jupyter Zillow_California_prices Last Checkpoint: 11/08/2021 (autosaved)

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Run Code

In [1]:
```
import numpy as np
import pandas as pd
import statsmodels.api as sm
from statsmodels.tsa.api import VAR
from statsmodels.tsa.statespace.sarimax import SARIMAX
import matplotlib.pyplot as plt
from statsmodels.tsa.stattools import adfuller
from statsmodels.tsa.base.datetools import dates_from_str
from sklearn.metrics import mean_squared_error

def diff(data, interval=1):
    diff = list()
    for i in range(interval, len(data)):
        value = data[i] - data[i - interval]
        diff.append(value)

    return diff

def plot_graph(title, data, color, name):
    fig, ax = plt.subplots(figsize=(12, 6))

    ax.plot(data, color=color)



    ax.grid(True, 'major', linewidth=0.34)
    spines = [ax.spines['bottom'], ax.spines['top'], ax.spines['right'], ax.spines['left']]

    for spine in spines:
        spine.set_visible(False)

    plt.title(title, fontweight=500, fontsize=22)

    plt.savefig(name)
```

In [2]:
```
df_zillow = pd.read_csv('data/zillow-california.csv', index_col='Date')
df_zillow = df_zillow[~df_zillow['MedianSoldPrice_AllHomes.California'].isnull()]
df_zillow.index = dates_from_str(df_zillow.index)
```

In [3]:
```
df_zillow.shape
```

Out[3]: (95, 3)

In [4]:
```
df_zillow.columns
```

Out[4]:
```
Index(['MedianSoldPrice_AllHomes.California', 'MedianMortageRate',
       'UnemploymentRate'],
      dtype='object')
```

In [5]:
```
df_zillow.tail()
```

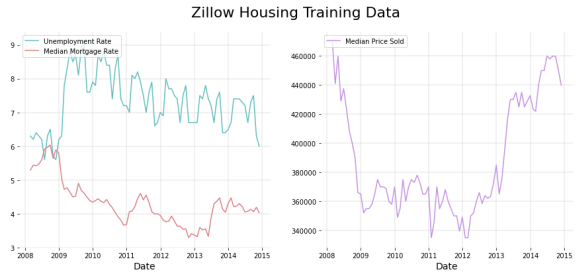
Out[5]:

	MedianSoldPrice_AllHomes.California	MedianMortageRate	UnemploymentRate
2015-08-31	475000.0	3.95	5.2
2015-09-30	470000.0	3.87	5.1
2015-10-31	470000.0	3.80	5.0
2015-11-30	485750.0	3.69	5.0
2015-12-31	485000.0	3.89	5.1

In [6]:
```
X = df_zillow[['MedianMortageRate', 'UnemploymentRate']]
y = df_zillow[['MedianSoldPrice_AllHomes.California']]
```

In [7]:
```
X_train = X.loc[:'11-30-2014']
y_train = y.loc[:'11-30-2014']
X_valid = X.loc['12-01-2014':'11-30-2015']
y_valid = y.loc['12-01-2014':'11-30-2015']
```

In [8]:
```
fig, axes = plt.subplots(1, 2, figsize=(15, 6))

axes[0].plot(X_train['UnemploymentRate'], label='Unemployment Rate', color='#61c0bf')
axes[0].plot(X_train['MedianMortageRate'], label="Median Mortgage Rate", color='#DC8185')
axes[1].plot(y_train, label="Median Price Sold", color='#C493E3')

for ax in axes:
    ax.grid(True, 'major', linewidth=0.34)
    ax.legend(loc='upper left')

    ax.set_xlabel("Date", fontweight=530, fontsize=14)
#ax.set_ylabel('Beer Drunk (Liters)', fontweight=530, fontsize=13)
    spines = [ax.spines['bottom'], ax.spines['top'], ax.spines['right'], ax.spines['left']]

    for spine in spines:
        spine.set_visible(False)

plt.title("Zillow Housing Training Data", fontweight=500, fontsize=22, x=-0.1, y=1.05)

plt.savefig('results/Zillow Housing EDA')
```

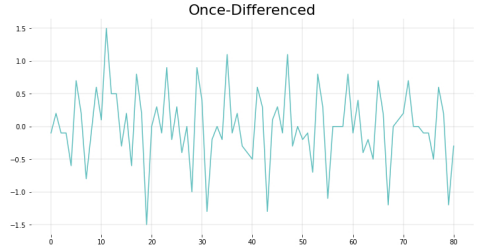


Unemployment Rate:

- Somewhat quadratic? Difference twice to detrend and see what happens
- Seasonality: 1 year cycles (m=12)

In [9]:
```
UnempDiff1 = diff(X_train['UnemploymentRate'], 1)
```

In [10]:
```
plot_graph("Once-Differenced", UnempDiff1, '#61c0bf', 'results/Unemployment-1D.png')
```

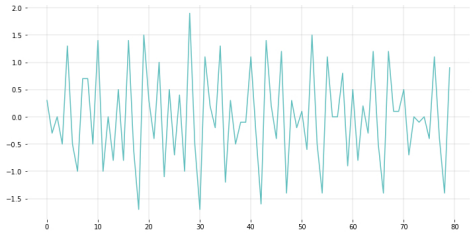


In [11]:
```
dftest = adfuller(UnempDiff1, autolag='BIC')
UnemploymentTest = pd.Series(dftest[0:2], index=['Test Statistic','p-value'])
UnemploymentTest
```

Out[11]:
```
Test Statistic   -1.566814
p-value           0.500239
dtype: float64
```

In [12]:
```
UnempDiff2 = diff(UnempDiff1, 1)
```

In [13]:
```
plot_graph("Twice-Differenced", UnempDiff2, '#61c0bf',  'results/Unemployment-2D.png')
```



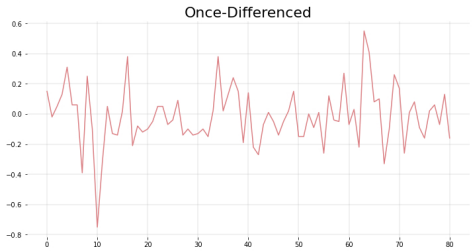
In [14]:
```
dftest = adfuller(UnempDiff2, autolag='BIC')
UnemploymentTest = pd.Series(dftest[0:2], index=['Test Statistic','p-value'])
UnemploymentTest
```

Out[14]:
```
Test Statistic   -1.436825e+01
p-value           9.590671e-27
dtype: float64
```

Median Mortgage Rate

- Linear, difference once
- Around a two year seasonality: m=24

In [17]:
```
MortRateDiff1 = diff(X_train['MedianMortageRate'], 1)
plot_graph('Once-Differenced', MortRateDiff1, '#DC8185', 'results/Median-Mortgage-1D.png')
```



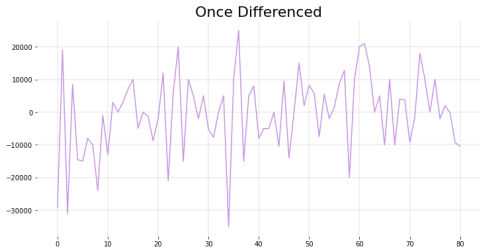
In [18]:
```
dftest = adfuller(MortRateDiff1, autolag='BIC')
MortRateTest = pd.Series(dftest[0:2], index=['Test Statistic','p-value'])
MortRateTest
```

Out[18]:
```
Test Statistic   -7.895040e+00
p-value           4.333583e-12
dtype: float64
```

Median Price Sold

- Also shows quadratic nature: difference twice

In [21]:
```
MedPriceDiff1 = diff(y_train['MedianSoldPrice_AllHomes.California'], 1)
plot_graph('Once Differenced', MedPriceDiff1, '#C493E3', 'results/Median-Price-1D.png')
```



In [22]:
```
dftest = adfuller(MedPriceDiff1, autolag='BIC')
MedPriceTest = pd.Series(dftest[0:2], index=['Test Statistic','p-value'])
MedPriceTest
```

Out[22]:
```
Test Statistic   -1.080568e+01
p-value           1.966155e-19
dtype: float64
```

EDA Conclusion:

-since Unemployment Rate needs to be twice differenced to become stationary, all other columns will follow suit

In [23]:
```
# MedPrice_Col2 = diff(MedPrice_Col, 1)
# MortRate_Col2 = diff(MortRate_Col, 1)
# zillow_diff = pd.DataFrame({'UnemploymentRate': Unemployment_Col,
#                             'MedianMortgageRate': MortRate_Col2,
#                             'MedianPriceSold': MedPrice_Col2
#                            })
# zillow_diff

zillow_diff = df_zillow.diff().dropna()
zillow_diff = zillow_diff.diff().dropna()
zillow_diff_train = zillow_diff.loc[:'11-30-2014']
zillow_diff_test  = zillow_diff.loc['12-1-2014':]
```

In [24]:
```
fig, axes = plt.subplots(1, 3, figsize=(20, 6))

axes[0].plot(zillow_diff_train['UnemploymentRate'], label='Unemployment Rate', color='#61c0bf')
axes[1].plot(zillow_diff_train['MedianMortgageRate'], label="Median Mortgage Rate", color='#DC8185')
axes[2].plot(zillow_diff_train['MedianSoldPrice_AllHomes.California'], label="Median Price Sold", color='#C493E3')

for ax in axes:
    ax.grid(True, 'major', linewidth=0.34)
    ax.legend(loc='upper left')

    ax.set_xlabel("Date", fontweight=530, fontsize=14)
#ax.set_ylabel("Beer Drunk (Liters)", fontweight=530, fontsize=13)
    spines = [ax.spines['bottom'], ax.spines['top'], ax.spines['right'], ax.spines['left']]

    for spine in spines:
        spine.set_visible(False)

plt.title("Twice Differenced Training Data", fontweight=500, fontsize=22, x=-.75, y=1.05)

plt.savefig('results/Zillow-Housing-2D-EDA.png')
```

- Everything is now stationary
- Let's normalize so that all columns are between 0 and 1

- Doing so because we are using a regression function which is sensitive to scale

In [25]:
```
from sklearn.preprocessing import MinMaxScaler
scaler = MinMaxScaler(feature_range=(0, 1))
scaled_input = scaler.fit_transform(zillow_diff_train)
zillow_diff_scaled = pd.DataFrame(scaled_input)
cols = zillow_diff_train.columns
zillow_diff_scaled.rename(columns = {0:cols[0], 1:cols[1], 2:cols[2]}, inplace=True)
zillow_diff_scaled.head()
```

Out[25]:

	MedianSoldPrice_AllHomes.California	MedianMortageRate	UnemploymentRate
0	1.000000	0.338028	0.555556
1	0.000000	0.507042	0.388889
2	0.913265	0.514085	0.472222
3	0.275510	0.584507	0.333333
4	0.505102	0.281690	0.833333

In [26]:
```
df_zillow = df_zillow.rename(columns={"MedianSoldPrice_AllHomes.California":"MedianPriceSold",
                                      "MedianMortageRate":"MedianMortgageRate"
})
zillow_diff_scaled = zillow_diff_scaled.rename(columns={"MedianSoldPrice_AllHomes.California":"MedianPriceSold",
                                      "MedianMortageRate":"MedianMortgageRate"
})
```

In [27]:
```
fig, axes = plt.subplots(1, 3, figsize=(20, 6))

axes[0].plot(zillow_diff_scaled['UnemploymentRate'], label='Unemployment Rate', color='#61c0bf')
axes[1].plot(zillow_diff_scaled['MedianMortgageRate'], label="Median Mortgage Rate", color='#DC8185')
axes[2].plot(zillow_diff_scaled['MedianPriceSold'], label="Median Price Sold", color='#C493E3')

for ax in axes:
    ax.grid(True, 'major', linewidth=0.34)
    ax.legend(loc='upper left')

    ax.set_xlabel("Date", fontweight=530, fontsize=14)
#ax.set_ylabel('Beer Drunk (Liters)', fontweight=530, fontsize=13)
    spines = [ax.spines['bottom'], ax.spines['top'], ax.spines['right'], ax.spines['left']]

    for spine in spines:
        spine.set_visible(False)

plt.title("Zillow Housing Differenced Train Data (Scaled)", fontweight=500, fontsize=22, x=-.75, y=1.05)

plt.show()
```

In [28]:
```
model = VAR(zillow_diff_scaled)
results = model.fit(maxlags=15, ic='bic')
results.summary()
```

Out[28]:

```
  Summary of Regression Results
==================================
Model:                         VAR
Method:                        OLS
Date:           Mon, 08, Nov, 2021
Time:                     19:17:02
--------------------------------------------------------------------
No. of Equations:         3.00000    BIC:                   -10.6017
Nobs:                     75.0000    HQIC:                  -11.4927
Log likelihood:           181.922    FPE:                5.75806e-06
AIC:                     -12.0849    Det(Omega_mle):     3.22356e-06
--------------------------------------------------------------------
Results for equation MedianPriceSold
================================================================================
                       coefficient       std. error           t-stat            prob
--------------------------------------------------------------------------------
const                     0.808931         0.266405            3.036           0.002
L1.MedianPriceSold       -0.807157         0.135795           -5.944           0.000
L1.MedianMortgageRate     0.038633         0.066047            0.585           0.559
L1.UnemploymentRate       0.131373         0.056569            2.322           0.020
L2.MedianPriceSold       -0.521436         0.151130           -3.450           0.001
L2.MedianMortgageRate     0.077491         0.078102            0.992           0.321
L2.UnemploymentRate       0.134453         0.076314            1.762           0.078
L3.MedianPriceSold       -0.214626         0.140026           -1.533           0.125
L3.MedianMortgageRate     0.132654         0.085020            1.560           0.119
L3.UnemploymentRate       0.403773         0.082506            4.894           0.000
L4.MedianPriceSold       -0.024349         0.120712           -0.202           0.840
L4.MedianMortgageRate    -0.062845         0.078180           -0.804           0.421
L4.UnemploymentRate       0.299898         0.097189            3.086           0.002
L5.MedianPriceSold       -0.070050         0.082012           -0.854           0.393
L5.MedianMortgageRate     0.063569         0.067940            0.936           0.349
L5.UnemploymentRate      -0.070137         0.079234           -0.885           0.376
================================================================================

Results for equation MedianMortgageRate
================================================================================
                       coefficient       std. error           t-stat            prob
--------------------------------------------------------------------------------
const                     0.360321         0.494555            0.729           0.466
L1.MedianPriceSold       -0.163778         0.252091           -0.650           0.516
L1.MedianMortgageRate    -0.700044         0.122609           -5.710           0.000
L1.UnemploymentRate       0.081409         0.105014            0.775           0.438
L2.MedianPriceSold        0.204519         0.280558            0.729           0.466
L2.MedianMortgageRate    -0.636471         0.144989           -4.390           0.000
L2.UnemploymentRate      -0.002091         0.141670           -0.015           0.988
L3.MedianPriceSold        0.302594         0.259945            1.164           0.244
L3.MedianMortgageRate    -0.356814         0.157831           -2.261           0.024
L3.UnemploymentRate       0.140902         0.153165            0.920           0.358
L4.MedianPriceSold        0.507503         0.224089            2.265           0.024
L4.MedianMortgageRate    -0.047946         0.145134           -0.330           0.741
L4.UnemploymentRate       0.229897         0.180422            1.274           0.203
L5.MedianPriceSold        0.383198         0.152247            2.517           0.012
L5.MedianMortgageRate    -0.094017         0.126125           -0.745           0.456
L5.UnemploymentRate       0.189584         0.147091            1.289           0.197
================================================================================

Results for equation UnemploymentRate
================================================================================
                       coefficient       std. error           t-stat            prob
--------------------------------------------------------------------------------
const                     2.789087         0.542785            5.138           0.000
L1.MedianPriceSold        0.322277         0.276676            1.165           0.244
L1.MedianMortgageRate     0.077964         0.134567            0.579           0.562
L1.UnemploymentRate      -0.956789         0.115255           -8.301           0.000
L2.MedianPriceSold        0.306579         0.307919            0.996           0.319
L2.MedianMortgageRate     0.179395         0.159129            1.127           0.260
L2.UnemploymentRate      -0.974701         0.155486           -6.269           0.000
L3.MedianPriceSold       -0.244309         0.285296           -0.856           0.392
L3.MedianMortgageRate    -0.137769         0.173223           -0.795           0.426
L3.UnemploymentRate      -0.763859         0.168102           -4.544           0.000
L4.MedianPriceSold       -0.540047         0.245943           -2.196           0.028
L4.MedianMortgageRate    -0.219592         0.159288           -1.379           0.168
L4.UnemploymentRate      -0.800094         0.198017           -4.041           0.000
L5.MedianPriceSold       -0.509329         0.167095           -3.048           0.002
L5.MedianMortgageRate    -0.037279         0.138425           -0.269           0.788
L5.UnemploymentRate      -0.563706         0.161436           -3.492           0.000
================================================================================

Correlation matrix of residuals
                     MedianPriceSold  MedianMortgageRate  UnemploymentRate
MedianPriceSold             1.000000           -0.072780          0.289204
MedianMortgageRate         -0.072780            1.000000          0.250494
UnemploymentRate            0.289204            0.250494          1.000000
```

Forecast Analysis

- Now that we have our forecast, we will:
  1. Unscale all columns
  2. Undifference all columns

In [30]:
```
test = pd.read_csv('data/test.csv', index_col='Month')
test.index = dates_from_str(test.index)
```

In [31]:
```
X_valid
```

Out[31]:

	MedianMortgageRate	UnemploymentRate

2014-12-31	3.90	6.2
2015-01-31	3.85	6.2
2015-02-28	3.89	5.7
2015-03-31	3.91	5.5
2015-04-30	3.79	5.4
2015-05-31	3.73	5.4
2015-06-30	3.85	5.6
2015-07-31	3.87	5.3
2015-08-31	3.95	5.2
2015-09-30	3.87	5.1
2015-10-31	3.80	5.0
2015-11-30	3.69	5.0