Importing Libraries

In [50]:
```
import numpy as np
import pandas as pd
import seaborn as sns
from matplotlib import pyplot as plt

from statsmodels.tsa.api import ExponentialSmoothing, SimpleExpSmoothing, Holt
from sklearn.linear_model import LinearRegression

import warnings
warnings.filterwarnings('ignore')
```

Uploading Files

In [ ]:
```
file_path = "D:\Amit_Project\Time_series_forecasting\gold_monthly_csv.csv"
df = pd.read_csv(file_path)
```

Time series forecasting

In [5]:
```
df.head()
```

Out[5]:

	Date	Price
0	1950-01	34.73
1	1950-02	34.73
2	1950-03	34.73
3	1950-04	34.73
4	1950-05	34.73

In [7]:
```
df.shape
```

Out[7]:
```
(847, 2)
```

In [8]:
```
print(f"Date range of gold prices vailable from - {df.loc[:,'Date'][0]} to {df.loc
```

```
Date range of gold prices vailable from - 1950-01 to 2020-07
```

In [20]:
```
date = pd.date_range(start='1/1/1950', end='8/1/2020', freq='M')
date
```

Out[20]:
```
DatetimeIndex(['1950-01-31', '1950-02-28', '1950-03-31', '1950-04-30',
               '1950-05-31', '1950-06-30', '1950-07-31', '1950-08-31',
               '1950-09-30', '1950-10-31',
               ...
               '2019-10-31', '2019-11-30', '2019-12-31', '2020-01-31',
               '2020-02-29', '2020-03-31', '2020-04-30', '2020-05-31',
               '2020-06-30', '2020-07-31'],
              dtype='datetime64[ns]', length=847, freq='M')
```

In [22]:
```
df['month']= date
df.drop('Date', axis=1, inplace=True)
df=df.set_index('month')
df.head()
```

Out[22]:

month	Price
1950-01-31	34.73
1950-02-28	34.73
1950-03-31	34.73
1950-04-30	34.73
1950-05-31	34.73

In [26]:
```
df.plot(figsize=(20,8))
plt.title("Gold prices monthly since 1950")
plt.ylabel("price")
plt.grid()
```

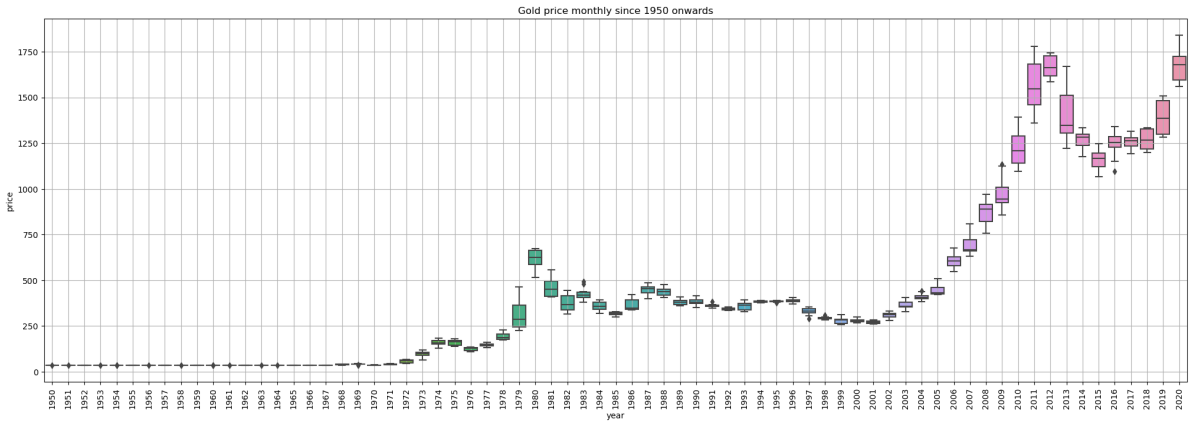
In [27]:
```
round(df.describe(), 3)
```

Out[27]:

