In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import statsmodels.api as sm
import plotly.graph_objects as go
import plotly.express as px
from statsmodels.graphics.tsaplots import plot_pacf, plot_acf
from statsmodels.tsa.statespace.sarimax import SARIMAX
from statsmodels.tsa.holtwinters import ExponentialSmoothing
from statsmodels.tsa.stattools import adfuller
from statsmodels.tsa.arima_model import ARIMA
from statsmodels.tsa.seasonal import seasonal_decompose
from sklearn.metrics import mean_squared_error, mean_absolute_error
from pmdarima.arima import auto_arima
from sklearn import preprocessing
from pandas.plotting import lag_plot
from pandas import Timestamp
from itertools import product
from tqdm.notebook import tqdm
import plotly.graph_objs as go
import plotly.express as px

import pmdarima as pm
from statsmodels.tsa.stattools import acf

import warnings
warnings.filterwarnings('ignore')

%matplotlib inline
from matplotlib.pylab import rcParams
rcParams['figure.figsize'] = 10, 6
```

In [2]:
```
sns.set_palette("icefire")
palette = sns.color_palette()
```

In [3]:
```
df = pd.read_csv("netflix_data.csv")
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 8807 entries, 0 to 8806
Data columns (total 12 columns):
 #   Column        Non-Null Count  Dtype 
---  ------        --------------  ----- 
 0   show_id       8807 non-null   object
 1   type          8807 non-null   object
 2   title         8807 non-null   object
 3   director      6173 non-null   object
 4   cast          7982 non-null   object
 5   country       7976 non-null   object
 6   date_added    8797 non-null   object
 7   release_year  8807 non-null   int64 
 8   rating        8803 non-null   object
 9   duration      8804 non-null   object
 10  listed_in     8807 non-null   object
 11  description   8807 non-null   object
dtypes: int64(1), object(11)
memory usage: 825.8+ KB
```

In [4]:
```
df.isnull().sum()
```

Out[4]:
```
show_id            0
type               0
title              0
director        2634
cast             825
country          831
date_added        10
release_year       0
rating             4
duration           3
listed_in          0
description        0
dtype: int64
```

In [5]:
```
df
```

Out[5]:

	show_id	type	title	director	cast	country	date_added	release_year	rating	du
0	s1	Movie	Dick Johnson Is Dead	Kirsten Johnson	NaN	United States	September 25, 2021	2020	PG-13	
1	s2	TV Show	Blood & Water	NaN	Ama Qamata, Khosi Ngema, Gail Mabalane, Thaban...	South Africa	September 24, 2021	2021	TV-MA	S
2	s3	TV Show	Ganglands	Julien Leclercq	Sami Bouajila, Tracy Gotoas, Samuel Jouy, Nabi...	NaN	September 24, 2021	2021	TV-MA	1
3	s4	TV Show	Jailbirds New Orleans	NaN	NaN	NaN	September 24, 2021	2021	TV-MA	1
4	s5	TV Show	Kota Factory	NaN	Mayur More, Jitendra Kumar, Ranjan Raj, Alam K...	India	September 24, 2021	2021	TV-MA	S
...	...	...	...	...	...	...	...	...	...	
8802	s8803	Movie	Zodiac	David Fincher	Mark Ruffalo, Jake Gyllenhaal, Robert Downey J...	United States	November 20, 2019	2007	R	1
8803	s8804	TV Show	Zombie Dumb	NaN	NaN	NaN	July 1, 2019	2018	TV-Y7	S
8804	s8805	Movie	Zombieland	Ruben Fleischer	Jesse Eisenberg, Woody Harrelson, Emma Stone, ...	United States	November 1, 2019	2009	R	

	show_id	type	title	director	cast	country	date_added	release_year	rating	du
8805	s8806	Movie	Zoom	Peter Hewitt	Tim Allen, Courteney Cox, Chevy Chase, Kate Ma...	United States	January 11, 2020	2006	PG	
8806	s8807	Movie	Zubaan	Mozez Singh	Vicky Kaushal, Sarah-Jane Dias, Raaghav Chanan...	India	March 2, 2019	2015	TV-14	1

8807 rows × 12 columns

In [6]:
```
# Strip leading and trailing whitespace from the 'date_added' column
df['date_added'] = df['date_added'].str.strip()

# Convert data_added from string to datetime
df['date_added'] = pd.to_datetime(df['date_added'], format="%B %d, %Y")

# Extract year and month
df['year_added'] = pd.DatetimeIndex(df['date_added']).year
df['month_added'] = df['date_added'].dt.month
```

In [7]:
```
df=df.dropna(subset=['year_added'])
df['year_added']=df['year_added'].astype(int)
```

In [8]:
```
df
```

Out[8]:

	show_id	type	title	director	cast	country	date_added	release_year	rating	du
0	s1	Movie	Dick Johnson Is Dead	Kirsten Johnson	NaN	United States	2021-09-25	2020	PG-13	
1	s2	TV Show	Blood & Water	NaN	Ama Qamata, Khosi Ngema, Gail Mabalane, Thaban...	South Africa	2021-09-24	2021	TV-MA	S
2	s3	TV Show	Ganglands	Julien Leclercq	Sami Bouajila, Tracy Gotoas, Samuel Jouy, Nabi...	NaN	2021-09-24	2021	TV-MA	1
3	s4	TV Show	Jailbirds New Orleans	NaN	NaN	NaN	2021-09-24	2021	TV-MA	1
4	s5	TV Show	Kota Factory	NaN	Mayur More, Jitendra Kumar, Ranjan Raj, Alam K...	India	2021-09-24	2021	TV-MA	S
...	...	...	...	...	...	...	...	...	...	
8802	s8803	Movie	Zodiac	David Fincher	Mark Ruffalo, Jake Gyllenhaal, Robert Downey J...	United States	2019-11-20	2007	R	1
8803	s8804	TV Show	Zombie Dumb	NaN	NaN	NaN	2019-07-01	2018	TV-Y7	S
8804	s8805	Movie	Zombieland	Ruben Fleischer	Jesse Eisenberg, Woody Harrelson, Emma Stone, ...	United States	2019-11-01	2009	R	

	show_id	type	title	director	cast	country	date_added	release_year	rating	du
8805	s8806	Movie	Zoom	Peter Hewitt	Tim Allen, Courteney Cox, Chevy Chase, Kate Ma...	United States	2020-01-11	2006	PG	
8806	s8807	Movie	Zubaan	Mozez Singh	Vicky Kaushal, Sarah-Jane Dias, Raaghav Chanan...	India	2019-03-02	2015	TV-14	1

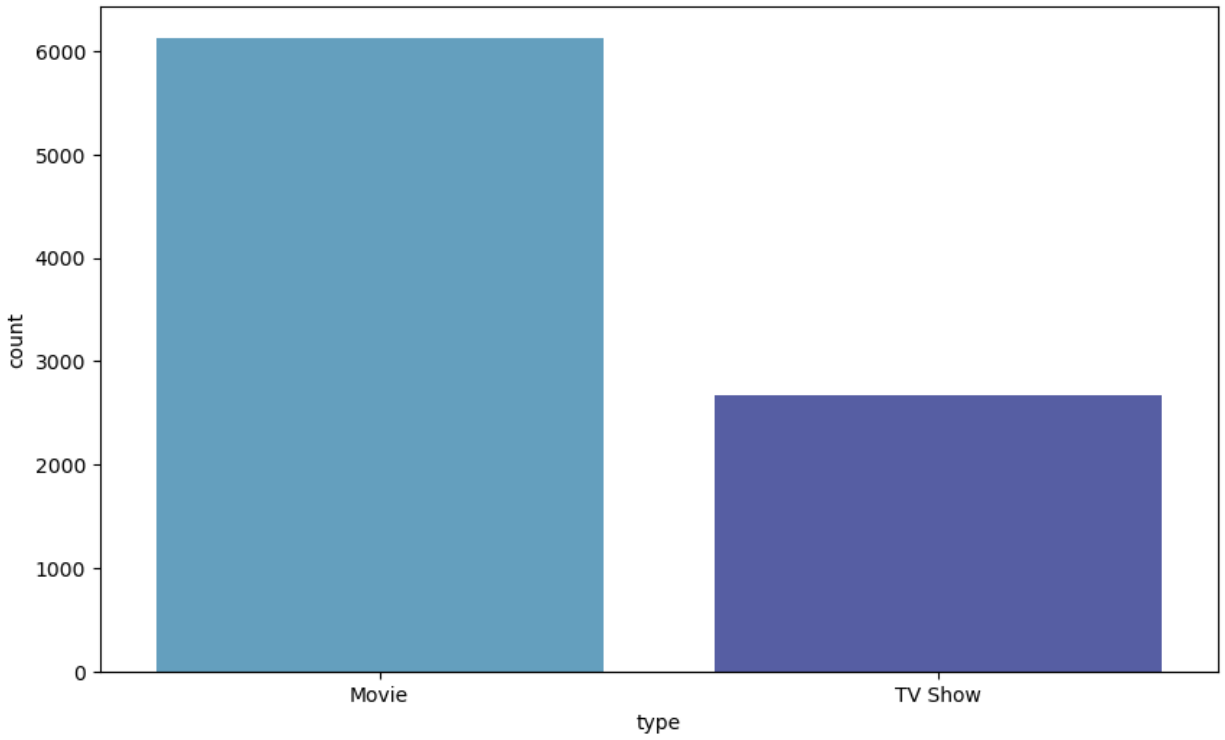
8797 rows × 14 columns

In [9]:
```
#Date_added should have no null values
df.isnull().sum()
```

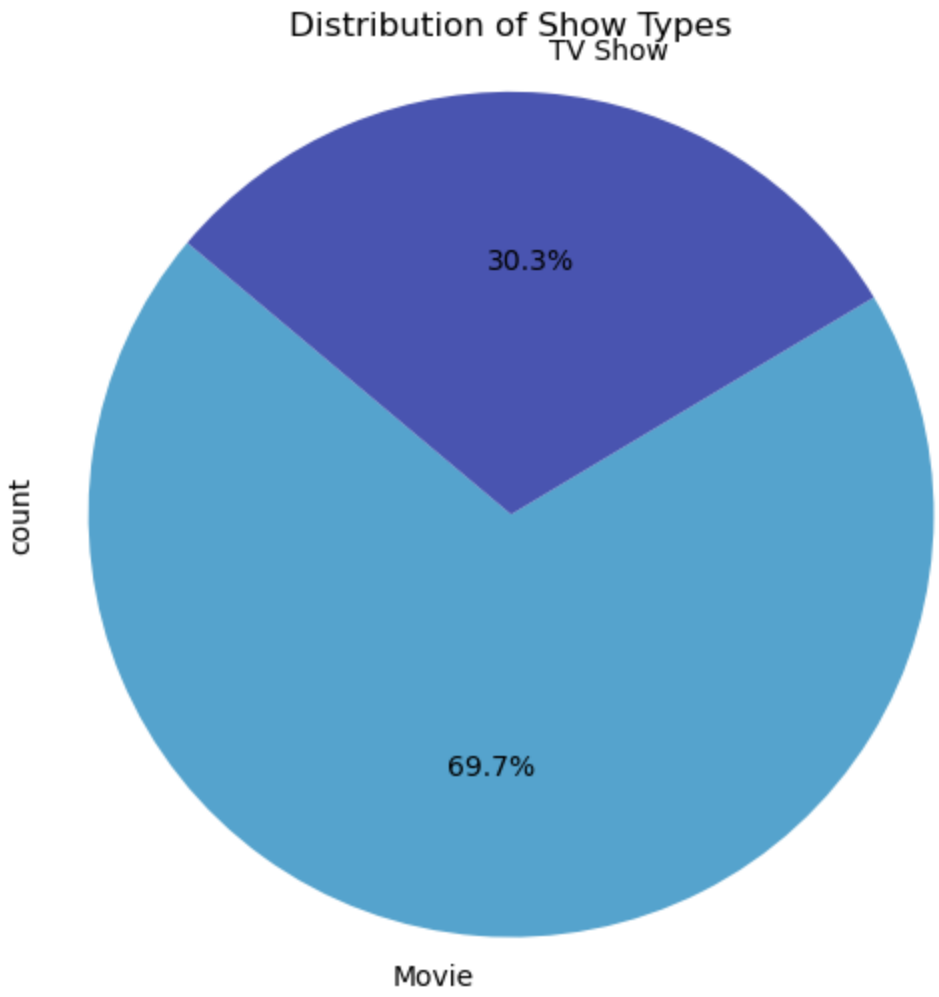
Out[9]:
```
show_id            0
type               0
title              0
director        2624
cast             825
country          830
date_added         0
release_year       0
rating             4
duration           3
listed_in          0
description        0
year_added         0
month_added        0
dtype: int64
```

In [10]:
```
sns.countplot(x=df['type'])
```

Out[10]:
```
<Axes: xlabel='type', ylabel='count'>
```



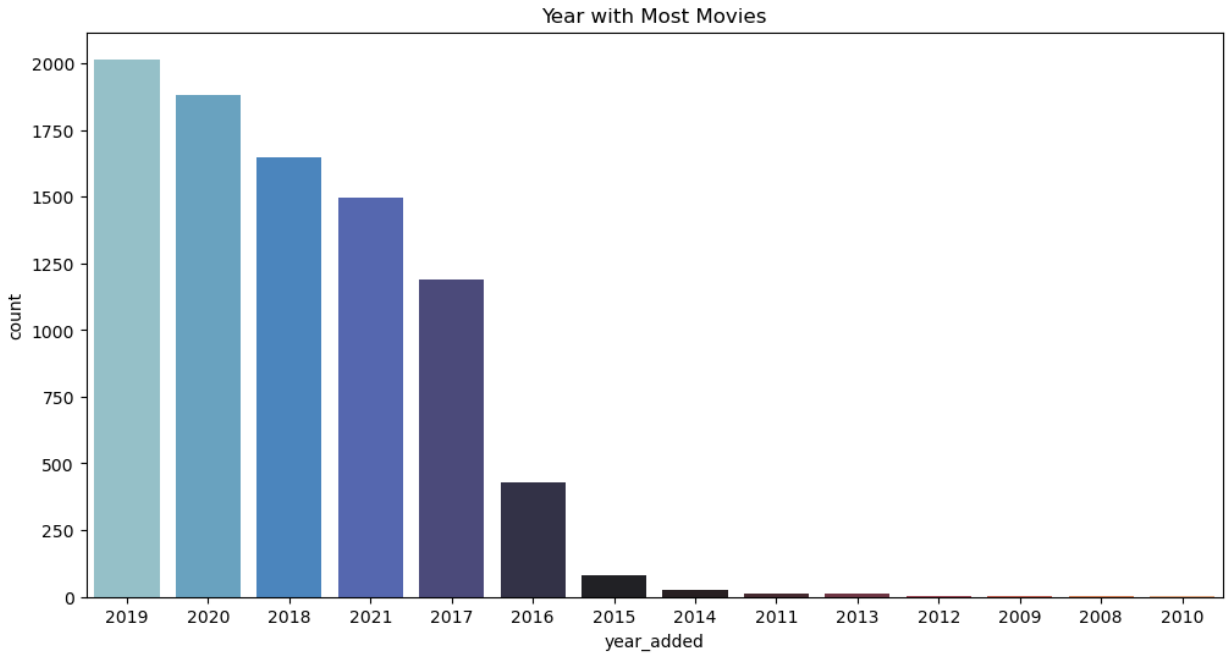
In [11]:
```
# Plot the pie chart
plt.figure(figsize=(6, 6))
df['type'].value_counts().plot.pie(autopct='%1.1f%%', startangle=140)
plt.title('Distribution of Show Types')
plt.axis('equal')
plt.show()
```



In [12]:
```
type_counts = df['type'].value_counts()
print(type_counts)
```

```
type
Movie      6131
TV Show    2666
Name: count, dtype: int64
```

In [13]:
```
plt.figure(figsize=(12, 6))
sns.countplot(x='year_added', data=df, order=df['year_added'].value_counts().index[:14
plt.title('Year with Most Movies')
plt.show()
```

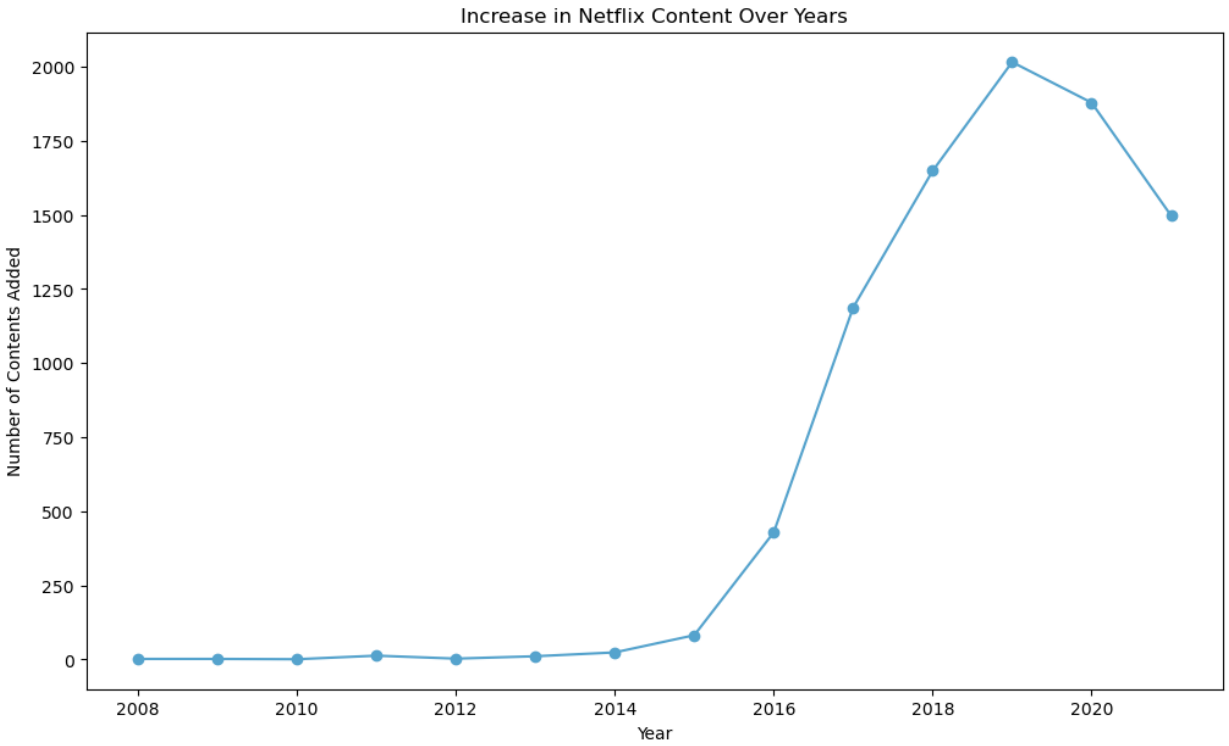


In [14]:
```
plt.figure(figsize=(12, 7))
plt.scatter(x=df["release_year"], y=df["year_added"])
plt.title("Time between release and Netflix addition")
plt.xlabel("Release Year")
plt.ylabel("Year Added")
```

Out[14]:
```
Text(0, 0.5, 'Year Added')
```

In [15]:
```
plt.figure(figsize=(12, 7))

df_1 = df.groupby("year_added")["show_id"].count()
df_1.plot(marker='o')
plt.title("Increase in Netflix Content Over Years")
plt.xlabel("Year", color="black")
```

```
plt.ylabel("Number of Contents Added")
plt.show()
```

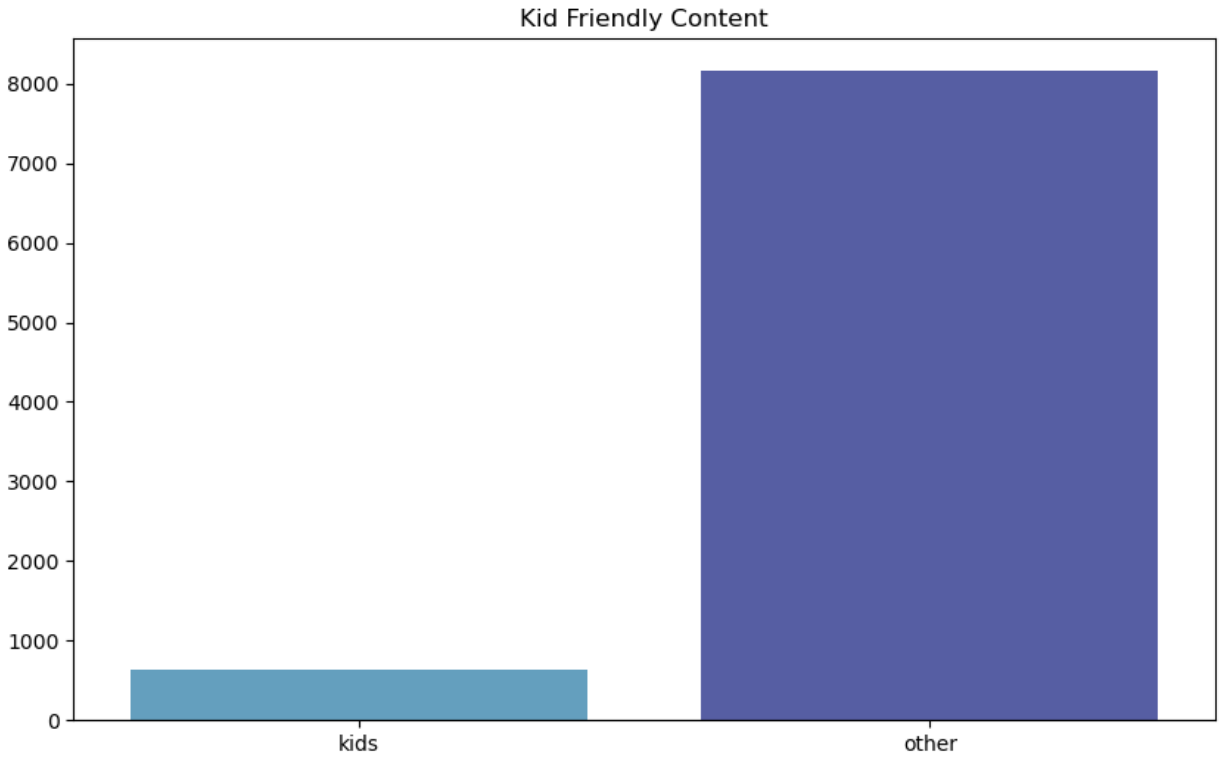


In [16]:
```
Totalkidscount = 0
for i in df["listed_in"]:
    if 'kids' in i or 'Children' in i:
        Totalkidscount += 1
Totalkidscount
```

Out[16]:
```
641
```

In [17]:
```
dic = {
    'kids': Totalkidscount,
    'other': df.shape[0] - Totalkidscount
}

sns.barplot(x=list(dic.keys()), y = list(dic.values()))
plt.title('Kid Friendly Content')
```

Out[17]:
```
Text(0.5, 1.0, 'Kid Friendly Content')
```

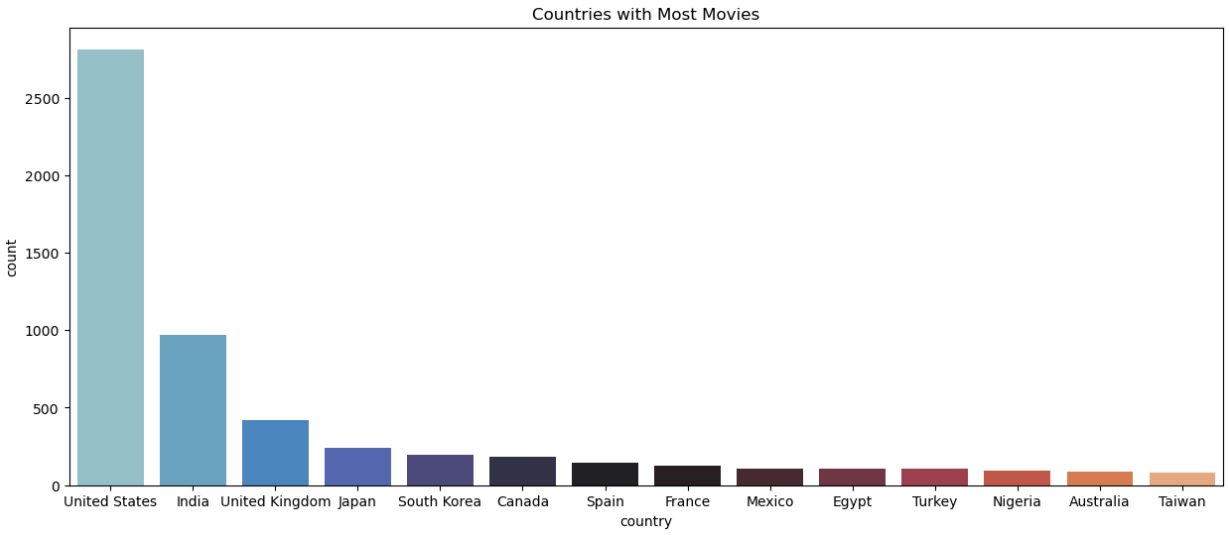


In [18]:
```
Totalkidscount*100/df.shape[0]
```

Out[18]:
```
7.286574968739343
```

In [19]:
```
plt.figure(figsize=(15, 6))
sns.countplot(x='country', data=df, order=df['country'].value_counts().index[:14], pal
plt.title('Countries with Most Movies')
```

Out[19]:
```
Text(0.5, 1.0, 'Countries with Most Movies')
```



In [20]:
```
# Filter data for US and sort by release year
oldest_us_series = df[df['country'] == 'United States'].sort_values(by='release_year')

# Define colors
header_fill_color = 'black'
cell_fill_color = 'gainsboro'
line_color = 'black'
```

```
font_color = 'white'

# Create Plotly figure
fig = go.Figure(data=[go.Table(
    header=dict(values=['Title', 'Release Year'], fill_color=header_fill_color, align=
    cells=dict(values=[oldest_us_series['title'], oldest_us_series['release_year']], f
])

# Show the figure
fig.show()
```

In [21]:

```
# Filter and group data
netflixfilter = df.query("release_year >= 2007").groupby(["type", "release_year"])["sh

# Create traces without specifying colors
traces = [
    go.Scatter(
        x=data['release_year'],
        y=data['show_id'],
        mode='lines+markers',
        name=show_type,
        text=data['show_id']
    )
    for show_type, _ in netflixfilter.groupby("type")
    for _, data in netflixfilter[netflixfilter["type"] == show_type].groupby("type")
]
```

```
# Create Plotly figure
fig = go.Figure(data=traces)

# Update layout
fig.update_layout(title_text='Movies/TV Show Release Yearly Trend')

# Show the figure
fig.show()
```

In [22]:

```
# Filter, group, and aggregate data
netflixfilter = (
    df.query("release_year >= 2007")
    .groupby(['release_year', 'month_added', 'type'])
    .size()
    .reset_index(name='total_shows')
    .groupby(['month_added', 'type'])
    .agg({'total_shows': 'mean'})
    .reset_index()
)

# Create traces without specifying colors
traces = [
    go.Scatter(
        x=data['month_added'],
        y=data['total_shows'],
```

```
        mode='lines+markers',
        name=show_type,
        text=data['total_shows']
    )
    for show_type, _ in netflixfilter.groupby("type")
    for _, data in netflixfilter[netflixfilter["type"] == show_type].groupby("type")
]

# Create Plotly figure
fig = go.Figure(data=traces)

# Update layout
fig.update_layout(title_text='Movies/TV Shows Average Monthly Release Trend')

# Show the figure
fig.show()
```

In [23]:

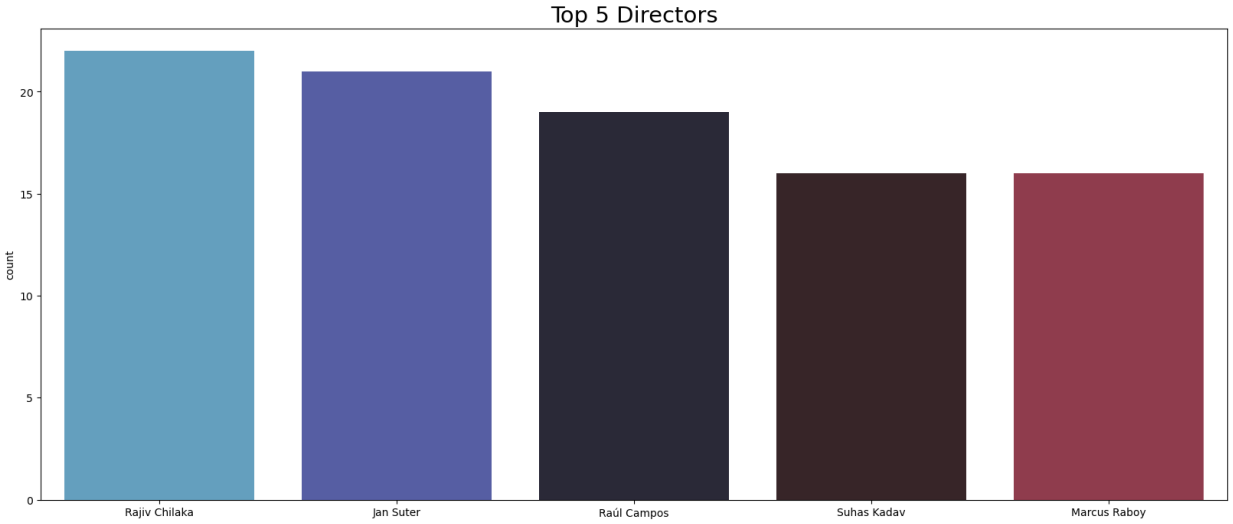
```
netflixtv = df.query("type == 'TV Show'")[["title", "duration"]]
netflixtv = netflixtv.groupby('duration').size().reset_index(name='TV Shows').sort_val
netflixtv = netflixtv.rename(columns={"duration": "Seasons"})

netflixmov = df.query("type == 'Movie'")
netflixmov['duration'] = netflixmov['duration'].fillna("0").str.split(" ").str[0].asty

fig_show = px.bar(netflixtv, x='Seasons', y='TV Shows', title='TV Shows Seasons')
fig_Movie = px.histogram(netflixmov, x="duration", nbins=20, title="Movie Duration")
```

```
fig_Movie.show()
fig_show.show()
```

In [24]:
```
df['director'].value_counts().head(10)
```

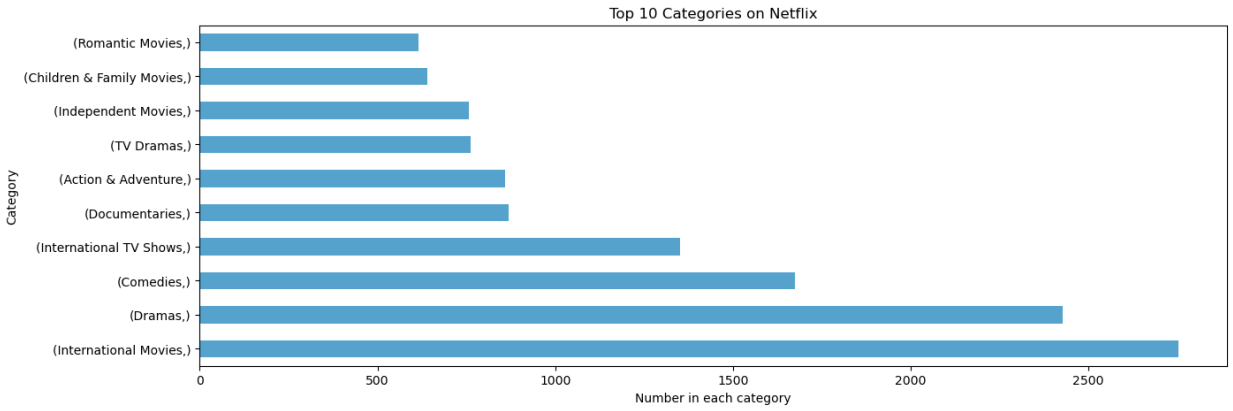
Out[24]:
```
director
Rajiv Chilaka             19
Raúl Campos, Jan Suter    18
Marcus Raboy              16
Suhas Kadav               16
Jay Karas                 14
Cathy Garcia-Molina       13
Martin Scorsese           12
Youssef Chahine           12
Jay Chapman               12
Steven Spielberg          11
Name: count, dtype: int64
```

In [25]:
```
plt.figure(figsize=(20,8))
netflix_directors = df[df.director != 'director unavailable'].set_index('title').direc
sns.countplot(x = netflix_directors, order=netflix_directors.value_counts().index[:5])
plt.title('Top 5 Directors', fontsize=21)
plt.show()
```



In [26]:
```
listofcg = []
for i in df["listed_in"].dropna():
    x = i.split(",")
    for j in x:
        listofcg.append(j.strip())

listofcg = pd.DataFrame(listofcg)
Top10C = listofcg.value_counts()[:10]
```

In [27]:
```
plt.figure(figsize=(15, 5))
Top10C.plot(kind="barh")
plt.xlabel("Number in each category")
plt.ylabel("Category")
plt.title("Top 10 Categories on Netflix")
plt.show()
```



In [28]:
```
#TimeSeries Analysis Take 1
```

In [29]:
```
df["date_added"]=pd.to_datetime(df['date_added'])
shows_added=df.groupby(pd.Grouper(key='date_added', axis=0, freq='M'))["show_id"].cour
shows_added=shows_added.to_frame()
shows_added = shows_added.rename({"show_id": "value"} , axis = 1)
shows_added
```

Out[29]:

date_added	value
2008-01-31	1
2008-02-29	1
2008-03-31	0
2008-04-30	0
2008-05-31	0
...	...
2021-05-31	132
2021-06-30	207
2021-07-31	257
2021-08-31	178
2021-09-30	183

165 rows × 1 columns

In [30]:
```
shows_added.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 165 entries, 2008-01-31 to 2021-09-30
Freq: M
Data columns (total 1 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   value   165 non-null    int64
dtypes: int64(1)
memory usage: 2.6 KB
```

In [31]:
```
shows_added.isnull().any()
```

Out[31]:
```
value    False
dtype: bool
```

In [32]:
```
start_date = '2014-1-1'
mask = (shows_added.index > start_date)
shows_added=shows_added.loc[mask]
shows_added
```

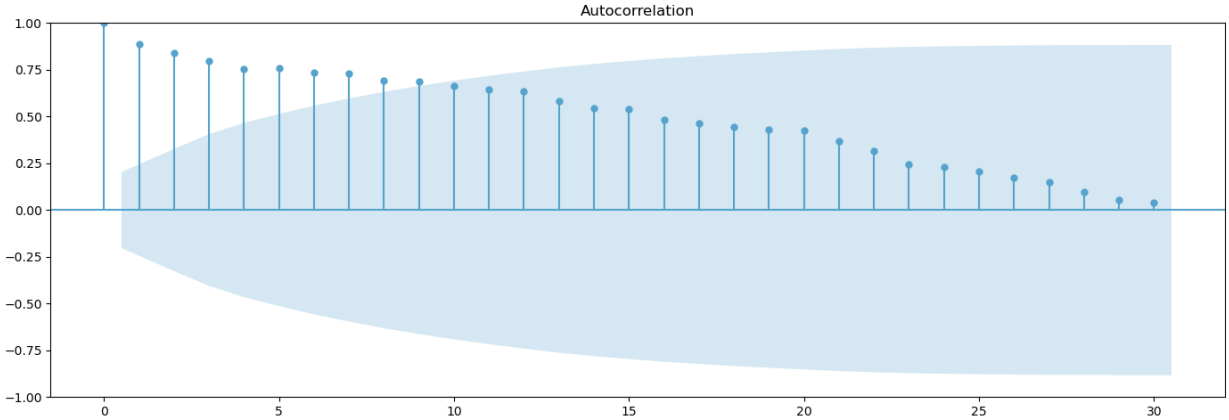
Out[32]:

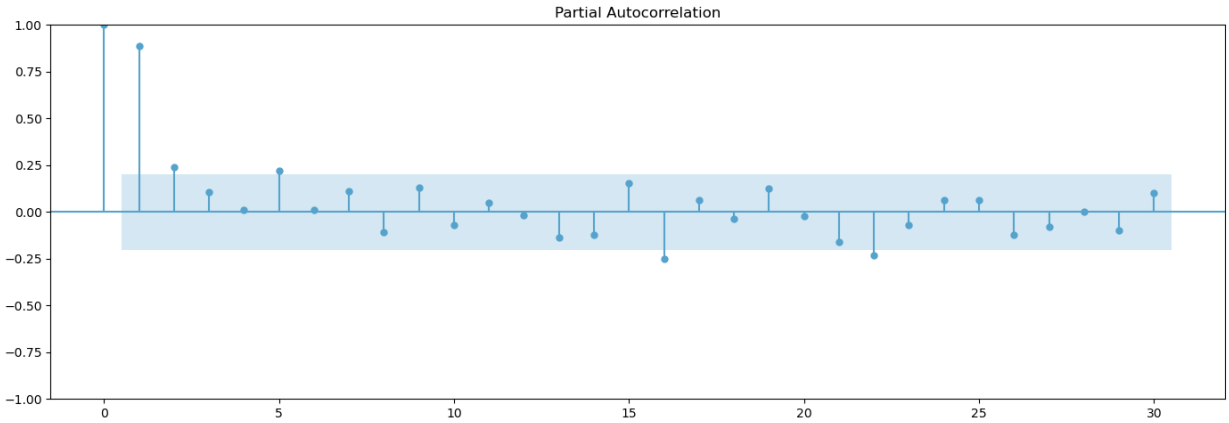
date_added	value
2014-01-31	2
2014-02-28	2
2014-03-31	0
2014-04-30	2
2014-05-31	0
...	...
2021-05-31	132
2021-06-30	207
2021-07-31	257
2021-08-31	178
2021-09-30	183

93 rows × 1 columns

In [33]:

```
def ACF_and_PACF(data):
    fig, (ax1, ax2) = plt.subplots(2, 1, figsize=(17, 12))
    plot_acf(data, lags=30, ax=ax1)
    plot_pacf(data, lags=30, ax=ax2)
   # plt.tight_layout()
    #plt.show()

ACF_and_PACF(shows_added['value'])
```





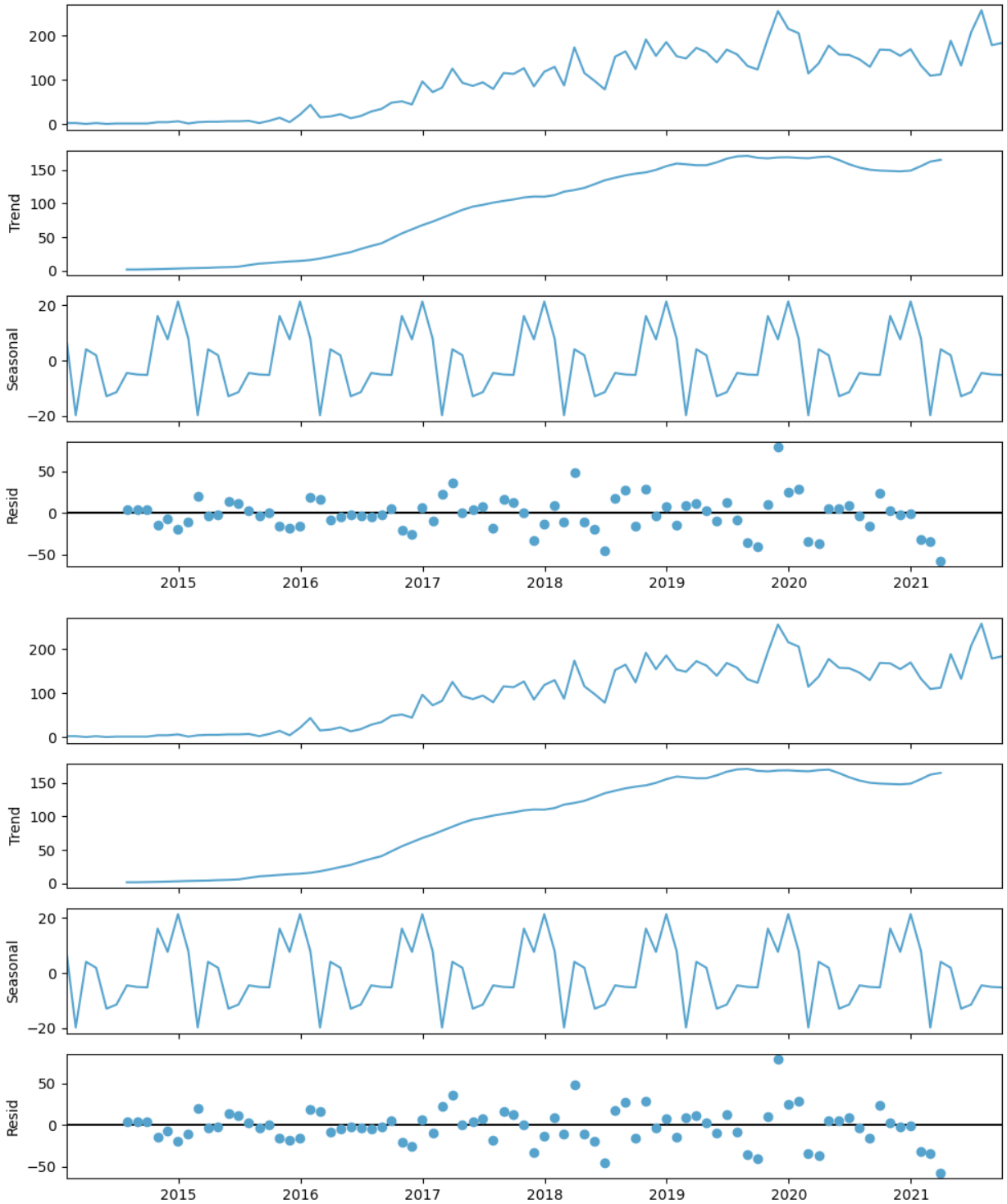
In [34]:
```
from statsmodels.tsa.stattools import acf, pacf
def ACF_and_PACF_values(data):
    acf_values = acf(data, nlags=30)
    pacf_values = pacf(data, nlags=30)
    return acf_values, pacf_values

acf_values, pacf_values = ACF_and_PACF_values(shows_added['value'])

print("Autocorrelation Values:")
print(acf_values)

print("\nPartial Autocorrelation Values:")
print(pacf_values)
```

```
Autocorrelation Values:
[1.         0.88667945 0.83714537 0.79797041 0.75401716 0.7565203
 0.73289871 0.72965457 0.69335386 0.68684813 0.66223455 0.64317725
 0.63470159 0.58308058 0.54461936 0.53734363 0.48163651 0.46203818
 0.44310114 0.42822411 0.42426637 0.36989983 0.31505007 0.24645046
 0.22926541 0.20577262 0.17339044 0.14820692 0.09859322 0.05256673
 0.03920036]

Partial Autocorrelation Values:
[ 1.          0.89631727  0.26528712  0.12792282  0.01851155  0.25917286
  0.03230337  0.14716779 -0.11669342  0.17182865 -0.07629167  0.07799017
 -0.02450379 -0.16335865 -0.1861196   0.20185635 -0.3850741   0.10988178
 -0.14313547  0.2638155  -0.16521212 -0.15191008 -0.53780311  0.01924747
 -0.18917169  0.3736234  -0.90441886  3.68609212  1.58460627 -0.80643314
  0.23230322]
```

In [35]:
```
decomposition = sm.tsa.seasonal_decompose(shows_added ,  model = "additive")
```

```
decomposition.plot()
```

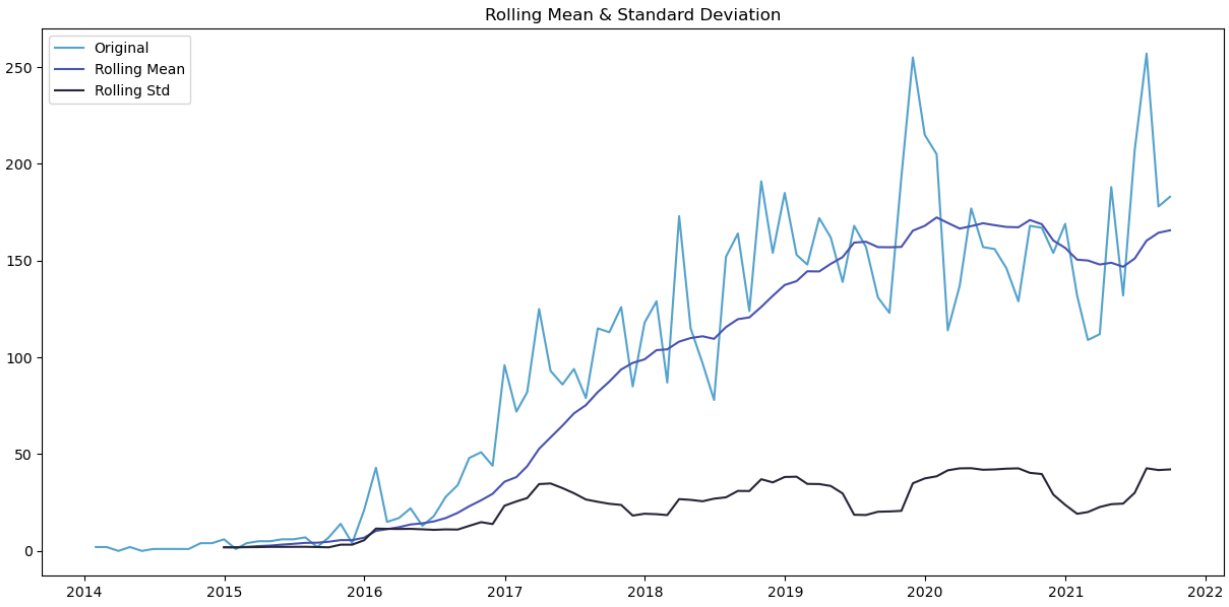
Out[35]:



In [36]:

```
plt.figure(figsize=(15, 7))

rolmean = shows_added.rolling(window=12).mean()
rolstd = shows_added.rolling(window=12).std()

# Plot rolling statistics
orig = plt.plot(shows_added, label='Original')
mean = plt.plot(rolmean, label='Rolling Mean')
std = plt.plot(rolstd, label='Rolling Std')

plt.legend(loc='best')
```

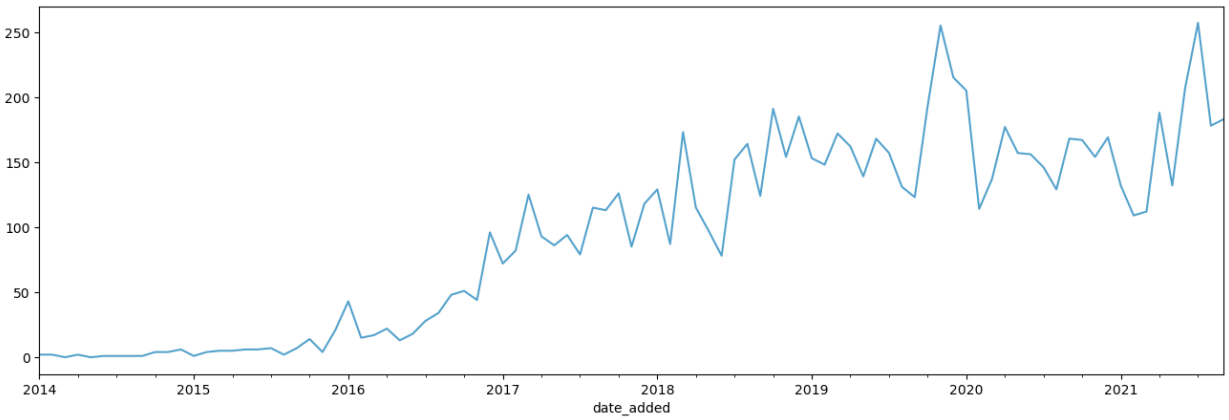
```
plt.title('Rolling Mean & Standard Deviation')
plt.show(block=False)
```



In [37]:
```
# Compute first difference and drop NaN values
df_diff = shows_added

# Perform Augmented Dickey-Fuller test
adfuller_results = adfuller(df_diff['value'])

# Print test results
print(f"ADF Test: Test statistic = {round(adfuller_results[0], 4)}, p-value = {round(a
print('Critical values:', adfuller_results[4])

if adfuller_results[1]<=0.05:
    print("Reject null hypothesis, the time series is stationary")
else:
    print("Failure to reject null hypothesis, the time series is non-stationary")

# Plot revenue difference
df_diff['value'].plot(figsize = [16,5])
```

```
ADF Test: Test statistic = -0.7685, p-value = 0.82820303
Critical values: {'1%': -3.510711795769895, '5%': -2.8966159448223734, '10%': -2.5854
823866213152}
Failure to reject null hypothesis, the time series is non-stationary
```

Out[37]:
```
<Axes: xlabel='date_added'>
```



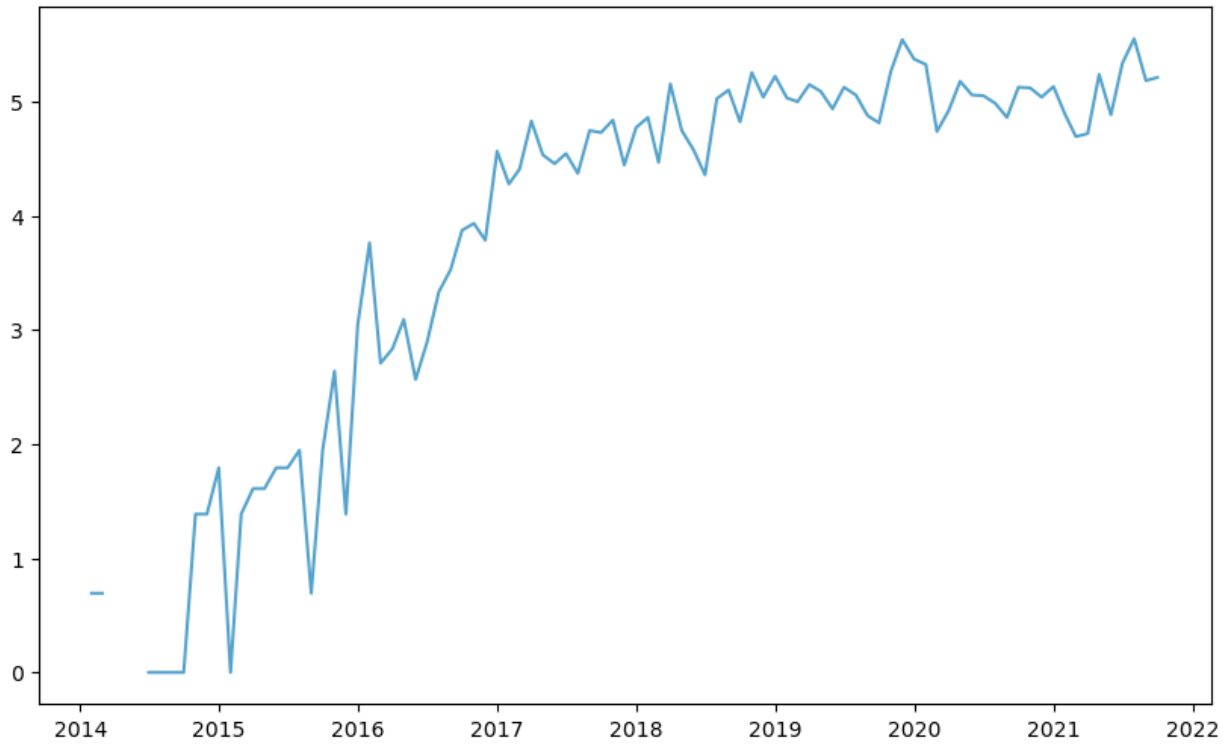
In [38]:
```
#Checking
```

In [39]:
```
print("Results of Dickey Fuller Test: ")
dftest = adfuller(shows_added['value'] , autolag= "AIC")

dfoutput = pd.Series(dftest[0:4], index=['Test Statistic','p-value','#Lags Used','Numb
for key,value in dftest[4].items():
    dfoutput['Critical Value (%s)'%key] = value

print(dfoutput)
```

```
Results of Dickey Fuller Test:
Test Statistic                 -0.768490
p-value                         0.828203
#Lags Used                      8.000000
Number of Observations Used    84.000000
Critical Value (1%)            -3.510712
Critical Value (5%)            -2.896616
Critical Value (10%)           -2.585482
dtype: float64
```

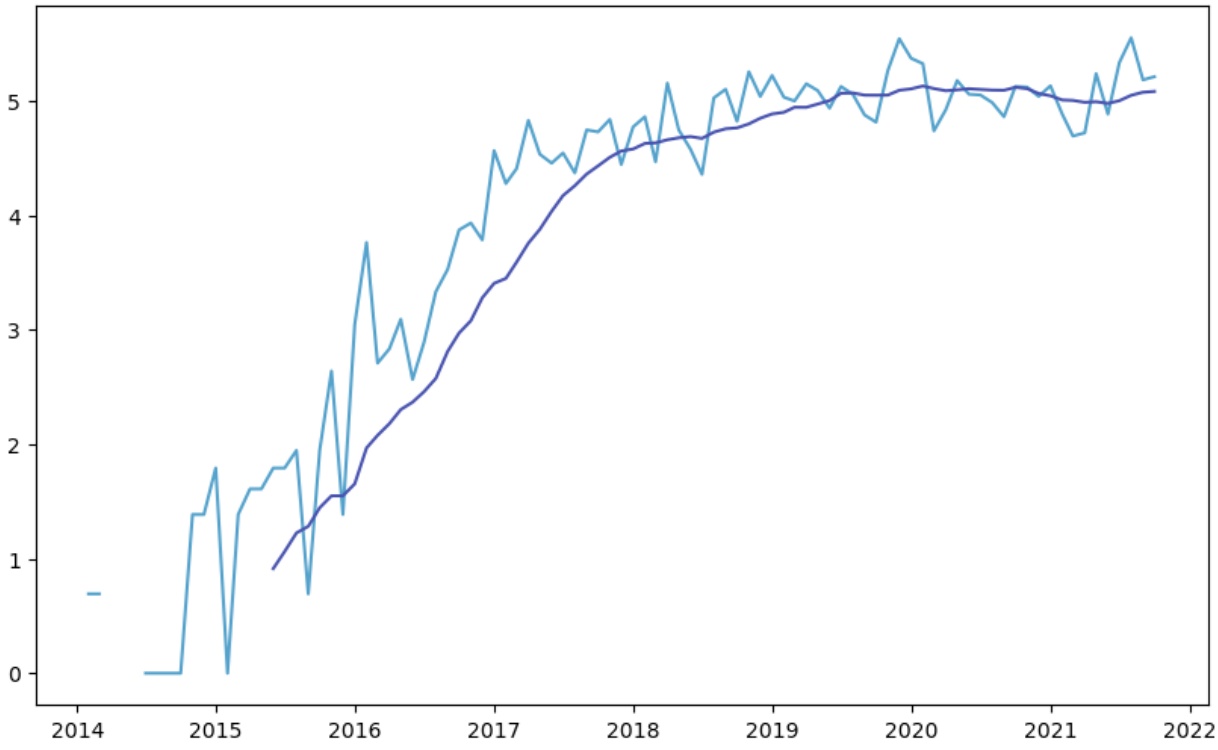
In [40]:
```
df_logScale = np.log(shows_added)
plt.plot(df_logScale)
```

Out[40]:
```
[<matplotlib.lines.Line2D at 0x149c8ec8350>]
```



In [41]:
```
#make series stationary
movingAverage = df_logScale.rolling(window=12).mean()
movingSTD = df_logScale.rolling(window=12).std()
plt.plot(df_logScale)
plt.plot(movingAverage)
```

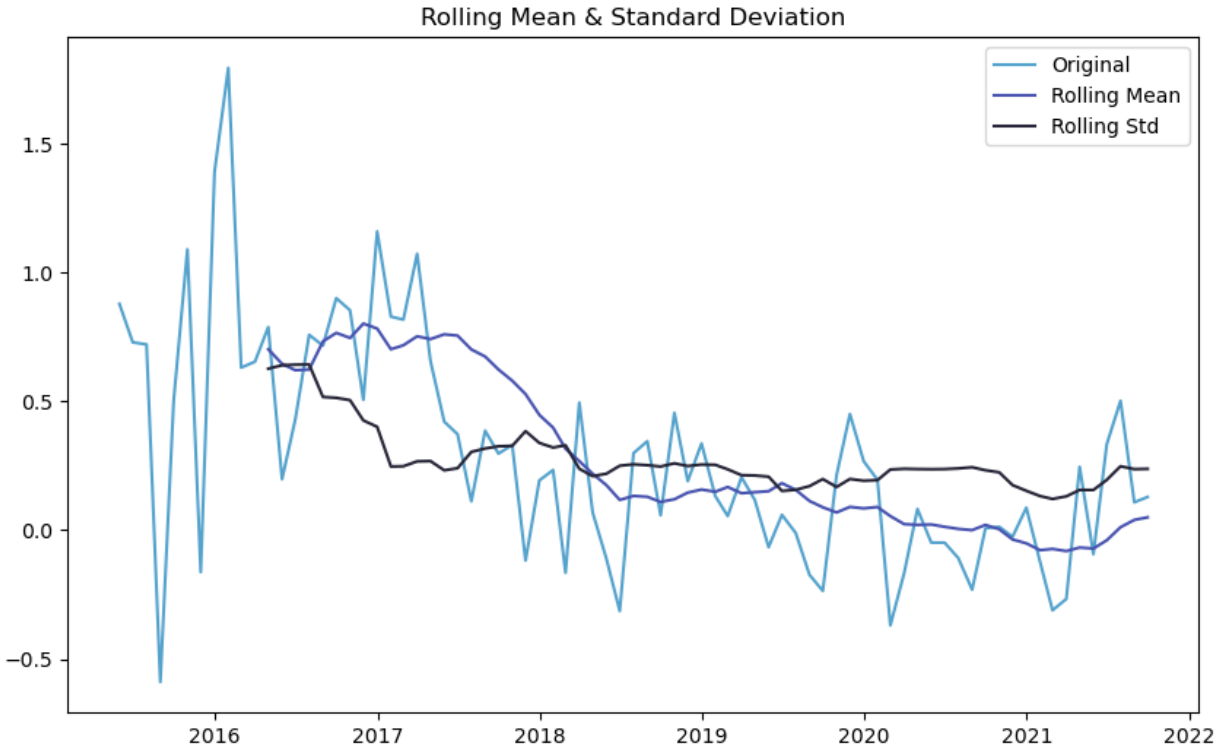
Out[41]:
```
[<matplotlib.lines.Line2D at 0x149c9bad550>]
```



In [42]:
```
data_SMMA = df_logScale - movingAverage
data_SMMA.head(12)
data_SMMA.dropna(inplace=True)
```

In [43]:
```
def test_stationarity(timeseries):

    #Determine rolling statistics
    movingAverage = timeseries.rolling(window=12).mean()
    movingSTD = timeseries.rolling(window=12).std()

    #Plot rolling statistics
    orig = plt.plot(timeseries, label='Original')
    mean = plt.plot(movingAverage,  label='Rolling Mean')
    std = plt.plot(movingSTD, label='Rolling Std')
    plt.legend(loc='best')
    plt.title('Rolling Mean & Standard Deviation')
    plt.show(block=False)

    #Perform Dickey-Fuller test:
    print('Results of Dickey Fuller Test:')
    dftest = adfuller(timeseries['value'], autolag='AIC')
    dfoutput = pd.Series(dftest[0:4], index=['Test Statistic','p-value','#Lags Used','
    for key,value in dftest[4].items():
        dfoutput['Critical Value (%s)'%key] = value
    print(dfoutput)
```

In [44]:
```
test_stationarity(data_SMMA)
```




```
Results of Dickey Fuller Test:
Test Statistic                  -2.303355
p-value                          0.170888
#Lags Used                       2.000000
Number of Observations Used     74.000000
Critical Value (1%)             -3.521980
Critical Value (5%)             -2.901470
Critical Value (10%)            -2.588072
dtype: float64
```

In [45]:
```
#Model
```

In [46]:
```
data = data_SMMA.dropna()
data
```

Out[46]:

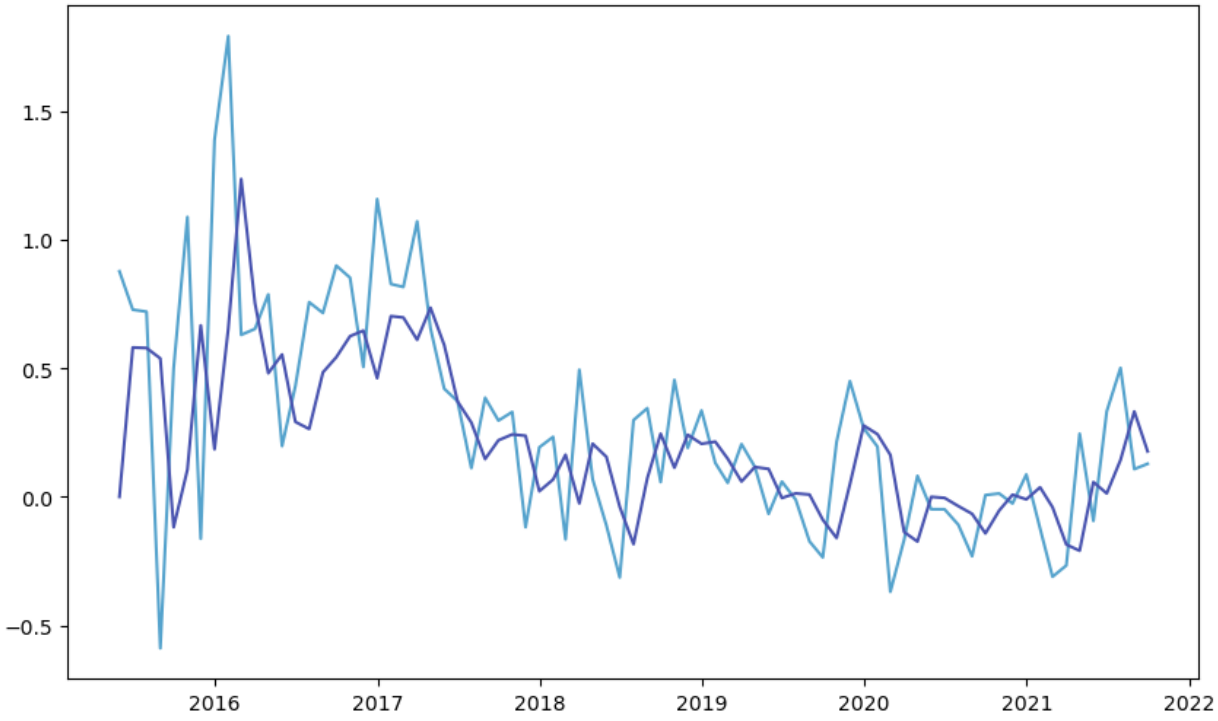
date_added	value
2015-05-31	0.878320
2015-06-30	0.729006
2015-07-31	0.720998
2015-08-31	-0.589527
2015-09-30	0.501076
...	...
2021-05-31	-0.093363
2021-06-30	0.332982
2021-07-31	0.502217
2021-08-31	0.108094
2021-09-30	0.128669

77 rows × 1 columns

In [47]:
```
train = data[:4988]
test = data[4988:]
```

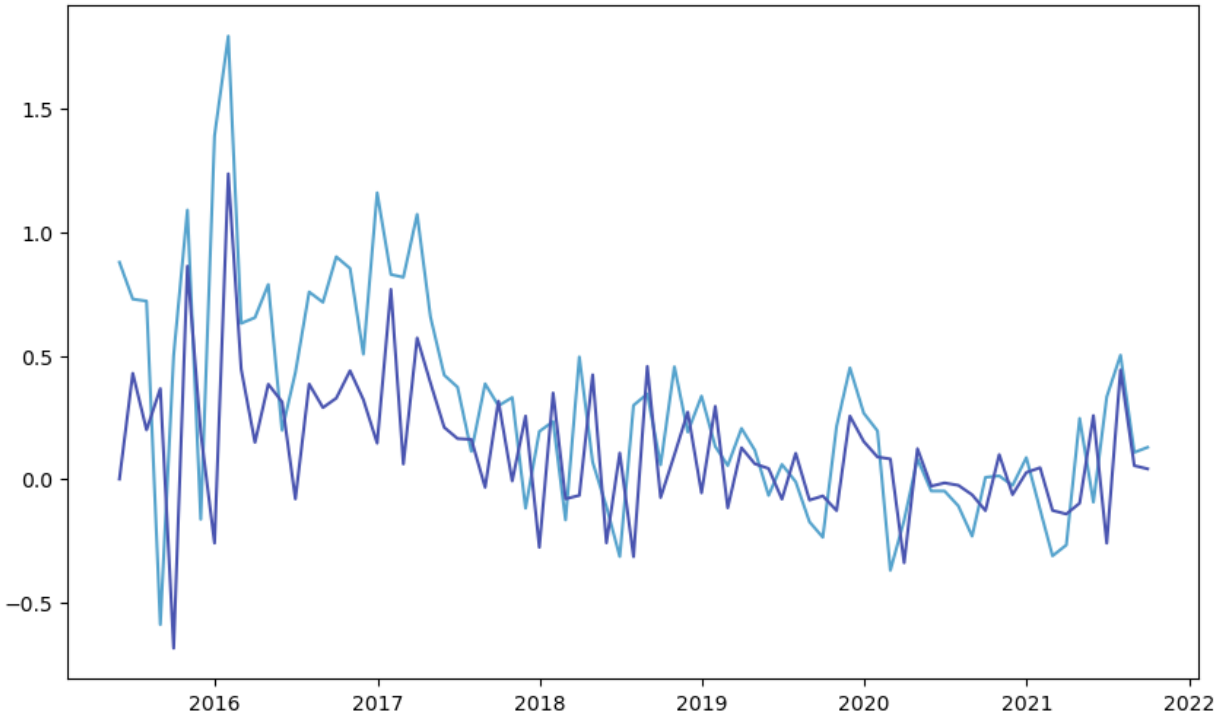
In [48]:
```
modelr = SARIMAX(train , order= (2,0,0))
tol = modelr.fit()
plt.plot(train)
plt.plot(tol.fittedvalues)
print(tol.summary())
```

```
                               SARIMAX Results
==============================================================================
Dep. Variable:                   value   No. Observations:                   77
Model:               SARIMAX(2, 0, 0)   Log Likelihood                -35.300
Date:                Wed, 21 Feb 2024   AIC                            76.600
Time:                        14:08:21   BIC                            83.631
Sample:                    05-31-2015   HQIC                           79.412
                         - 09-30-2021
Covariance Type:                  opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1          0.5000      0.060      8.347      0.000       0.383       0.617
ar.L2          0.2449      0.069      3.572      0.000       0.111       0.379
sigma2         0.1451      0.017      8.732      0.000       0.113       0.178
===================================================================================
Ljung-Box (L1) (Q):                   2.10   Jarque-Bera (JB):                12.76
Prob(Q):                              0.15   Prob(JB):                         0.00
Heteroskedasticity (H):               0.17   Skew:                             0.27
Prob(H) (two-sided):                  0.00   Kurtosis:                         4.92
===================================================================================

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



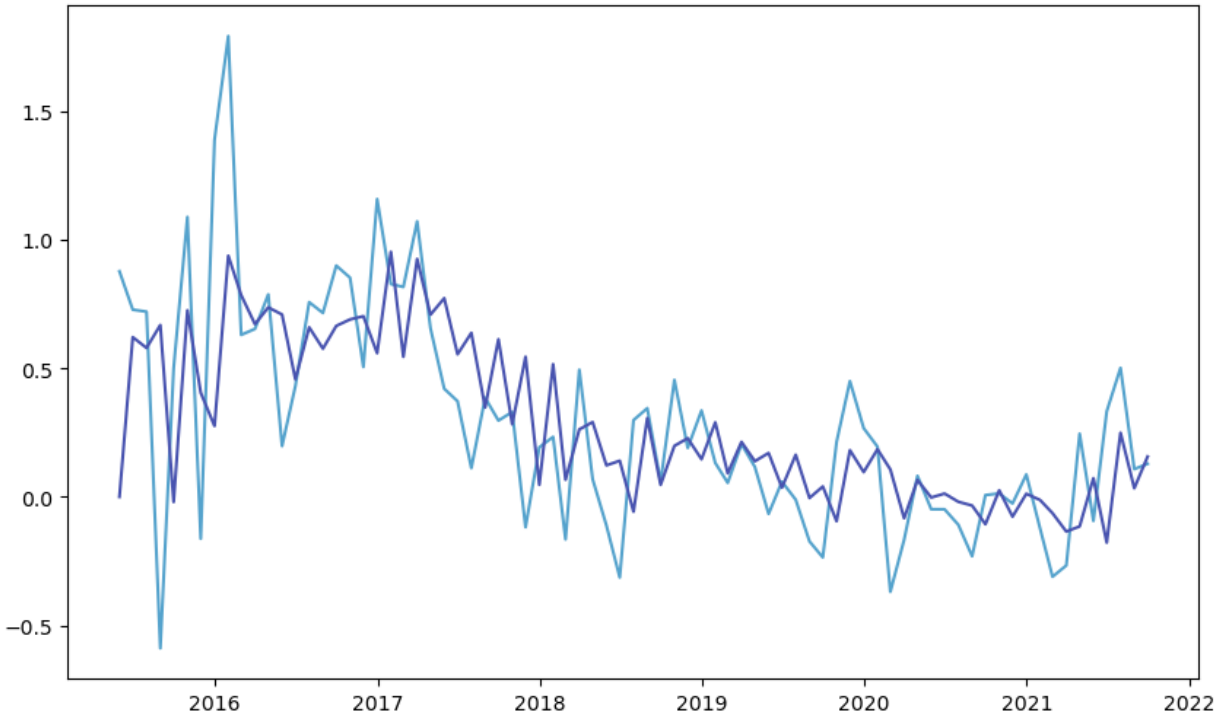
In [49]:
```
model2 = SARIMAX(train , order= (0,0,2))
dol = model2.fit()
plt.plot(train)
plt.plot(dol.fittedvalues)
print(dol.summary())
```

```
                               SARIMAX Results
==============================================================================
Dep. Variable:                   value   No. Observations:                   77
Model:               SARIMAX(0, 0, 2)   Log Likelihood                -41.707
Date:                Wed, 21 Feb 2024   AIC                             89.414
Time:                        14:08:22   BIC                             96.446
Sample:                    05-31-2015   HQIC                            92.227
                         - 09-30-2021
Covariance Type:                  opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ma.L1          0.7549      0.109      6.897      0.000       0.540       0.969
ma.L2          0.0152      0.106      0.142      0.887      -0.193       0.224
sigma2         0.1712      0.023      7.435      0.000       0.126       0.216
===================================================================================
Ljung-Box (L1) (Q):                   2.83   Jarque-Bera (JB):                28.71
Prob(Q):                              0.09   Prob(JB):                         0.00
Heteroskedasticity (H):               0.12   Skew:                             0.76
Prob(H) (two-sided):                  0.00   Kurtosis:                         5.58
===================================================================================

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



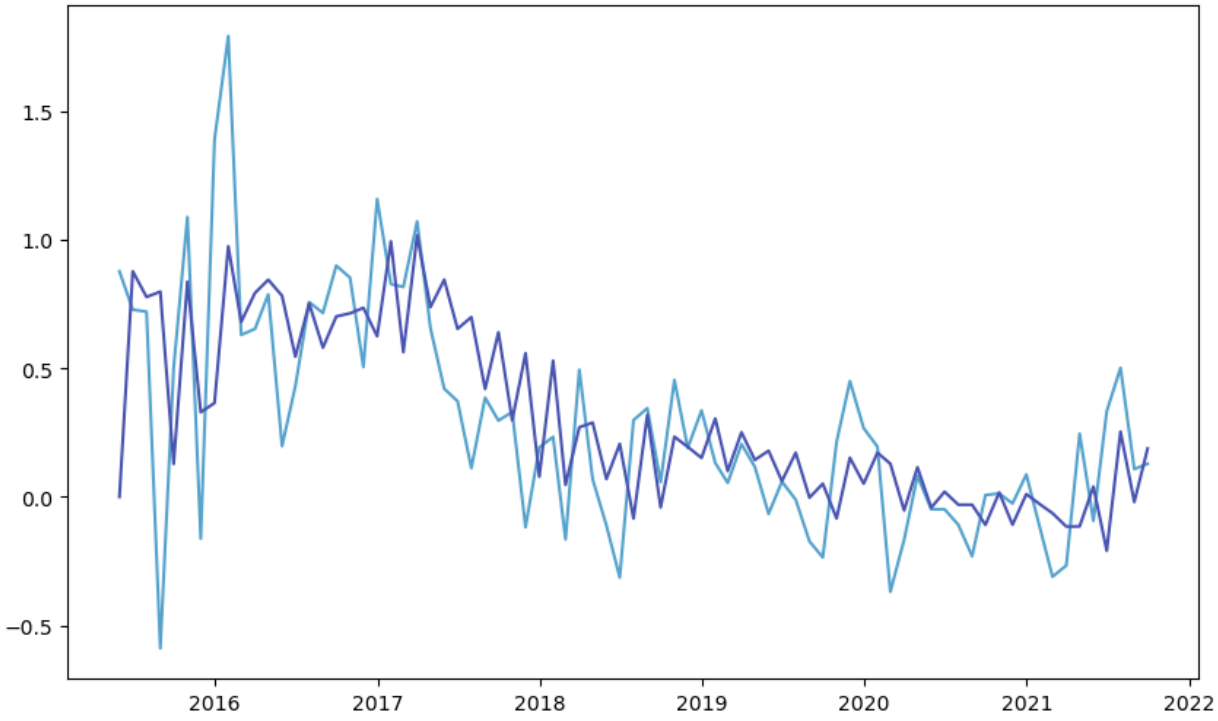
In [50]:
```
model3 = SARIMAX(train , order= (2,0,2))
col = model3.fit()
plt.plot(train)
plt.plot(col.fittedvalues)
print(col.summary())
```

```
                               SARIMAX Results
==============================================================================
Dep. Variable:                   value   No. Observations:                   77
Model:               SARIMAX(2, 0, 2)   Log Likelihood                -24.178
Date:                Wed, 21 Feb 2024   AIC                             58.357
Time:                        14:08:22   BIC                             70.076
Sample:                    05-31-2015   HQIC                            63.044
                         - 09-30-2021
Covariance Type:                  opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1          0.3872      0.111      3.475      0.001       0.169       0.606
ar.L2          0.5908      0.100      5.884      0.000       0.394       0.788
ma.L1          0.1008      0.157      0.643      0.520      -0.207       0.408
ma.L2         -0.7494      0.083     -9.023      0.000      -0.912      -0.587
sigma2         0.1067      0.012      8.627      0.000       0.082       0.131
===================================================================================
Ljung-Box (L1) (Q):                   0.43   Jarque-Bera (JB):                21.39
Prob(Q):                              0.51   Prob(JB):                         0.00
Heteroskedasticity (H):               0.22   Skew:                             0.03
Prob(H) (two-sided):                  0.00   Kurtosis:                         5.58
===================================================================================

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



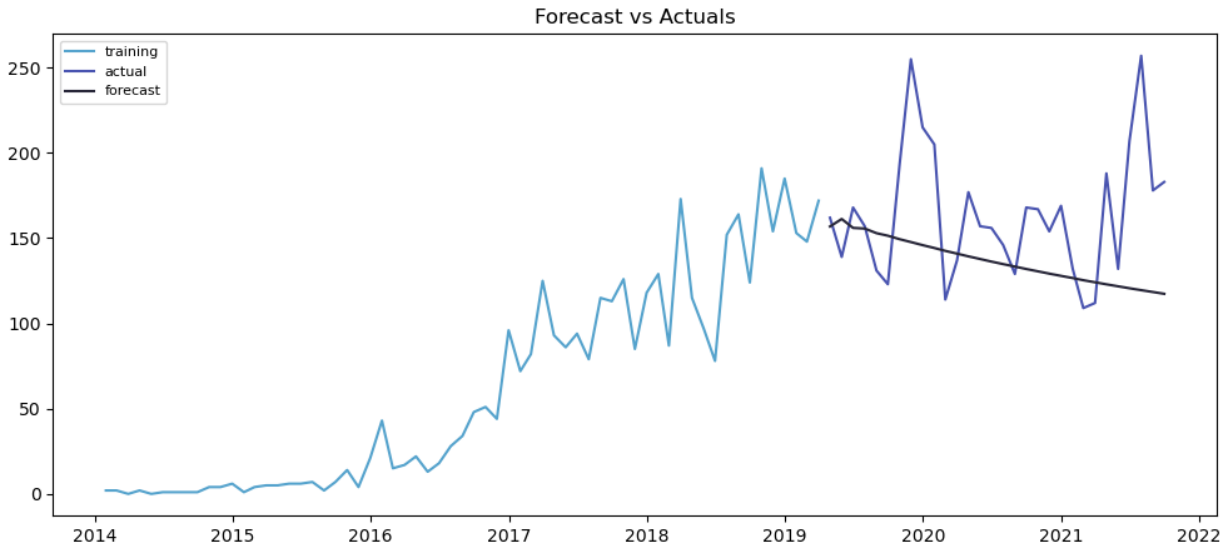
In [51]:
```
model4 = SARIMAX(train , order= (2,1,2))
pol = model4.fit()
plt.plot(train)
plt.plot(pol.fittedvalues)
print(pol.summary())
```

```
                               SARIMAX Results
==============================================================================
Dep. Variable:                   value   No. Observations:                   77
Model:               SARIMAX(2, 1, 2)   Log Likelihood                -23.256
Date:                Wed, 21 Feb 2024   AIC                             56.513
Time:                        14:08:23   BIC                             68.166
Sample:                    05-31-2015   HQIC                            61.170
                         - 09-30-2021
Covariance Type:                  opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1         -0.6639      0.121     -5.468      0.000      -0.902      -0.426
ar.L2         -0.1610      0.169     -0.952      0.341      -0.492       0.170
ma.L1          0.1085      0.175      0.620      0.535      -0.234       0.451
ma.L2         -0.6779      0.118     -5.750      0.000      -0.909      -0.447
sigma2         0.1058      0.011      9.378      0.000       0.084       0.128
===================================================================================
Ljung-Box (L1) (Q):                   0.00   Jarque-Bera (JB):                30.91
Prob(Q):                              0.95   Prob(JB):                         0.00
Heteroskedasticity (H):               0.26   Skew:                            -0.21
Prob(H) (two-sided):                  0.00   Kurtosis:                         6.10
===================================================================================

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



In [52]:
```
# Create Training and Test
train = shows_added[:63]
test = shows_added[63:]
```

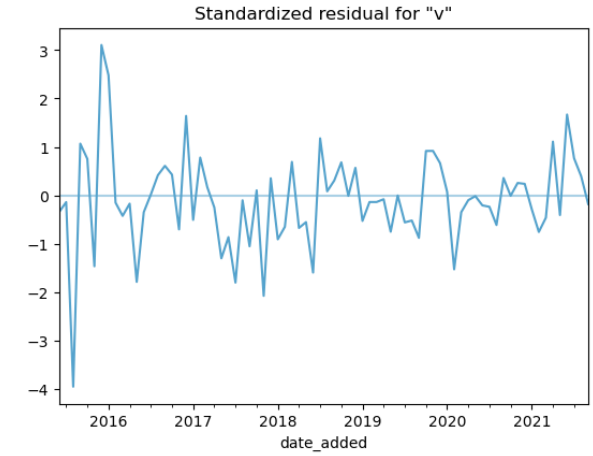
In [53]:
```
# Build Model
model = sm.tsa.arima.ARIMA(train, order=(2,0,0))
fitted = model.fit()

# Forecast
fc= fitted.forecast(steps=30, alpha=0.05)  # 95% conf

# Make as pandas series
fc_series = pd.Series(fc)

# Plot
plt.figure(figsize=(12,5), dpi=100)
plt.plot(train, label='training')
plt.plot(test, label='actual')
plt.plot(fc_series, label='forecast')
plt.title('Forecast vs Actuals')
plt.legend(loc='upper left', fontsize=8)
plt.show()
```

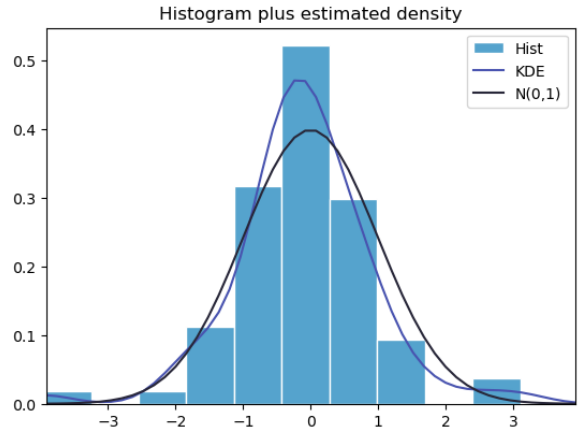


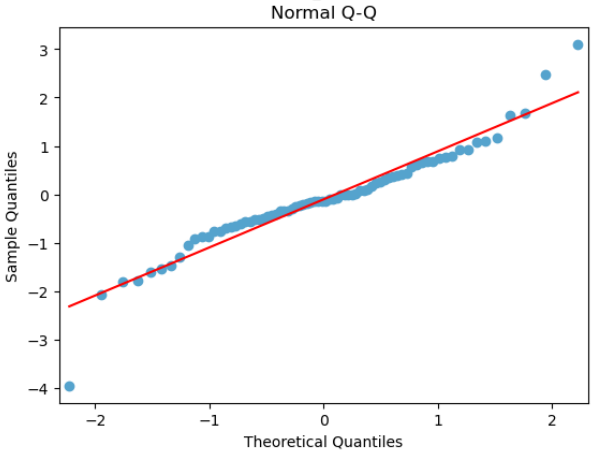
In [54]:
```
def forecast_accuracy(forecast, actual):
    forecast = forecast.squeeze()
    actual = actual.squeeze()

    mape = np.mean(np.abs(forecast - actual)/np.abs(actual))
    me = np.mean(forecast - actual)
    mae = np.mean(np.abs(forecast - actual))
    mpe = np.mean((forecast - actual)/actual)
    rmse = np.mean((forecast - actual)**2)**.5
    corr = np.corrcoef(forecast, actual)[0, 1]
    mins = np.amin(np.vstack([forecast, actual]), axis=0)
    maxs = np.amax(np.vstack([forecast, actual]), axis=0)
    minmax = 1 - np.mean(mins/maxs)

    acf1 = acf(forecast - actual)[1]
    return {'mape':mape, 'me':me, 'mae': mae,
            'mpe': mpe, 'rmse':rmse, 'acf1':acf1,
            'corr':corr, 'minmax':minmax}

forecast_accuracy(fc, test)
```

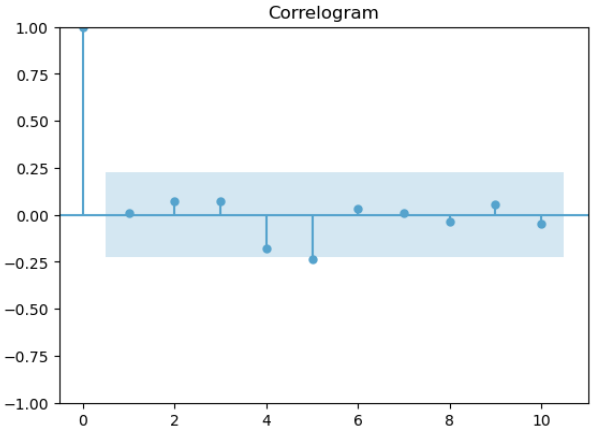
Out[54]:
```
{'mape': 0.19970231694348803,
 'me': -27.232842180121768,
 'mae': 36.43382671187031,
 'mpe': -0.12433409244963155,
 'rmse': 48.616288887525435,
 'acf1': 0.4491040148429595,
 'corr': -0.07615978582871992,
 'minmax': 0.1939721697303377}
```

In [58]:
```
pol.plot_diagnostics(figsize=(14,10))
plt.show()
```


Standardized residual for "v"
date_added


Histogram plus estimated density
Hist
KDE
N(0,1)


Normal Q-Q
Sample Quantiles
Theoretical Quantiles


Correlogram

In [ ]: