In [1]:
```
# This notebook tests that stationarity of the sentiment variables
# and then makes stationary any variables that are not stationary.
```

In [2]:
```
import warnings
warnings.filterwarnings('ignore')
```

In [3]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from statsmodels.graphics.tsaplots import plot_acf
from statsmodels.graphics.tsaplots import plot_pacf
from statsmodels.tsa.stattools import adfuller
```

In [4]:
```
# Quick look at the first two lines of the TXT
with open('data/econ_and_sent_vars_consolidated.txt') as f:
    print(f.readline())
    next(f)
    print(f.readline())
```

```
month_date      tb      pi      ur      nyse    pce     ics     num_words
perc_pos        perc_neg        perc_uncert     perc_litig      perc_modal_wk
perc_modal_wod  perc_modal_str  perc_constrain  num_alphanum    num_digits
num_nums        avg_syll_word   avg_word_len    vocab   num_words_rev_weighted
perc_pos_rev_weighted   perc_neg_rev_weighted   perc_uncert_rev_weighted
perc_litig_rev_weighted perc_modal_wk_rev_weighted      perc_modal_wod_rev_weigh
ted     perc_modal_str_rev_weighted     perc_constrain_rev_weighted     num_alph
anum_rev_weighted       num_digits_rev_weighted num_nums_rev_weighted   avg_syll
_word_rev_weighted      avg_word_len_rev_weighted       vocab_rev_weighted

2/1/11  0.13    12077.34136     9       8674.228596     10762.5176      77.5
8662.724138     2.025964984     0.991311045     0.929677755     0.06865454
0.421887611     0.697340185     0.626665545     0.094072965     43593.44828
599.3448276     221.3103448     1.521549135     4.681305418     1354.793103
9846.054438     2.055310798     0.93588036      0.887691462     0.064782495
0.390423476     0.556728544     0.729389353     0.115867806     50438.84659
828.7344123     312.4547135     1.555901554     4.800785644     1417.444823
```

In [5]:
```
# Set data types for features
dts = {"month_date": str
    , "perc_pos_rev_weighted": np.float64, "perc_neg_rev_weighted": np.float64
    , "perc_uncert_rev_weighted": np.float64, "perc_litig_rev_weighted": np.float
64
    , "perc_modal_wk_rev_weighted": np.float64, "perc_modal_wod_rev_weighted": np.
float64
    , "perc_modal_str_rev_weighted": np.float64, "perc_constrain_rev_weighted": n
p.float64}
```

In [6]:
```
# Set date feature to be parsed
parse_dates = ['month_date']
```

In [7]:
```
# Import data
data_raw = pd.read_csv("data/econ_and_sent_vars_consolidated.txt"
                   , sep="\t"
                   , skiprows=0
                   , dtype=dts
                    , usecols=[0,23,24,25,26,27,28,29,30]
                   , parse_dates=parse_dates)
```

In [8]:
```
# Rename a column
data_raw.rename(columns={'perc_modal_wod_rev_weighted': 'perc_modal_mod_rev_weight
ed'}, inplace=True)
```

In [9]:
```
# Check the dataframe
data_raw.head()
```

Out[9]:

	month_date	perc_pos_rev_weighted	perc_neg_rev_weighted	perc_uncert_rev_weighted	perc_litig
0	2011-01-01	2.052988	0.931237	0.872381	0.062692
1	2011-02-01	2.055311	0.935880	0.887691	0.064782
2	2011-03-01	1.960705	0.979452	0.957425	0.073102
3	2011-04-01	1.938265	0.996468	0.923577	0.078601
4	2011-05-01	1.876116	0.981002	0.898622	0.096360

In [10]:
```
# Convert month column to regular column then set to index
data_raw['date'] = data_raw['month_date']
data_raw["month_date"] = data_raw["month_date"].dt.to_period('M')
data_raw = data_raw.set_index("month_date", drop=True)
```

In [11]:
```
# Copy to data
data = data_raw.copy()
```

In [12]:
```
# Create function to apply the Dickey-Fuller test
def adf_test(timeseries):
    print ('Results of Dickey-Fuller Test:')
    dftest = adfuller(timeseries, autolag='AIC')
    dfoutput = pd.Series(dftest[0:4], index=['Test Statistic','p-value','#Lags Use
d','Number of Observations Used'])
    for key,value in dftest[4].items():
       dfoutput['Critical Value (%s)'%key] = value
    print (dfoutput)
```

In [13]:
```
# Run the Dickey-Fuller test on each sentiment feature
for column in data.iloc[:, 0:-1]:
    print ("\nTest Variable: {}\n".format(column))
    adf_test(data[column].dropna())
```

```
Test Variable: perc_pos_rev_weighted

Results of Dickey-Fuller Test:
Test Statistic                 -4.137713
p-value                         0.000838
#Lags Used                      0.000000
Number of Observations Used    89.000000
Critical Value (1%)            -3.506057
Critical Value (5%)            -2.894607
Critical Value (10%)           -2.584410
dtype: float64

Test Variable: perc_neg_rev_weighted

Results of Dickey-Fuller Test:
Test Statistic                 -4.163463
p-value                         0.000759
#Lags Used                      0.000000
Number of Observations Used    89.000000
Critical Value (1%)            -3.506057
Critical Value (5%)            -2.894607
Critical Value (10%)           -2.584410
dtype: float64

Test Variable: perc_uncert_rev_weighted

Results of Dickey-Fuller Test:
Test Statistic                -6.140022e+00
p-value                        8.013023e-08
#Lags Used                     0.000000e+00
Number of Observations Used    8.900000e+01
Critical Value (1%)           -3.506057e+00
Critical Value (5%)           -2.894607e+00
Critical Value (10%)          -2.584410e+00
dtype: float64

Test Variable: perc_litig_rev_weighted

Results of Dickey-Fuller Test:
Test Statistic                 -4.840466
p-value                         0.000045
#Lags Used                      0.000000
Number of Observations Used    89.000000
Critical Value (1%)            -3.506057
Critical Value (5%)            -2.894607
Critical Value (10%)           -2.584410
dtype: float64

Test Variable: perc_modal_wk_rev_weighted

Results of Dickey-Fuller Test:
Test Statistic                 -4.738456
p-value                         0.000071
#Lags Used                      7.000000
Number of Observations Used    82.000000
Critical Value (1%)            -3.512738
Critical Value (5%)            -2.897490
Critical Value (10%)           -2.585949
dtype: float64

Test Variable: perc_modal_mod_rev_weighted

Results of Dickey-Fuller Test:
Test Statistic                 -4.518157
p-value                         0.000182
```

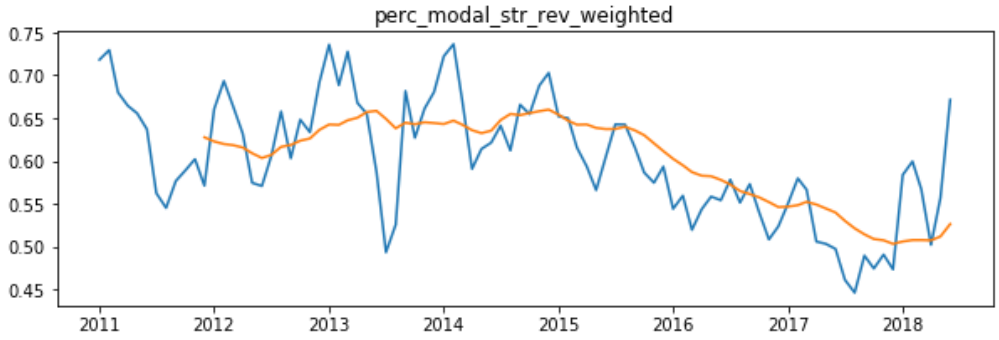
In [14]:
```
# Create function that displays two plots comparing stationary transformations
# Includes rolling mean

def two_plots(x, x_log):
    fig, (ax1, ax2) = plt.subplots(2, 1, figsize=(10,8))
    fig.subplots_adjust(hspace=0.25)
    rm1 = x.rolling(window=12).mean()
    rm2 = x_log.rolling(window=12).mean()
    ax1.plot(data['date'], x)
    ax1.plot(data['date'], rm1)
    ax1.set_title(x.name)
    ax2.plot(data['date'], x_log)
    ax2.plot(data['date'], rm2)
    ax2.set_title(x_log.name)
    plt.show()
```

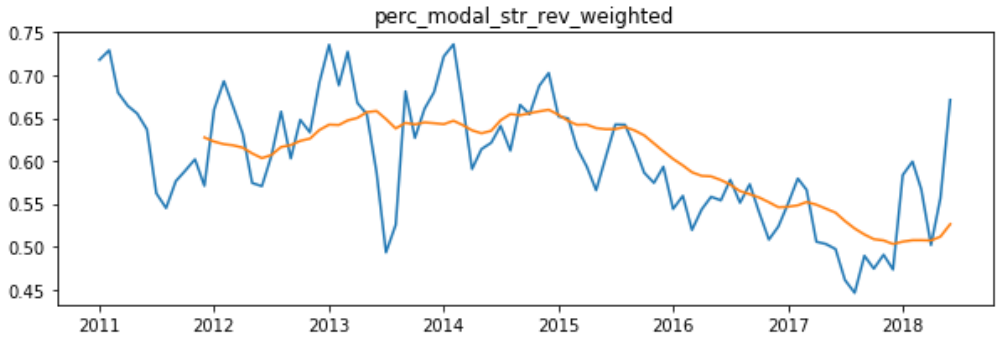
In [15]:
```
# Create function that displays three plots comparing transformations
# First two plots are same as above
# Third plot includes rolling mean and rolling standar deviation

def three_plots(x, x_log, x_log_diff):
    fig, (ax1, ax2, ax3) = plt.subplots(3, 1, figsize=(10,12))
    fig.subplots_adjust(hspace=0.5)
    rm1 = x.rolling(window=12).mean()
    rm2 = x_log.rolling(window=12).mean()
    rm3 = x_log_diff.rolling(window=12).mean()
    rsd3 = x_log_diff.rolling(window=12).std()
    ax1.plot(data['date'], x)
    ax1.plot(data['date'], rm1)
    ax1.set_title(x.name)
    ax2.plot(data['date'], x_log)
    ax2.plot(data['date'], rm2)
    ax2.set_title(x_log.name)
    ax3.plot(data['date'], x_log_diff)
    ax3.plot(data['date'], rm3)
    ax3.plot(data['date'], rsd3)
    ax3.set_title(x_log_diff.name)
    plt.show()
```

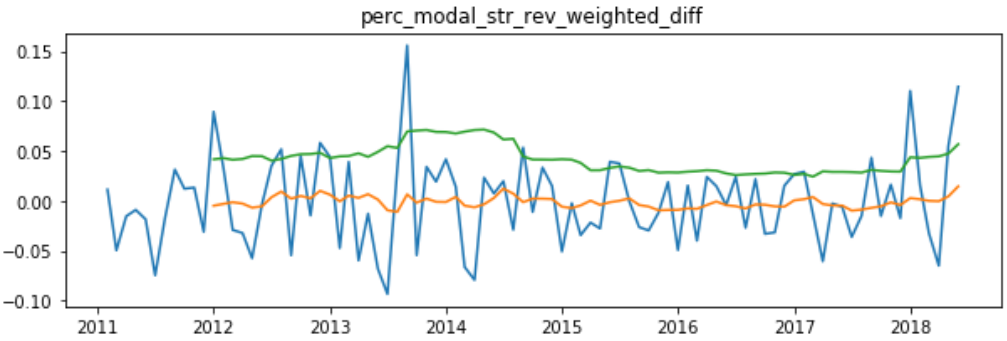
In [16]:
```
two_plots(data['perc_modal_str_rev_weighted'], data['perc_modal_str_rev_weighted
'])
```

In [17]:
```
# Difference the feature order 2
data['perc_modal_str_rev_weighted_diff'] = data['perc_modal_str_rev_weighted'] - d
ata['perc_modal_str_rev_weighted'].shift(1)
```

In [18]:
```
three_plots(data['perc_modal_str_rev_weighted'], data['perc_modal_str_rev_weighted
'], data['perc_modal_str_rev_weighted_diff'])
```







In [19]:
```
# Set comlumns to test for stationarity after transformations
test_columns = ['perc_modal_str_rev_weighted_diff']
```

In [20]:
```
# Run the Dickey-Fuller test on the stationary features
for column in data[test_columns]:
    print ("\nTest Variable: {}\n".format(column))
    adf_test(data[column].dropna())
```

```
Test Variable: perc_modal_str_rev_weighted_diff

Results of Dickey-Fuller Test:
Test Statistic                -6.546560e+00
p-value                        9.068607e-09
#Lags Used                     6.000000e+00
Number of Observations Used    8.200000e+01
Critical Value (1%)           -3.512738e+00
Critical Value (5%)           -2.897490e+00
Critical Value (10%)          -2.585949e+00
dtype: float64
```

In [21]:
```
# List all the features in the dataframe
print (data.columns)
```

```
Index(['perc_pos_rev_weighted', 'perc_neg_rev_weighted',
       'perc_uncert_rev_weighted', 'perc_litig_rev_weighted',
       'perc_modal_wk_rev_weighted', 'perc_modal_mod_rev_weighted',
       'perc_modal_str_rev_weighted', 'perc_constrain_rev_weighted', 'date',
       'perc_modal_str_rev_weighted_diff'],
      dtype='object')
```

In [22]:
```
# Drop non-stationary feature
data = data.drop(data.columns[[6]], axis=1)
```

In [23]:
```
# Copy to stationary dataframe
data_stationary = data.copy()
```

In [24]:
```
# Rename stationary features
data_stationary = data_stationary[[ 'date', 'perc_pos_rev_weighted', 'perc_neg_rev
_weighted',
       'perc_uncert_rev_weighted', 'perc_litig_rev_weighted',
       'perc_modal_wk_rev_weighted', 'perc_modal_mod_rev_weighted',
       'perc_constrain_rev_weighted',
       'perc_modal_str_rev_weighted_diff']]
```

In [25]:
```
# Confirm the stationary columns are in the new dataframe
print (data_stationary.columns)
```

```
Index(['date', 'perc_pos_rev_weighted', 'perc_neg_rev_weighted',
       'perc_uncert_rev_weighted', 'perc_litig_rev_weighted',
       'perc_modal_wk_rev_weighted', 'perc_modal_mod_rev_weighted',
       'perc_constrain_rev_weighted', 'perc_modal_str_rev_weighted_diff'],
      dtype='object')
```

In [26]:
```
# Drop observations that have Nan from differencing
data_stationary = data_stationary.dropna()
```

In [27]:
```
# Confirm shape of stationary dataframe
data_stationary.shape
```

Out[27]: (89, 9)

In [28]:
```
# Output to CSV
data_stationary.to_csv("data/rev_means_vars_stationary.csv", sep=",", index=False)
```