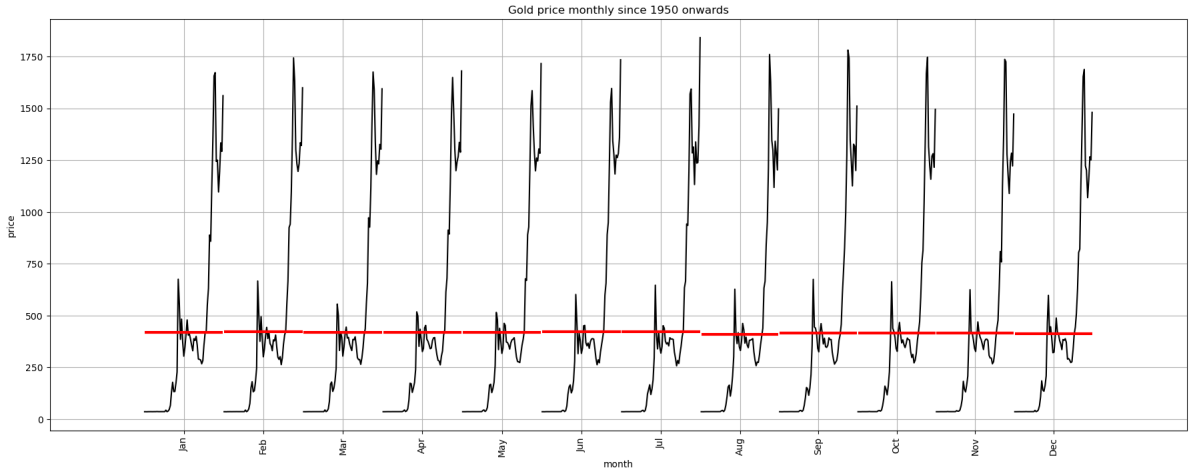
	Price
count	847.000
mean	416.557
std	453.665
min	34.490
25%	35.190
50%	319.622
75%	447.029
max	1840.807

In [30]:
```
_, ax = plt.subplots(figsize=(25,8))
sns.boxplot(x=df.index.year, y=df.values[:,0], ax=ax)
plt.title("Gold price monthly since 1950 onwards")
plt.xlabel('year')
```

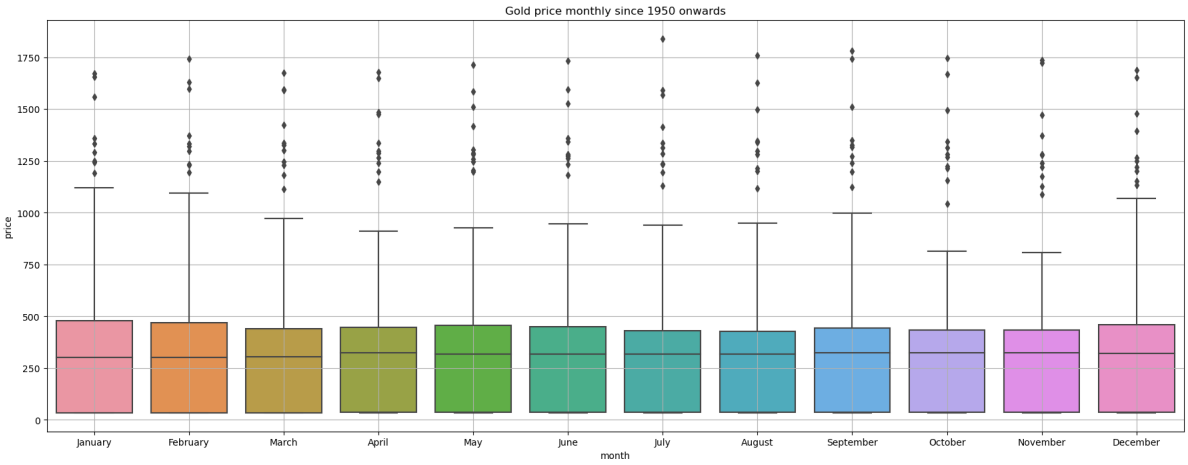
```
plt.ylabel('price')
plt.xticks(rotation = 90)
plt.grid()
```



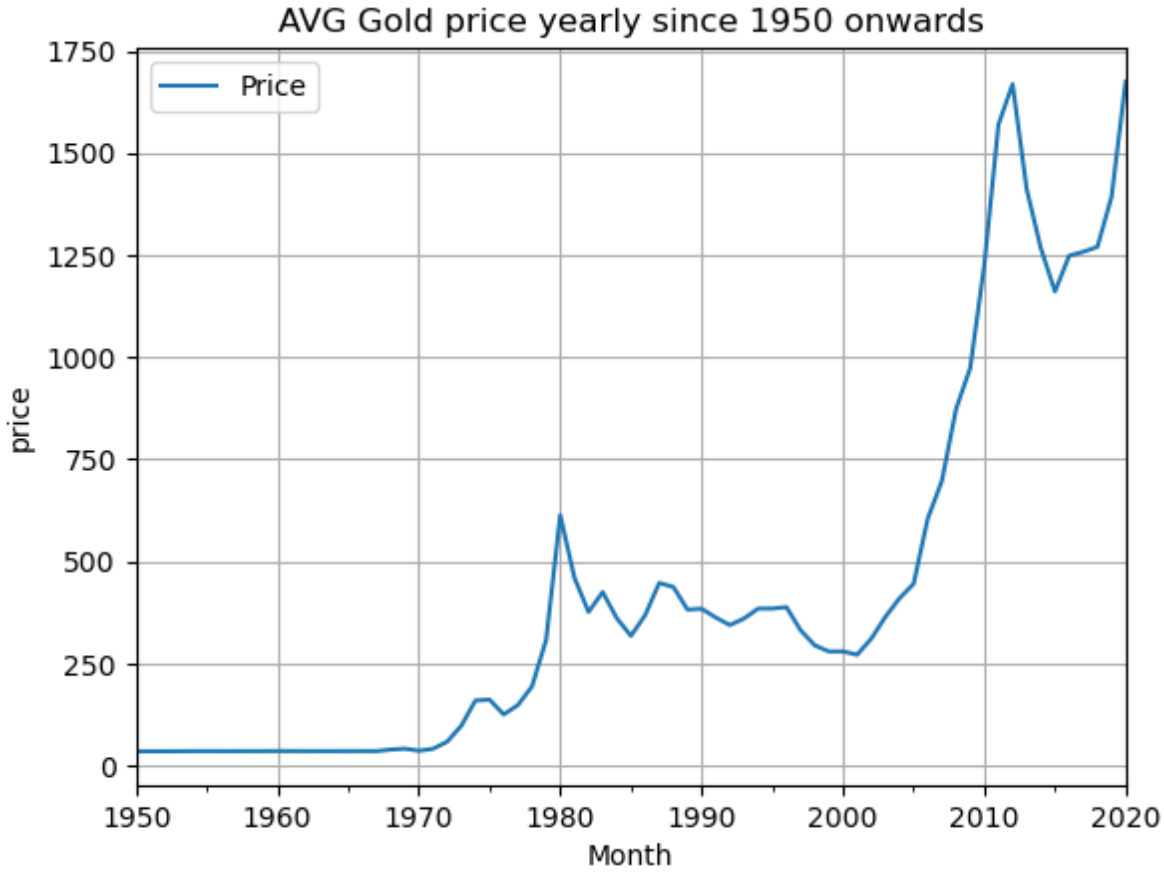
In [32]:
```
from statsmodels.graphics.tsaplots import month_plot

fig, ax = plt.subplots(figsize=(22,8))
month_plot(df, ylabel= 'Gold price', ax=ax)
plt.title("Gold price monthly since 1950 onwards")
plt.xlabel('month')
plt.ylabel('price')
plt.xticks(rotation = 90)
plt.grid()
```



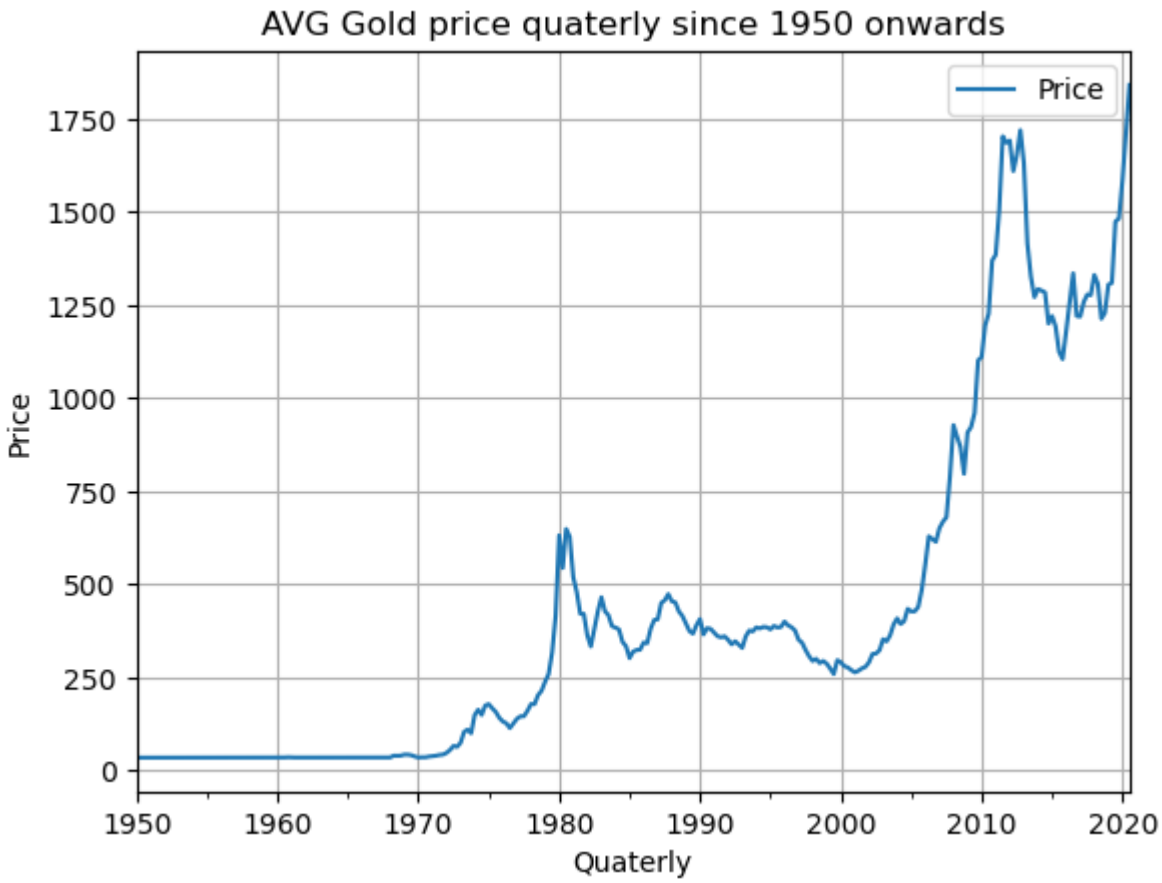
In [33]:
```
_, ax = plt.subplots(figsize=(22,8))
sns.boxplot(x = df.index.month_name(), y = df.values[:,0], ax=ax)
plt.title("Gold price monthly since 1950 onwards")
plt.xlabel('month')
plt.ylabel('price')
plt.grid()
```



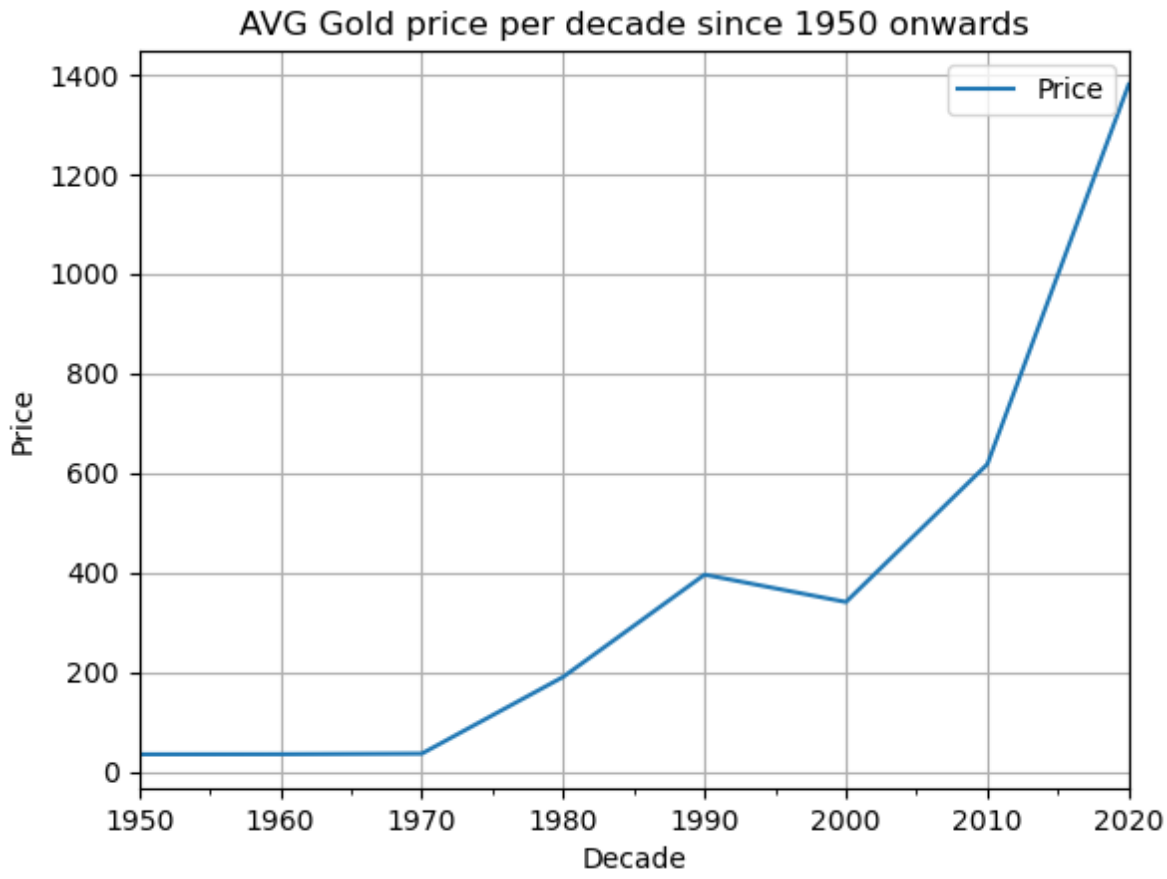
In [55]:
```
#Avg gold price per year since 1950
df_yearly_sum = df.resample('A').mean()
df_yearly_sum.plot()
plt.title("AVG Gold price yearly since 1950 onwards")
plt.xlabel('Month')
plt.ylabel('price')
plt.grid()
```



In [40]:
```
#Avg gold price per Quater since 1950
df_quaterly_sum = df.resample('Q').mean()
df_quaterly_sum.plot();
plt.title("AVG Gold price quaterly since 1950 onwards")
plt.xlabel('Quaterly')
plt.ylabel('Price')
plt.grid()
```



In [42]:
```
#Avg gold price per decade since 1950
df_decade_sum = df.resample('10Y').mean()
df_decade_sum.plot();
plt.title("AVG Gold price per decade since 1950 onwards")
plt.xlabel('Decade')
plt.ylabel('Price')
plt.grid()
```

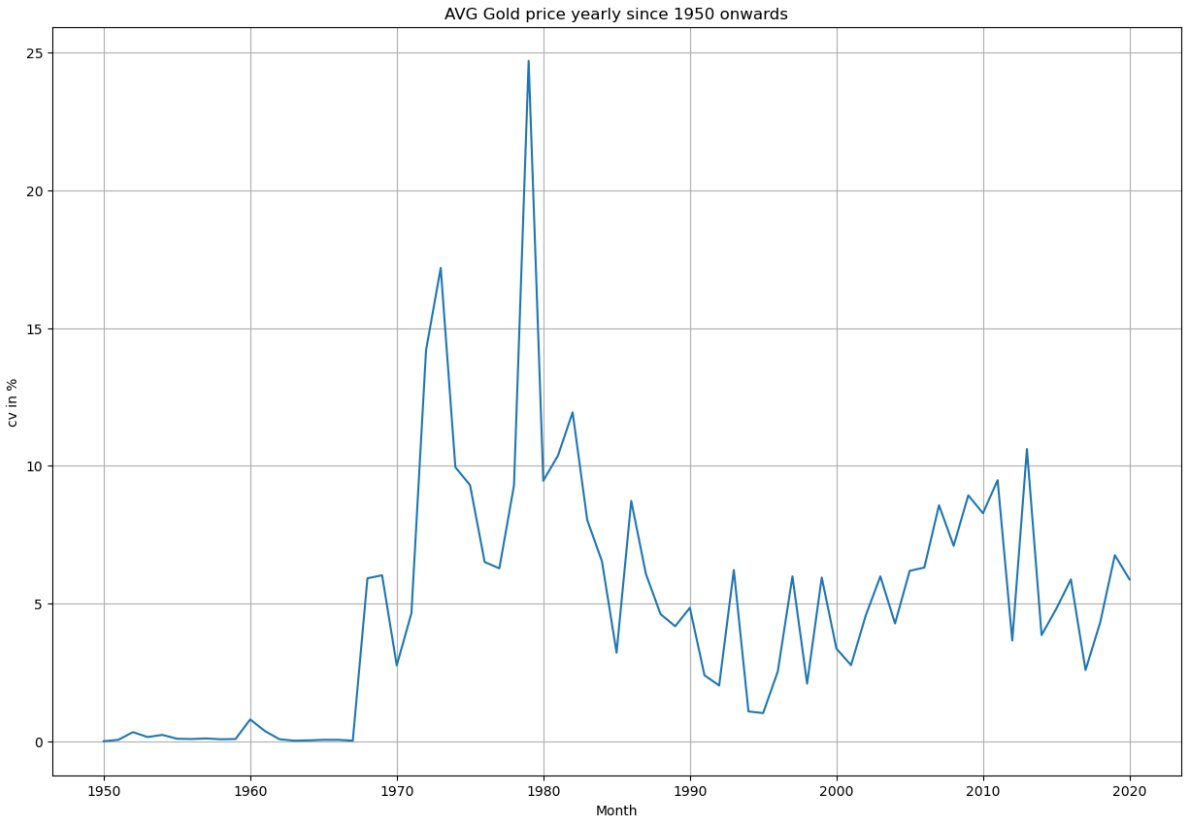


In [54]:
```
# Analyzing coefficient of variation

df_1=df.groupby(df.index.year).mean().rename(columns= {'Price':'Mean'})
df_1=df_1.merge(df.groupby(df.index.year).std().rename(columns={'Price':'Std'}), le
df_1['Cov_pct']= ((df_1['Std']/df_1['Mean'])*100).round(2)
df_1.tail()
```

Out[54]:

month	Mean	Std	Cov_pct
2016	1248.161833	73.454098	5.88
2017	1257.848583	32.529524	2.59
2018	1269.852583	54.900304	4.32
2019	1392.585750	94.198272	6.76
2020	1674.830857	98.431766	5.88

In [136…
```
#Coefficient of Variation
fig, ax = plt.subplots(figsize=(15,10))
df_1['Cov_pct'].plot()
plt.title("AVG Gold price yearly since 1950 onwards")
plt.xlabel('Month')
plt.ylabel('cv in %')
plt.grid()
```



In [58]:
```
train = df[df.index.year <= 2015]
test = df[df.index.year > 2015]
```

In [60]:
```
print(train.shape)
```

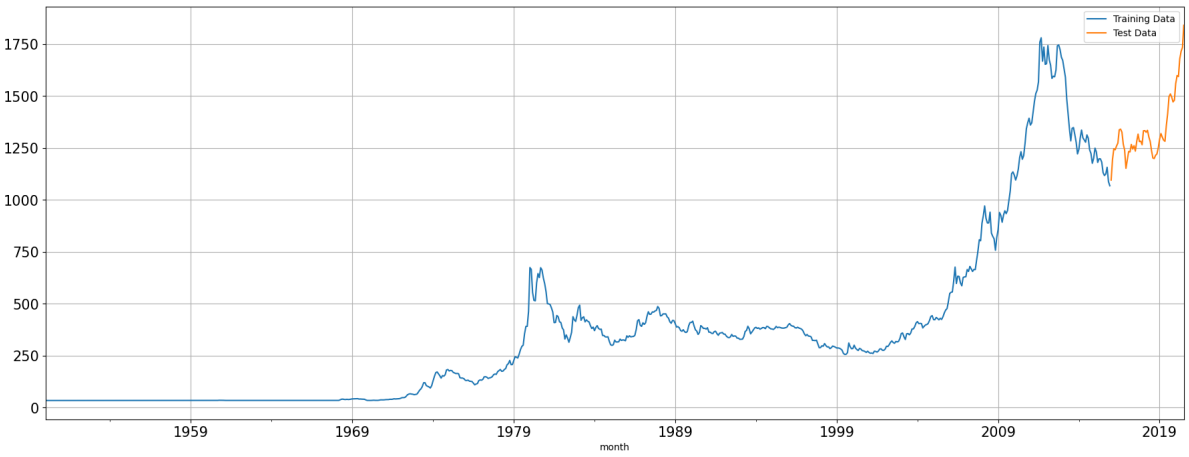
```
(792, 1)
```

In [61]:
```
print(test.shape)
```

```
(55, 1)
```

In [65]:
```
train["Price"].plot(figsize=(22,8), fontsize=15)
test["Price"].plot(figsize=(22,8), fontsize=15)
plt.grid()
plt.legend(['Training Data', 'Test Data'])
```

Out[65]:
```
<matplotlib.legend.Legend at 0x175dabe7cd0>
```



In [67]:
```
train_time = [i+1 for i in range(len(train))]
test_time = [i+len(train)+1 for i in range(len(test))]
len(train_time), len(test_time)
```

Out[67]: (792, 55)

In [68]:
```
LR_train = train.copy()
LR_test =  test.copy()
```

In [71]:
```
LR_train['time'] = train_time
LR_test['time'] = test_time
```

In [130…
```
lr = LinearRegression()
lr.fit(LR_train[['time']], LR_train['Price'].values)
```

Out[130]:
```
▾ LinearRegression
LinearRegression()
```

In [118…
```
test_predictions_model1 = lr.predict(LR_test[['time']])
LR_test['forecast'] =  test_prediction_model1

plt.figure(figsize=(14,6))
plt.plot(train['Price'], label='train')
plt.plot(test['Price'], label='test')
plt.plot(LR_test['forecast'], label='regression on time_test data')
plt.legend(loc = 'best')
plt.grid()
```

In [134…
```
def mape(actual, pred):
    return round((np.mean(abs(actual - pred)/actual))*100, 2)
```

In [135…
```
mape_model1_test = mape(test['Price'].values,test_predictions_model1)
print("Mape is %3.f"%(mape_model1_test),"%")
```

```
Mape is 29.630 %
```

In [120…
```
results = pd.DataFrame({'Test Mape (%)': [mape_model1_test]}, index=['RegressionOnT
results
```

Out[120]:

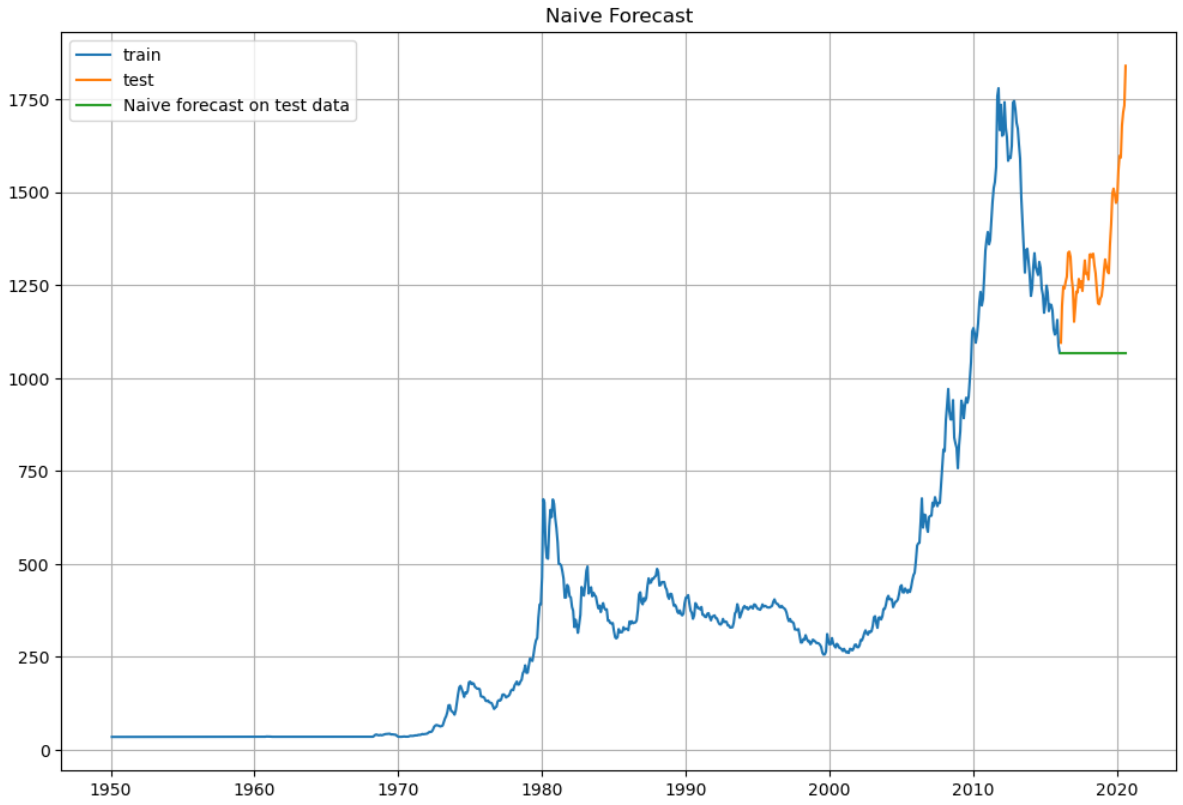
	Test Mape (%)
RegressionOnTime	29.63

In [121…
```
naive_train = train.copy()
naive_test = test.copy()
```

In [122…
```
naive_test['naive']= np.asarray(train["Price"])[len(np.asarray(train["Price"]))-1]
naive_test['naive'].head()
```

Out[122]:
```
month
2016-01-31    1068.317
2016-02-29    1068.317
2016-03-31    1068.317
2016-04-30    1068.317
2016-05-31    1068.317
Name: naive, dtype: float64
```

In [112…
```
plt.figure(figsize=(12,8))
plt.plot(naive_train['Price'], label='train')
plt.plot(test['Price'], label='test')
plt.plot(naive_test['naive'], label='Naive forecast on test data')
plt.legend(loc = 'best')
plt.title("Naive Forecast")
plt.grid()
```



In [123…
```
mape_model2_test = mape(test['Price'].values, naive_test['naive'].values)
print("For naive forecast on test data, Mape is %3.3f"%(mape_model2_test),"%")
```

```
For naive forecast on test data, Mape is 19.380 %
```

In [124…
```
resultdf_2 = pd.DataFrame({'Test MAPE (%)': [mape_model2_test]}, index=['NaiveModel
results = pd.concat([results, resultdf_2])
results
```

Out[124]:

	Test Mape (%)	Test MAPE (%)
RegressionOnTime	29.63	NaN
NaiveModel	NaN	19.38

In [125…
```
#Final Model

final_model = ExponentialSmoothing(df,
```

```
                                    trend = 'additive',
                                    seasonal = 'additive').fit(smoothing_level = 0.4,
                                                               smoothing_trend = 0.3,
                                                               smoothing_seasonal = 0.6)
```

In [126…
```
mape_final_model = mape(df['Price'].values, final_model.fittedvalues)
print('Mape:', mape_final_model)
```

```
Mape: 17.24
```

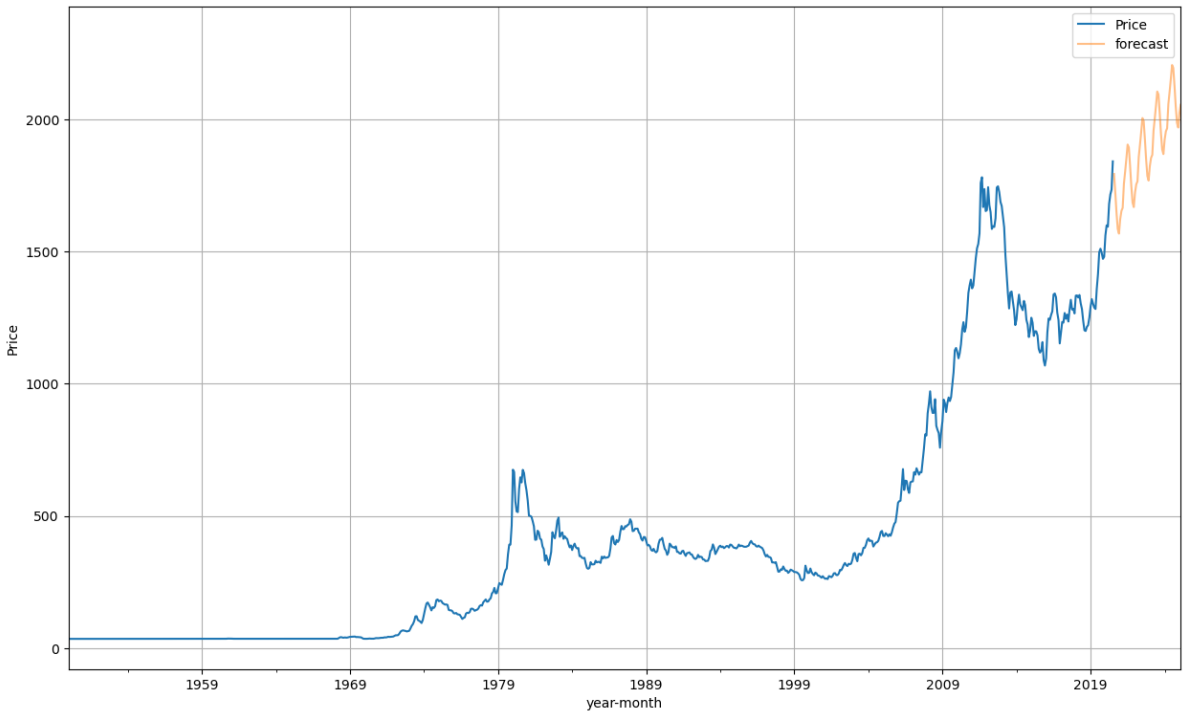
In [127…
```
prediction = final_model.forecast(steps=len(test))
```

In [110…
```
pred_df = pd.DataFrame({'lower_CI':prediction - 1.96*np.std(final_model.resid,ddof=
                        'prediction': prediction,
                        'upper_CI':prediction+ 1.96*np.std(final_model.resid,ddof=1)
pred_df.head()
```

Out[110]:

	lower_CI	prediction	upper_CI
2020-08-31	1684.718274	1792.869246	1901.020219
2020-09-30	1615.301815	1723.452788	1831.603760
2020-10-31	1538.560879	1646.711851	1754.862823
2020-11-30	1476.748832	1584.899804	1693.050776
2020-12-31	1459.315210	1567.466182	1675.617154

In [128…
```
axis= df.plot(label = 'Actual', figsize=(15,9))
pred_df['prediction'].plot(ax = axis, label = 'forecast', alpha = 0.5)
axis.fill_between(pred_df.index, pred_df['lower_CI'], pred_df['upper_CI'], color =
axis.set_xlabel('year-month')
axis.set_ylabel('Price')
plt.legend(loc = 'best')
plt.grid()
plt.show()
```



In [ ]:

In [ ]: