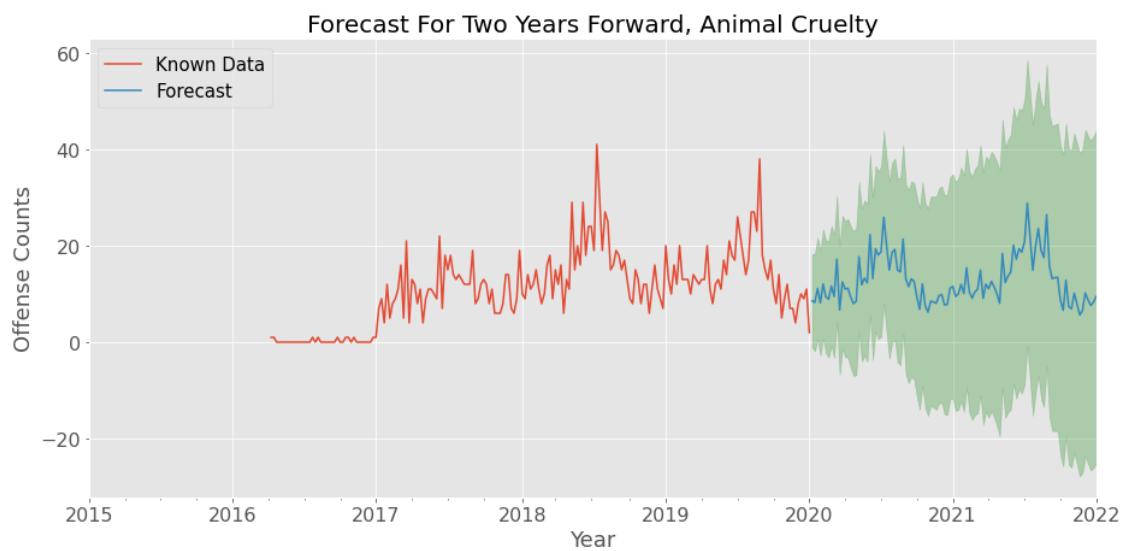
"""



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*  
OFFENSE CATEGORY: Sex Offenses

THE FINAL MODEL SUMMARY:

```

<class 'statsmodels.iolib.summary.Summary'>
"""
=====
              SARIMAX Results
=====

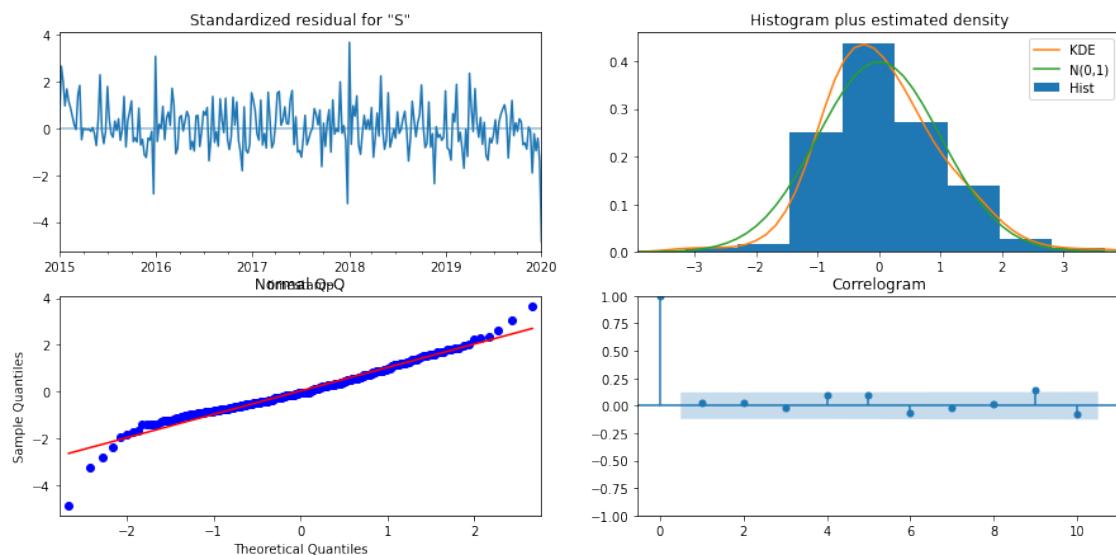
Dep. Variable:                  Sex Offenses    No. Observations:                   262
Model: SARIMAX(2, 0, 1)x(1, 0, [], 52)    Log Likelihood:                -1150.300
Date: Fri, 23 Jul 2021            AIC:                            2310.599
Time: 11:30:28                     BIC:                            2328.441
Sample: 01-04-2015 - 01-05-2020   HQIC:                           2317.770
Covariance Type:                    opg

=====

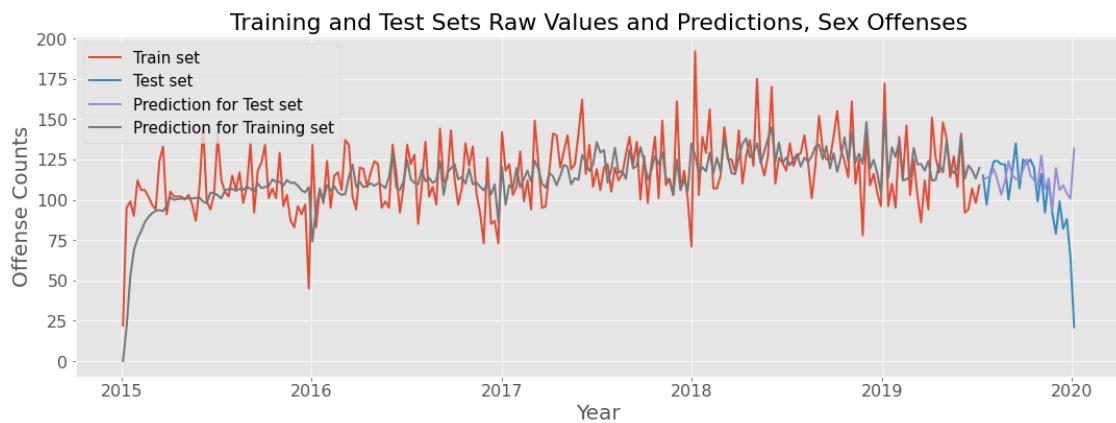
            coef      std err       z     P>|z|      [0.025      0.975]
-----
ar.L1      0.8545      0.083    10.310      0.000      0.692      1.017
ar.L2      0.1441      0.082     1.752      0.080     -0.017      0.305
ma.L1     -0.8308      0.052   -16.010      0.000     -0.932     -0.729
ar.S.L52    0.3267      0.049     6.613      0.000      0.230      0.424
sigma2    366.4911    25.233    14.524      0.000    317.035    415.947
Ljung-Box (L1) (Q):             0.15  Jarque-Bera (JB):           72.75
Prob(Q):                      0.70  Prob(JB):                  0.00
Heteroskedasticity (H):        1.14  Skew:                     -0.10
Prob(H) (two-sided):          0.55  Kurtosis:                  5.57
"""

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

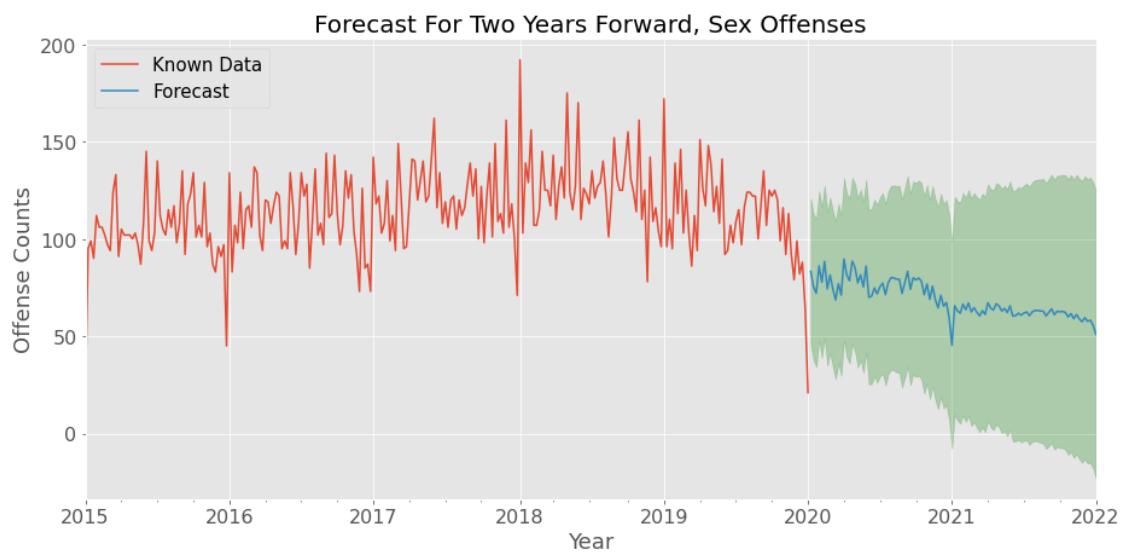
```



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



\*\*\*\*\*  
OFFENSE CATEGORY: Weapon Law Violations

THE FINAL MODEL SUMMARY:

```

<class 'statsmodels.iolib.summary.Summary'>
"""
=====
          SARIMAX Results
=====

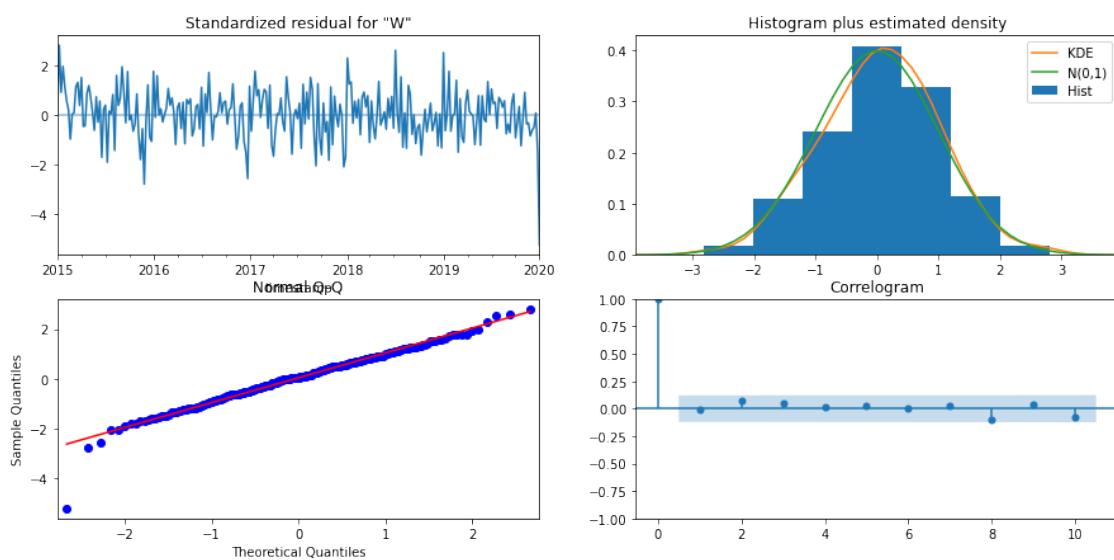
Dep. Variable:           Weapon Law Violations   No. Observations:                  262
Model:                 SARIMAX(1, 0, 1)x(0, 0, 1, 52)   Log Likelihood:                -1066.105
Date:                    Fri, 23 Jul 2021             AIC:                            2140.210
Time:                      11:30:29                BIC:                            2154.483
Sample:                 01-04-2015 - 01-05-2020   HQIC:                           2145.946
Covariance Type:            opg

=====

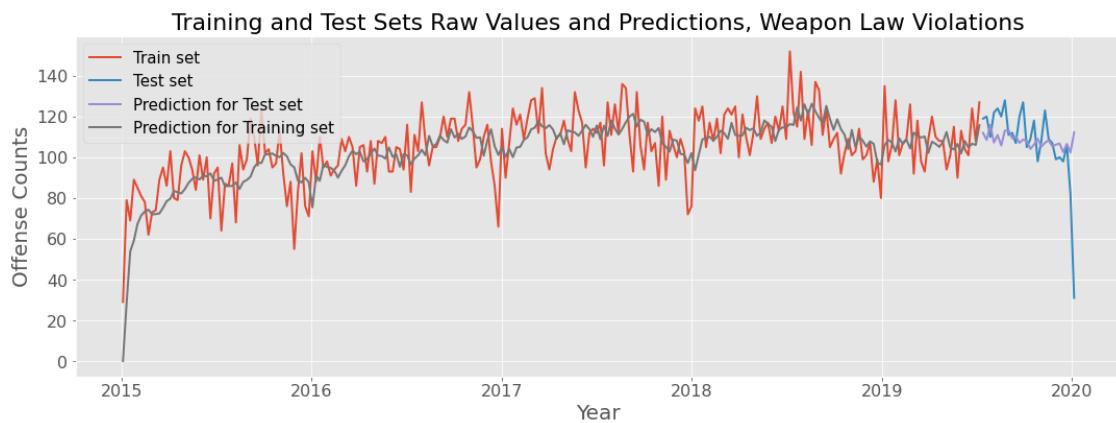
              coef    std err          z      P>|z|      [0.025      0.975]
-----
ar.L1      1.0000   9.32e-05   1.07e+04      0.000      1.000      1.000
ma.L1     -0.7818      0.041     -18.994      0.000     -0.863     -0.701
ma.S.L52    0.1099      0.058       1.880      0.060     -0.005      0.224
sigma2     194.3384     13.072      14.867      0.000    168.718    219.959
Ljung-Box (L1) (Q):      0.02      Jarque-Bera (JB):        75.04
Prob(Q):               0.90      Prob(JB):                   0.00
Heteroskedasticity (H):  1.09      Skew:                     -0.54
Prob(H) (two-sided):    0.70      Kurtosis:                  5.39
=====

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
"""

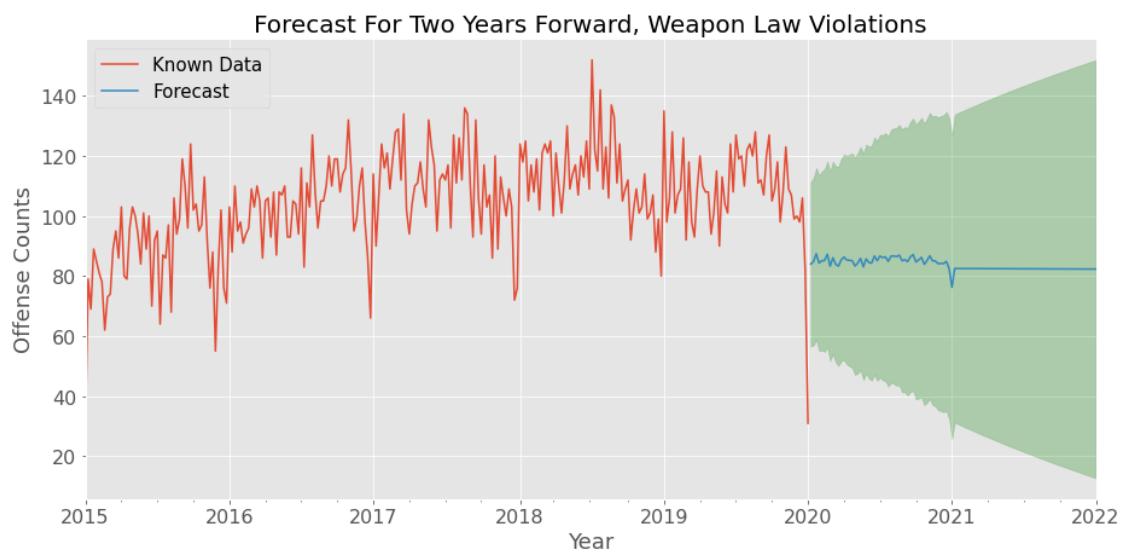
```



PREDICTION FOR TRAIN AND TEST sets:



FORECAST:



**It takes ~1 minute to run this notebook**

The main notebook combining all of the partial ones can be found [here](#)

[ ]: