SARIMA

In [ ]:

```
from statsmodels.graphics.tsaplots import plot_pacf
from statsmodels.graphics.tsaplots import plot_acf
from statsmodels.tsa.statespace.sarimax import SARIMAX
from statsmodels.tsa.holtwinters import ExponentialSmoothing
from statsmodels.tsa.stattools import adfuller
import matplotlib.pyplot as plt
from tqdm import tqdm_notebook
import numpy as np
import pandas as pd

from itertools import product

import warnings
warnings.filterwarnings('ignore')

%matplotlib inline
```

Johnson and Johnson Quaterly Earnings

In [3]:

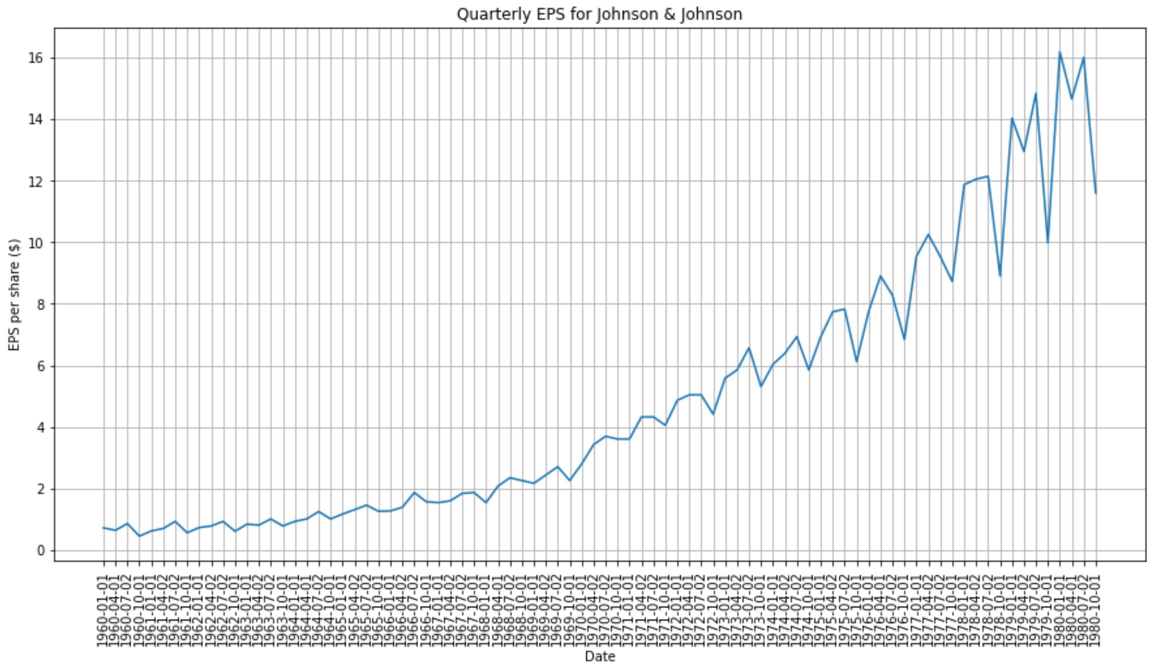
```
data = pd.read_csv('./data/jj.csv')
data.head()
```

Out[3]:

	date	data
0	1960-01-01	0.71
1	1960-04-01	0.63
2	1960-07-02	0.85
3	1960-10-01	0.44
4	1961-01-01	0.61

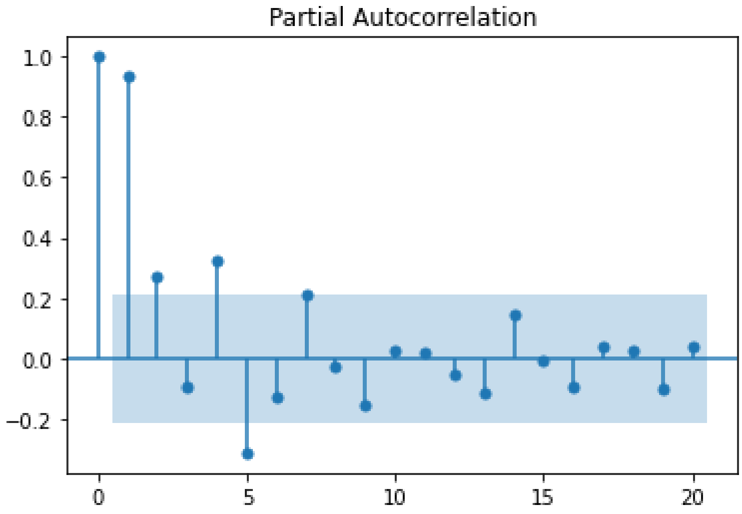
In [5]:

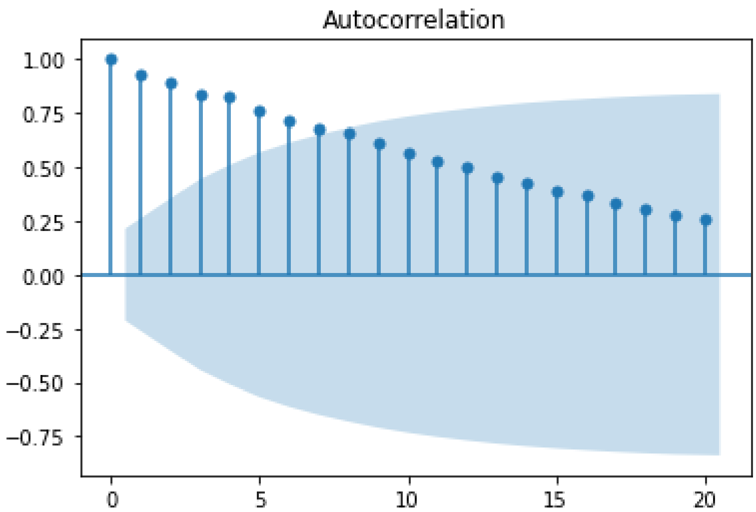
```
plt.figure(figsize=[15, 7.5]); # Set dimensions for figure
plt.plot(data['date'], data['data'])
plt.title('Quarterly EPS for Johnson & Johnson')
plt.ylabel('EPS per share ($)')
plt.xlabel('Date')
plt.xticks(rotation=90)
plt.grid(True)
plt.show()
```



In [6]:

```
plot_pacf(data['data']);
plot_acf(data['data']);
```





In [7]:

```
# Augmented Dickey-Fuller test

ad_fuller_result = adfuller(data['data'])
print(f'ADF Statistic: {ad_fuller_result[0]}')
print(f'p-value: {ad_fuller_result[1]}')
```

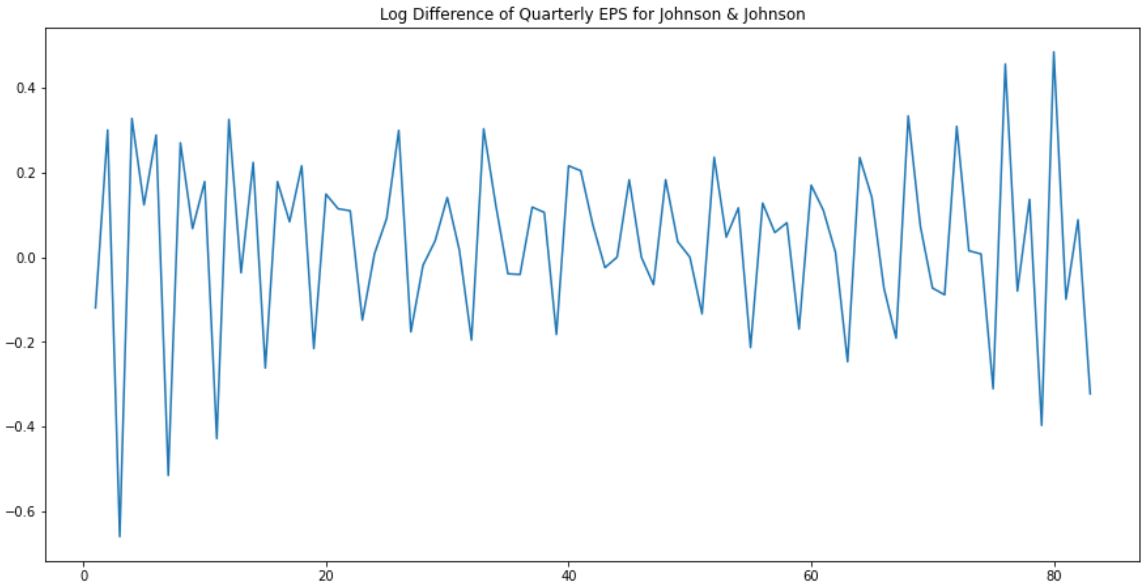
```
ADF Statistic: 2.7420165734574766
p-value: 1.0
```

In [8]:

```
# Take the log difference to make data stationary

data['data'] = np.log(data['data'])
data['data'] = data['data'].diff()
data = data.drop(data.index[0])
```

In [9]:

```
plt.figure(figsize=[15, 7.5]); # Set dimensions for figure
plt.plot(data['data'])
plt.title("Log Difference of Quarterly EPS for Johnson & Johnson")
plt.show()
```



In [10]:

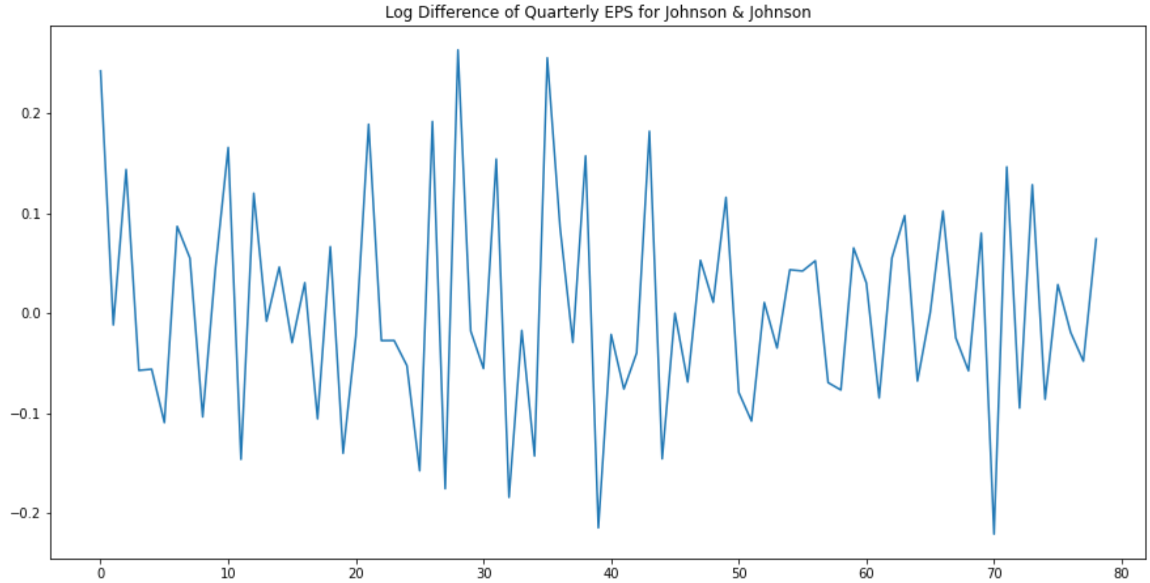
```
# Seasonal differencing

data['data'] = data['data'].diff(4)
data = data.drop([1, 2, 3, 4], axis=0).reset_index(drop=True)
data.head()
```

Out[10]:

	date	data
0	1961-04-02	0.242778
1	1961-07-02	-0.011834
2	1961-10-01	0.144006
3	1962-01-01	-0.057351
4	1962-04-02	-0.056093

In [11]:

```
plt.figure(figsize=[15, 7.5]); # Set dimensions for figure
plt.plot(data['data'])
plt.title("Log Difference of Quarterly EPS for Johnson & Johnson")
plt.show()
```



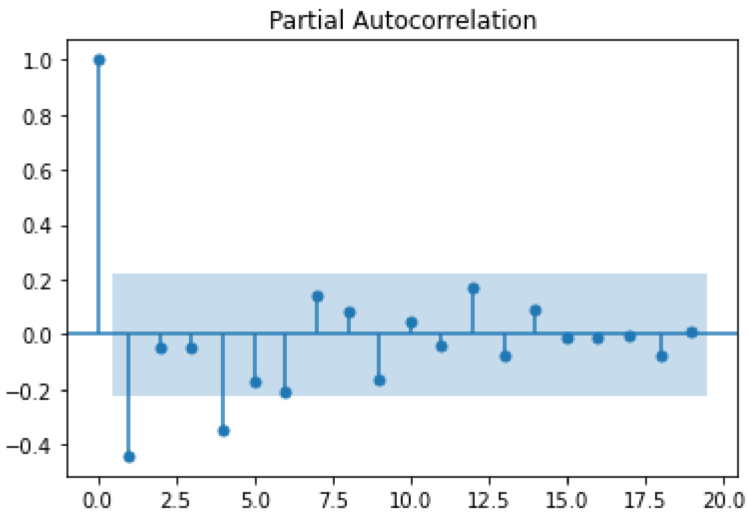
In [12]:

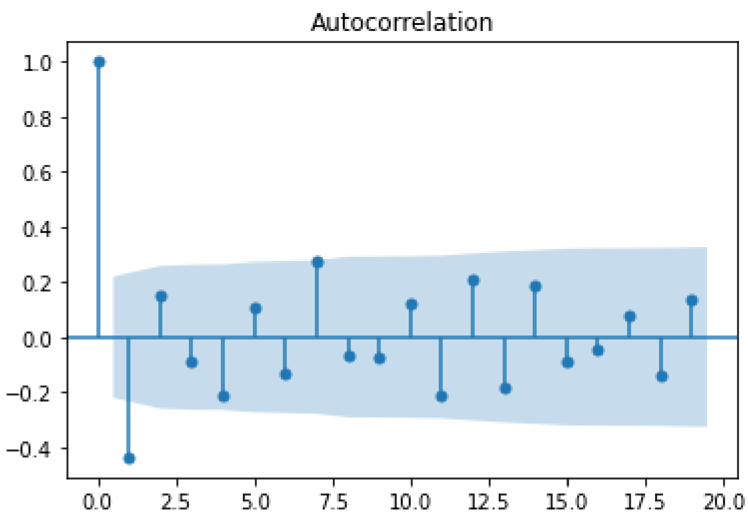
```
# Augmented Dickey-Fuller test

ad_fuller_result = adfuller(data['data'])
print(f'ADF Statistic: {ad_fuller_result[0]}')
print(f'p-value: {ad_fuller_result[1]}')
```

```
ADF Statistic: -6.630805109914262
p-value: 5.72157869513621e-09
```

In [13]:

```
plot_pacf(data['data']);
plot_acf(data['data']);
```





In [14]:

```
def optimize_SARIMA(parameters_list, d, D, s, exog):
    """
        Return dataframe with parameters, corresponding AIC and SSE

        parameters_list - list with (p, q, P, Q) tuples
        d - integration order
        D - seasonal integration order
        s - length of season
        exog - the exogenous variable
    """

    results = []

    for param in tqdm_notebook(parameters_list):
        try:
            model = SARIMAX(exog, order=(param[0], d, param[1]), seasonal_order=(param[
2], D, param[3], s)).fit(disp=-1)
        except:
            continue

        aic = model.aic
        results.append([param, aic])

    result_df = pd.DataFrame(results)
    result_df.columns = ['(p,q)x(P,Q)', 'AIC']
    #Sort in ascending order, lower AIC is better
    result_df = result_df.sort_values(by='AIC', ascending=True).reset_index(drop=True)

    return result_df
```

In [15]:

```
p = range(0, 4, 1)
d = 1
q = range(0, 4, 1)
P = range(0, 4, 1)
D = 1
Q = range(0, 4, 1)
s = 4

parameters = product(p, q, P, Q)
parameters_list = list(parameters)
print(len(parameters_list))
```

256

In [16]:

```
result_df = optimize_SARIMA(parameters_list, 1, 1, 4, data['data'])
result_df
```

Out[16]:

	(p,q)x(P,Q)	AIC
0	(0, 2, 0, 2)	-114.463302
1	(0, 2, 1, 2)	-114.254288
2	(0, 2, 1, 3)	-113.492421
3	(0, 2, 2, 2)	-113.093774
4	(0, 2, 0, 3)	-113.076516
...	...	...
251	(0, 0, 1, 1)	-24.752955
252	(0, 0, 0, 1)	-23.122474
253	(1, 0, 0, 0)	-19.068826
254	(0, 0, 1, 0)	2.594264
255	(0, 0, 0, 0)	25.090985

256 rows × 2 columns

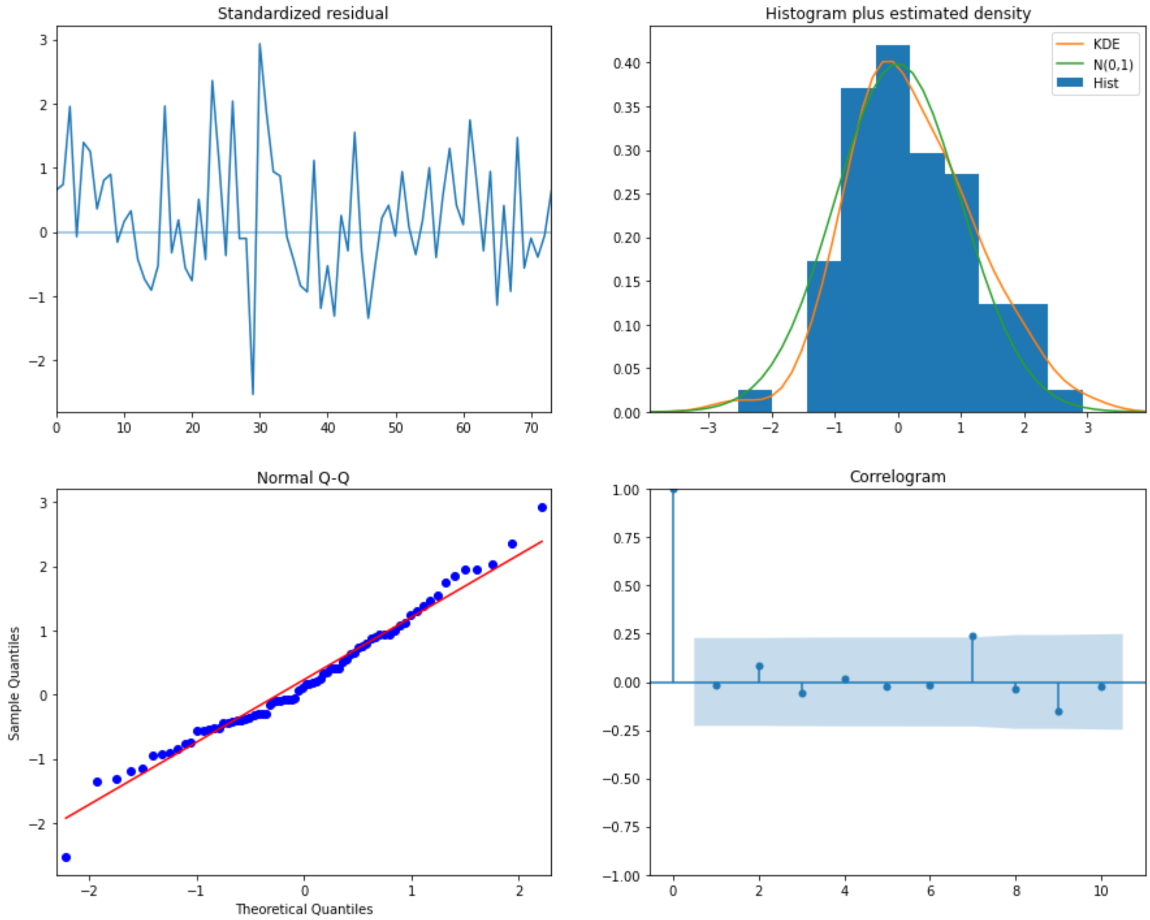
In [17]:

```
best_model = SARIMAX(data['data'], order=(0, 1, 2), seasonal_order=(0, 1, 2, 4)).fit(di
s=-1)
print(best_model.summary())
```

```
                                     SARIMAX Results
==========================================================================
===============
Dep. Variable:                                data   No. Observations:
79
Model:               SARIMAX(0, 1, 2)x(0, 1, 2, 4)   Log Likelihood
62.232
Date:                             Sun, 21 Mar 2021   AIC
-114.463
Time:                                     16:57:03   BIC
-102.943
Sample:                                          0   HQIC
-109.868
                                              - 79
Covariance Type:                               opg
==========================================================================
====
                 coef    std err          z      P>|z|      [0.025      0.
975]
--------------------------------------------------------------------------
----
ma.L1         -1.5879      0.169     -9.421      0.000      -1.918      -
1.258
ma.L2          0.5953      0.122      4.883      0.000       0.356
0.834
ma.S.L4       -1.2682      0.144     -8.823      0.000      -1.550      -
0.987
ma.S.L8        0.4446      0.145      3.062      0.002       0.160
0.729
sigma2         0.0087      0.002      4.661      0.000       0.005
0.012
==========================================================================
=========
Ljung-Box (Q):                    41.28   Jarque-Bera (JB):
1.07
Prob(Q):                           0.41   Prob(JB):
0.59
Heteroskedasticity (H):            0.61   Skew:
0.26
Prob(H) (two-sided):               0.22   Kurtosis:
3.26
==========================================================================
=========

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

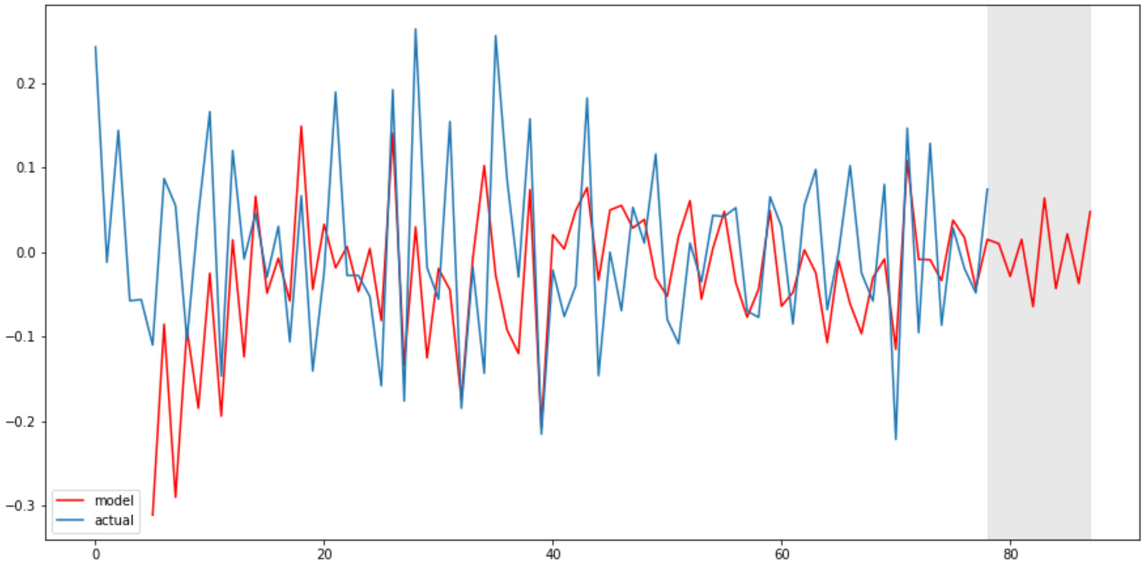
In [18]:

```
best_model.plot_diagnostics(figsize=(15,12));
```



In [27]:

```
data['arima_model'] = best_model.fittedvalues
data['arima_model'][:4+1] = np.NaN # 첫 주기까지(여기서는 4)는 NaN으로 처리하는 듯

forecast = best_model.predict(start=data.shape[0], end=data.shape[0] + 8)
forecast = data['arima_model'].append(forecast)

plt.figure(figsize=(15, 7.5))
plt.plot(forecast, color='r', label='model')
plt.axvspan(data.index[-1], forecast.index[-1], alpha=0.5, color='lightgrey')
plt.plot(data['data'], label='actual')
plt.legend()

plt.show()
```



Exponential Smoothing (Holt-Winters)

In [27]:

```
data = pd.read_csv('jj.csv')
data.shape
```

Out[27]:

```
(84, 2)
```

In [28]:

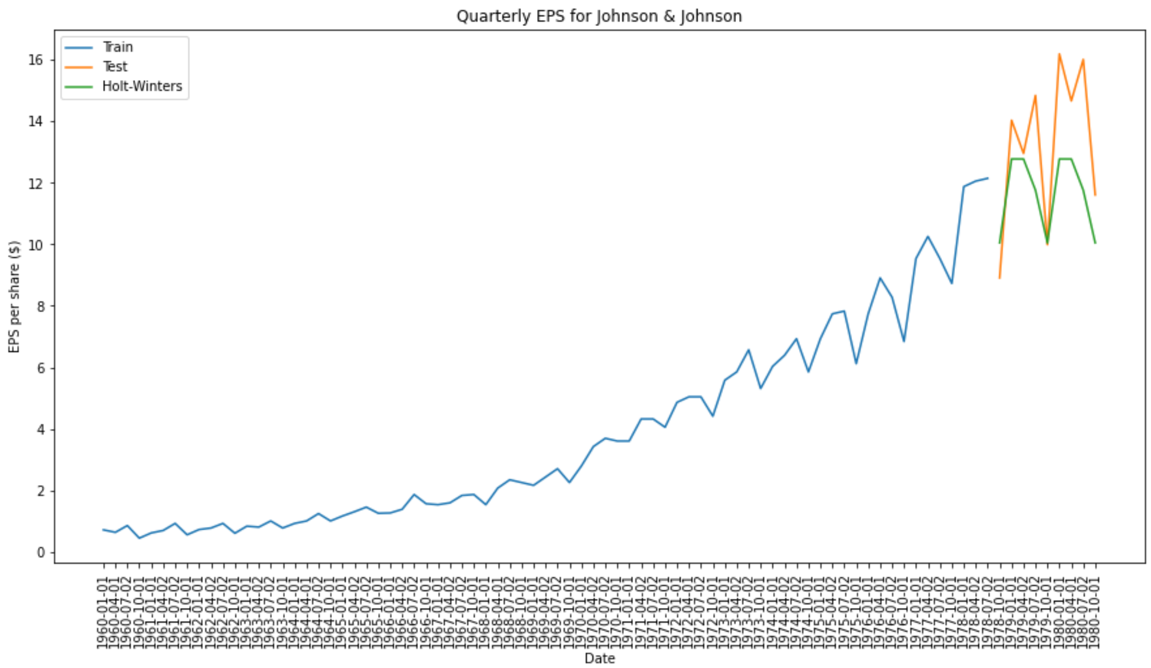
```
train, test = data.iloc[:75,:], data.iloc[75:,:]
```

In [32]:

```
model = ExponentialSmoothing(train['data'], seasonal='mul', seasonal_periods=4).fit()
pred = model.predict(start=test.index[0], end=test.index[-1])
```

In [36]:

```
plt.figure(figsize=(15, 7.5))
plt.plot(train['date'], train['data'], label='Train')
plt.plot(test['date'], test['data'], label='Test')
plt.plot(pred.index, pred, label='Holt-Winters')
plt.title('Quarterly EPS for Johnson & Johnson')
plt.ylabel('EPS per share ($)')
plt.xlabel('Date')
plt.xticks(rotation=90)
plt.legend()
plt.show()
```



In [ ]: