INDIAGDP

December 3, 2023

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px
import plotly.graph_objects as go
from plotly.subplots import make_subplots
from IPython.display import Image
#System
import os
import sys
import traceback
#Random
import random
```

[2]:
```
from sklearn.preprocessing import MinMaxScaler
from sklearn.linear_model import LinearRegression,ElasticNet
```

[3]:
```
import warnings
warnings.filterwarnings('ignore')
```

[4]:
```
dataset = pd.read_csv("indianEco.csv")
```

[5]:
```
 dataset.head()
```

[5]:

	Year	Country Name	GDP (current US$)	GDP per capita (current US$)	GDP growth (annual %)	Imports of goods and services (% of GDP)
0	1960	India	3.702988e+10	82	0.00	6.83
1	1961	India	3.923244e+10	85	3.72	5.96
2	1962	India	4.216148e+10	90	2.93	6.03
3	1963	India	4.842192e+10	101	5.99	5.91
4	1964	India	5.648029e+10	116	7.45	5.69

```
   Exports of goods and services (% of GDP)  \
0                                      4.46
1                                      4.30
2                                      4.17
3                                      4.28
4                                      3.73

    Total reserves (includes gold, current US$)   \
0                                  6.745366e+08
1                                  6.663571e+08
2                                  5.127918e+08
3                                  6.078625e+08
4                                  4.991451e+08

   Inflation, consumer prices (annual %)  Population, total  \
0                                   1.78          445954579
1                                   1.70          456351876
2                                   3.63          467024193
3                                   2.95          477933619
4                                  13.36          489059309

   Population growth (annual %)  Life expectancy at birth, total (years)
0                          2.31                                    41.13
1                          2.33                                    41.74
2                          2.34                                    42.34
3                          2.34                                    42.94
4                          2.33                                    43.57
```

[6]:
```
dataset.head(10)
```

[6]:
```
   Year Country Name  GDP (current US$)    GDP per capita (current US$)   \
0  1960        India        3.702988e+10                             82
1  1961        India        3.923244e+10                             85
2  1962        India        4.216148e+10                             90
3  1963        India        4.842192e+10                            101
4  1964        India        5.648029e+10                            116
5  1965        India        5.955485e+10                            119
6  1966        India        4.586546e+10                             90
7  1967        India        5.013494e+10                             96
8  1968        India        5.308546e+10                            100
9  1969        India        5.844800e+10                            108

   GDP growth (annual %)  Imports of goods and services (% of GDP)  \
0                   0.00                                      6.83
1                   3.72                                      5.96
2                   2.93                                      6.03
```

3	5.99	5.91
4	7.45	5.69
5	-2.64	5.21
6	-0.06	6.67
7	7.83	5.95
8	3.39	4.94
9	6.54	4.03

	Exports of goods and services (% of GDP) \
0	4.46
1	4.30
2	4.17
3	4.28
4	3.73
5	3.31
6	4.14
7	4.03
8	4.04
9	3.71

	Total reserves (includes gold, current US$) \
0	6.745366e+08
1	6.663571e+08
2	5.127918e+08
3	6.078625e+08
4	4.991451e+08
5	6.008509e+08
6	6.096946e+08
7	6.637641e+08
8	7.303527e+08
9	9.277641e+08

	Inflation, consumer prices (annual %)	Population, total \
0	1.78	445954579
1	1.70	456351876
2	3.63	467024193
3	2.95	477933619
4	13.36	489059309
5	9.47	500114346
6	10.80	510992617
7	13.06	521987069
8	3.24	533431909
9	-0.58	545314670

	Population growth (annual %)	Life expectancy at birth, total (years)
0	2.31	41.13
1	2.33	41.74

```
2                          2.34                                    42.34
3                          2.34                                    42.94
4                          2.33                                    43.57
5                          2.26                                    44.20
6                          2.18                                    44.84
7                          2.15                                    45.47
8                          2.19                                    46.10
9                          2.23                                    46.75
```

[7]:
```
dataset.describe()
```

[7]:
```
              Year  GDP (current US$)    GDP per capita (current US$)   \
count    61.000000        6.100000e+01                      61.000000
mean   1990.000000        6.584725e+11                     575.557377
std      17.752934        8.129606e+11                     584.079062
min    1960.000000        3.702988e+10                      82.000000
25%    1975.000000        9.952590e+10                     161.000000
50%    1990.000000        2.882084e+11                     340.000000
75%    2005.000000        8.203816e+11                     715.000000
max    2020.000000        2.831552e+12                    2101.000000

       GDP growth (annual %)  Imports of goods and services (% of GDP)  \
count              61.000000                                  61.000000
mean                4.938197                                  12.746393
std                 3.344891                                   8.155110
min                -7.250000                                   3.710000
25%                 3.720000                                   6.590000
50%                 5.530000                                   8.570000
75%                 7.450000                                  19.640000
max                 9.630000                                  31.260000

       Exports of goods and services (% of GDP)  \
count                                 61.000000
mean                                  10.885574
std                                    7.060458
min                                    3.310000
25%                                    5.200000
50%                                    7.050000
75%                                   18.690000
max                                   25.430000

        Total reserves (includes gold, current US$)   \
count                                  6.100000e+01
mean                                   9.802227e+10
std                                    1.497102e+11
min                                    4.991451e+08
25%                                    2.324650e+09
```

```
50%                                    1.151174e+10
75%                                    1.378248e+11
max                                    5.902274e+11

       Inflation, consumer prices (annual %)  Population, total  \
count                              61.000000       6.100000e+01
mean                                7.413279       8.913946e+08
std                                 4.940153       2.974496e+08
min                                -7.630000       4.459546e+08
25%                                 4.010000       6.235242e+08
50%                                 6.670000       8.704522e+08
75%                                10.020000       1.154639e+09
max                                28.600000       1.396387e+09

       Population growth (annual %)  Life expectancy at birth, total (years)
count                     61.000000                                61.000000
mean                       1.927705                                57.146230
std                        0.419024                                 8.459559
min                        0.960000                                41.130000
25%                        1.620000                                50.630000
50%                        2.150000                                57.660000
75%                        2.260000                                64.310000
max                        2.340000                                69.730000
```

[8]:
```
dataset.corr()
```

[8]:
```
                                                    Year  GDP (current US$)   \
Year                                            1.000000            0.846589
GDP (current US$)                               0.846589            1.000000
 GDP per capita (current US$)                   0.865053            0.998605
GDP growth (annual %)                           0.278268            0.119174
Imports of goods and services (% of GDP)        0.873956            0.835933
Exports of goods and services (% of GDP)        0.909573            0.847781
 Total reserves (includes gold, current US$)    0.814619            0.980297
Inflation, consumer prices (annual %)          -0.037177           -0.105585
Population, total                               0.997523            0.863530
Population growth (annual %)                   -0.907750           -0.957492
Life expectancy at birth, total (years)         0.995487            0.803927

                                                 GDP per capita (current US$)   \
Year                                                                 0.865053
GDP (current US$)                                                    0.998605
 GDP per capita (current US$)                                        1.000000
GDP growth (annual %)                                                0.142764
Imports of goods and services (% of GDP)                             0.853837
Exports of goods and services (% of GDP)                             0.863811
 Total reserves (includes gold, current US$)                         0.977189
```

```
Inflation, consumer prices (annual %)                          -0.091981
Population, total                                               0.880301
Population growth (annual %)                                   -0.959680
Life expectancy at birth, total (years)                         0.825702

                                                    GDP growth (annual %)  \
Year                                                              0.278268
GDP (current US$)                                                 0.119174
 GDP per capita (current US$)                                     0.142764
GDP growth (annual %)                                             1.000000
Imports of goods and services (% of GDP)                          0.280289
Exports of goods and services (% of GDP)                          0.269356
 Total reserves (includes gold, current US$)                      0.049946
Inflation, consumer prices (annual %)                             0.007843
Population, total                                                 0.276103
Population growth (annual %)                                     -0.168449
Life expectancy at birth, total (years)                           0.294472

                                                    Imports of goods and services (%
of GDP)  \
Year
0.873956
GDP (current US$)
0.835933
 GDP per capita (current US$)
0.853837
GDP growth (annual %)
0.280289
Imports of goods and services (% of GDP)
1.000000
Exports of goods and services (% of GDP)
0.989499
 Total reserves (includes gold, current US$)
0.841084
Inflation, consumer prices (annual %)
-0.034099
Population, total
0.894541
Population growth (annual %)
-0.912249
Life expectancy at birth, total (years)
0.849597

                                                    Exports of goods and services (%
of GDP)  \
Year
0.909573
```

```
GDP (current US$)
0.847781
 GDP per capita (current US$)
0.863811
GDP growth (annual %)
0.269356
Imports of goods and services (% of GDP)
0.989499
Exports of goods and services (% of GDP)
1.000000
 Total reserves (includes gold, current US$)
0.851635
Inflation, consumer prices (annual %)
-0.073604
Population, total
0.927934
Population growth (annual %)
-0.935063
Life expectancy at birth, total (years)
0.886921

                                                 Total reserves (includes gold,
current US$)   \
Year
0.814619
GDP (current US$)
0.980297
 GDP per capita (current US$)
0.977189
GDP growth (annual %)
0.049946
Imports of goods and services (% of GDP)
0.841084
Exports of goods and services (% of GDP)
0.851635
 Total reserves (includes gold, current US$)
1.000000
Inflation, consumer prices (annual %)
-0.107925
Population, total
0.835249
Population growth (annual %)
-0.957013
Life expectancy at birth, total (years)
0.767909

                                                Inflation, consumer prices
```

```
(annual %)  \
Year
-0.037177
GDP (current US$)
-0.105585
 GDP per capita (current US$)
-0.091981
GDP growth (annual %)
0.007843
Imports of goods and services (% of GDP)
-0.034099
Exports of goods and services (% of GDP)
-0.073604
 Total reserves (includes gold, current US$)
-0.107925
Inflation, consumer prices (annual %)
1.000000
Population, total
-0.053939
Population growth (annual %)
0.123497
Life expectancy at birth, total (years)
-0.014927
```

	Population, total \
Year	0.997523
GDP (current US$)	0.863530
GDP per capita (current US$)	0.880301
GDP growth (annual %)	0.276103
Imports of goods and services (% of GDP)	0.894541
Exports of goods and services (% of GDP)	0.927934
Total reserves (includes gold, current US$)	0.835249
Inflation, consumer prices (annual %)	-0.053939
Population, total	1.000000
Population growth (annual %)	-0.928431
Life expectancy at birth, total (years)	0.987134

	Population growth (annual %) \
Year	-0.907750
GDP (current US$)	-0.957492
GDP per capita (current US$)	-0.959680
GDP growth (annual %)	-0.168449
Imports of goods and services (% of GDP)	-0.912249
Exports of goods and services (% of GDP)	-0.935063
Total reserves (includes gold, current US$)	-0.957013
Inflation, consumer prices (annual %)	0.123497
Population, total	-0.928431

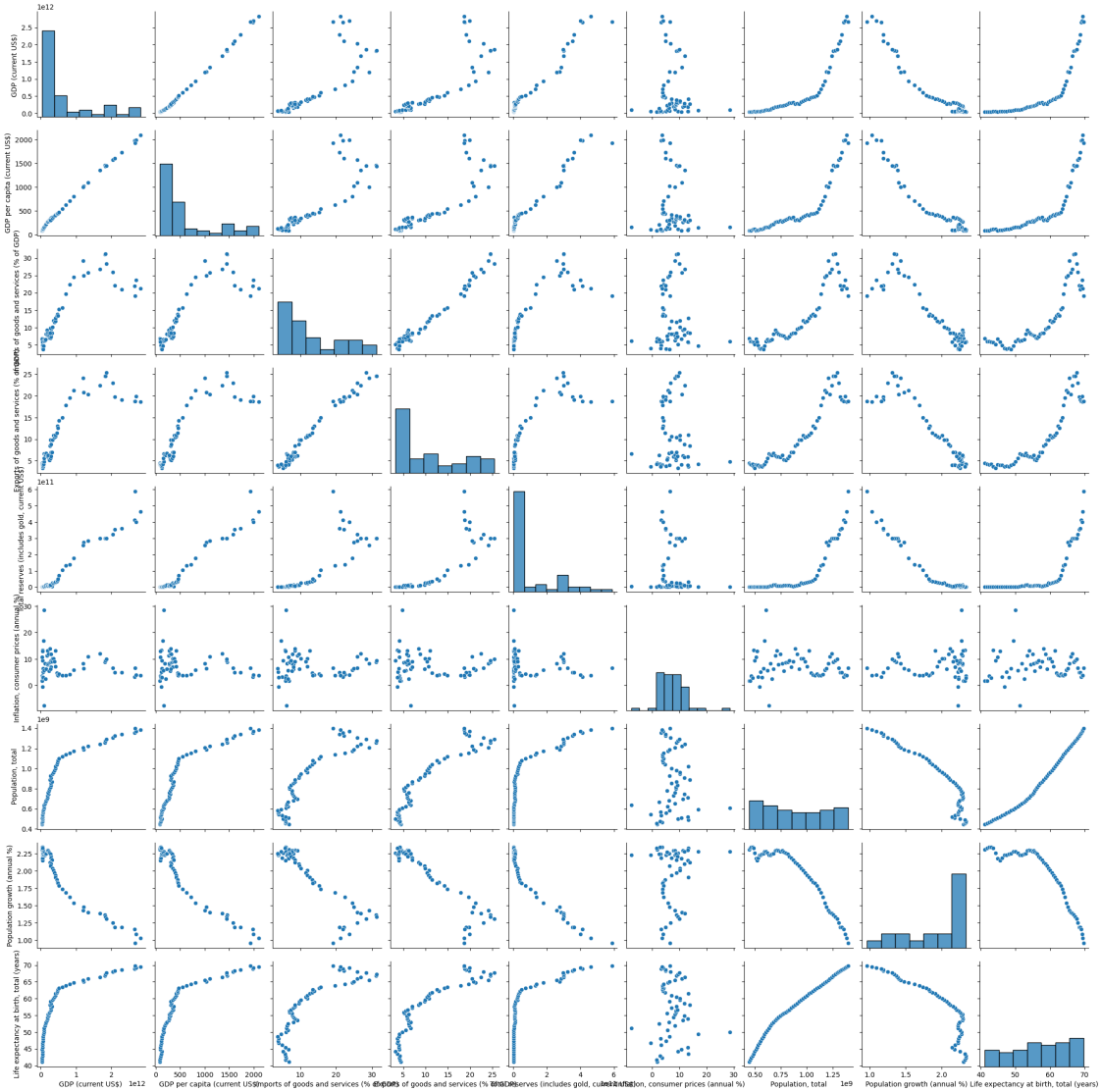
```
Population growth (annual %)                                    1.000000
Life expectancy at birth, total (years)                        -0.868766

                                                 Life expectancy at birth, total
(years)
Year
0.995487
GDP (current US$)
0.803927
 GDP per capita (current US$)
0.825702
GDP growth (annual %)
0.294472
Imports of goods and services (% of GDP)
0.849597
Exports of goods and services (% of GDP)
0.886921
 Total reserves (includes gold, current US$)
0.767909
Inflation, consumer prices (annual %)
-0.014927
Population, total
0.987134
Population growth (annual %)
-0.868766
Life expectancy at birth, total (years)
1.000000
```

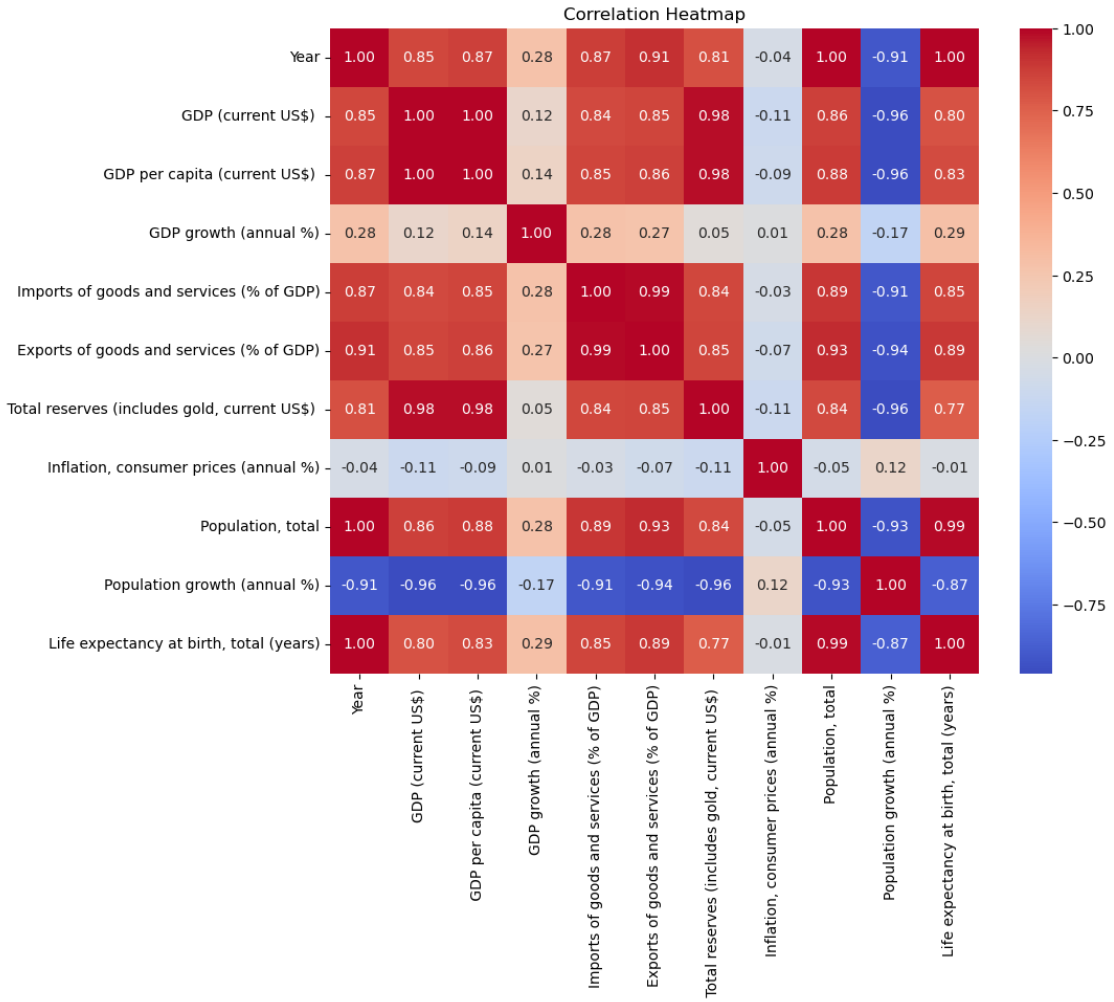
[9]:
```
print(dataset.columns)
```

```
Index(['Year', 'Country Name', 'GDP (current US$) ',
       ' GDP per capita (current US$) ', 'GDP growth (annual %)',
       'Imports of goods and services (% of GDP)',
       'Exports of goods and services (% of GDP)',
       ' Total reserves (includes gold, current US$) ',
       'Inflation, consumer prices (annual %)', 'Population, total',
       'Population growth (annual %)',
       'Life expectancy at birth, total (years)'],
      dtype='object')
```

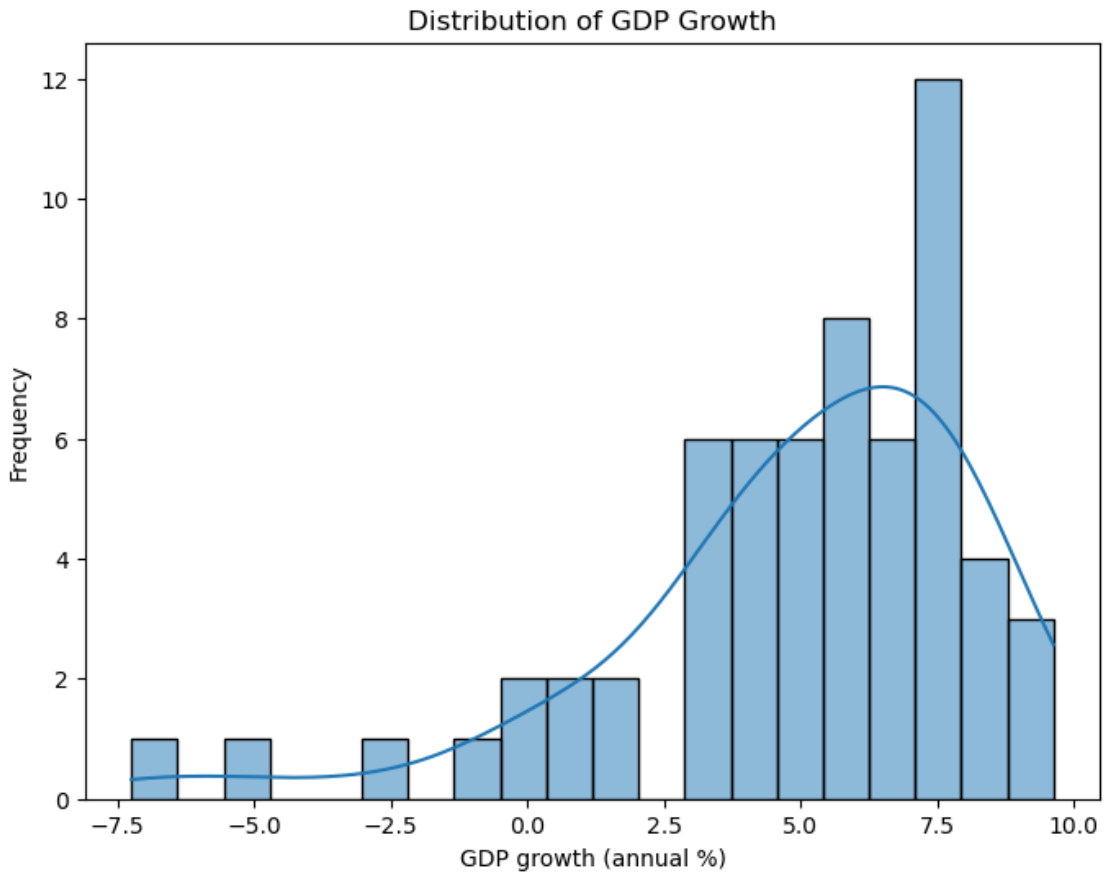
[10]:
```
import matplotlib.pyplot as plt
import seaborn as sns

# Pairplot for numerical features
sns.pairplot(dataset, vars=['GDP (current US$) ', ' GDP per capita (current␣
 ↪US$) ',
                            'Imports of goods and services (% of GDP)',
```

```
                        'Exports of goods and services (% of GDP)',
                        ' Total reserves (includes gold, current US$) ',
                        'Inflation, consumer prices (annual %)',
                        'Population, total',
                        'Population growth (annual %)',
                        'Life expectancy at birth, total (years)'])
plt.show()

# Correlation heatmap
correlation_matrix = dataset.corr()
plt.figure(figsize=(10, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f")
plt.title("Correlation Heatmap")
plt.show()
```





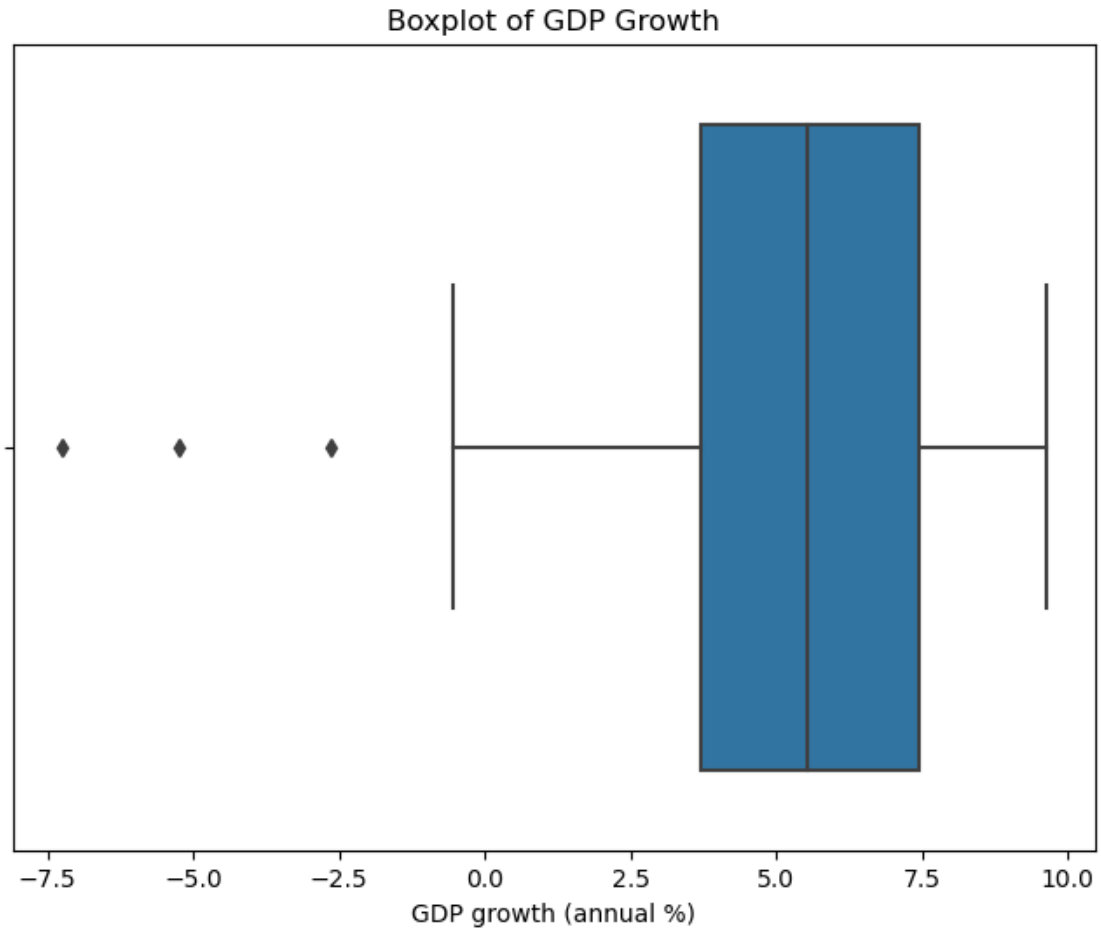
[11]:
```
# Histogram for GDP growth
plt.figure(figsize=(8, 6))
sns.histplot(dataset['GDP growth (annual %)'], bins=20, kde=True)
plt.xlabel('GDP growth (annual %)')
plt.ylabel('Frequency')
plt.title('Distribution of GDP Growth')
plt.show()
```



[12]:
```
# Check for missing values
missing_values = dataset.isnull().sum()

# Display columns with missing values
print('Columns with missing values:')
print(missing_values[missing_values > 0])

# Remove rows with missing values (if needed)
data_cleaned = dataset.dropna()
```

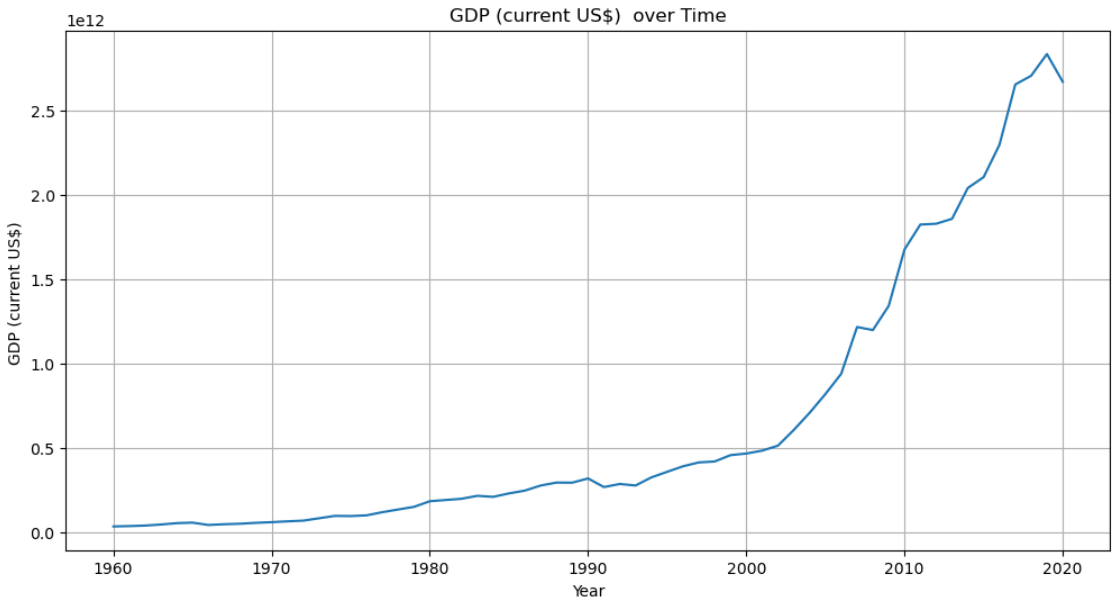
```
Columns with missing values:
Series([], dtype: int64)
```

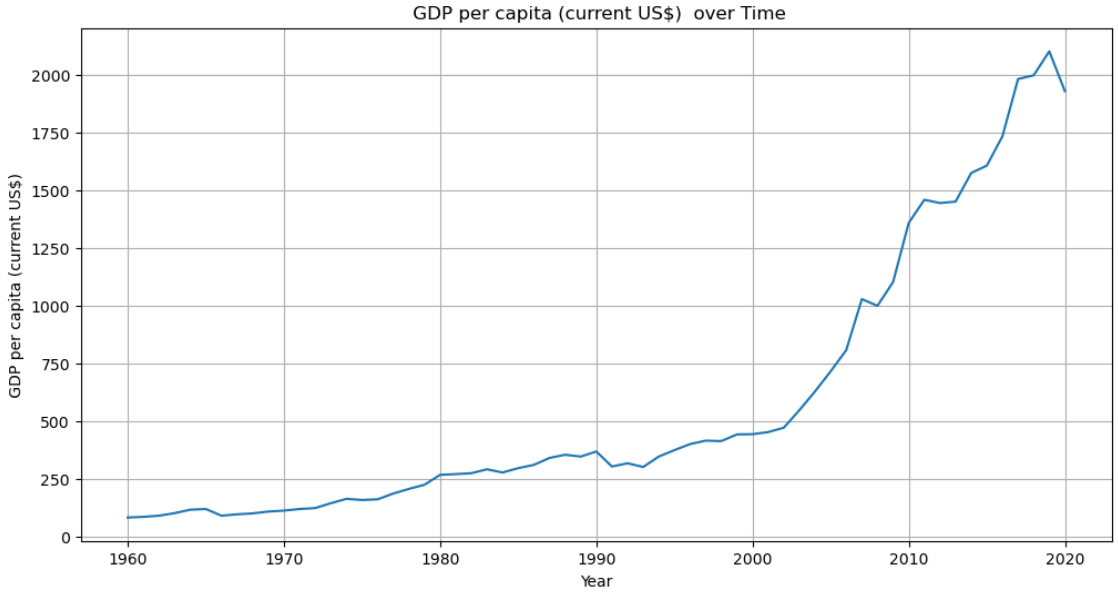
[13]:
```
# Boxplot for GDP growth
plt.figure(figsize=(8, 6))
sns.boxplot(dataset['GDP growth (annual %)'])
plt.xlabel('GDP growth (annual %)')
plt.title('Boxplot of GDP Growth')
plt.show()
```

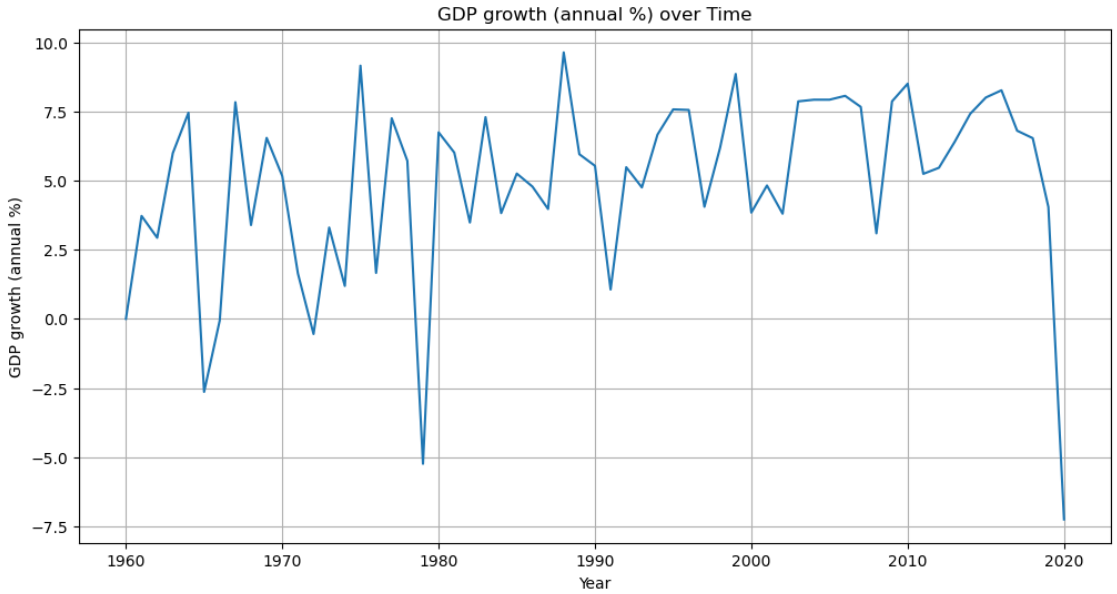


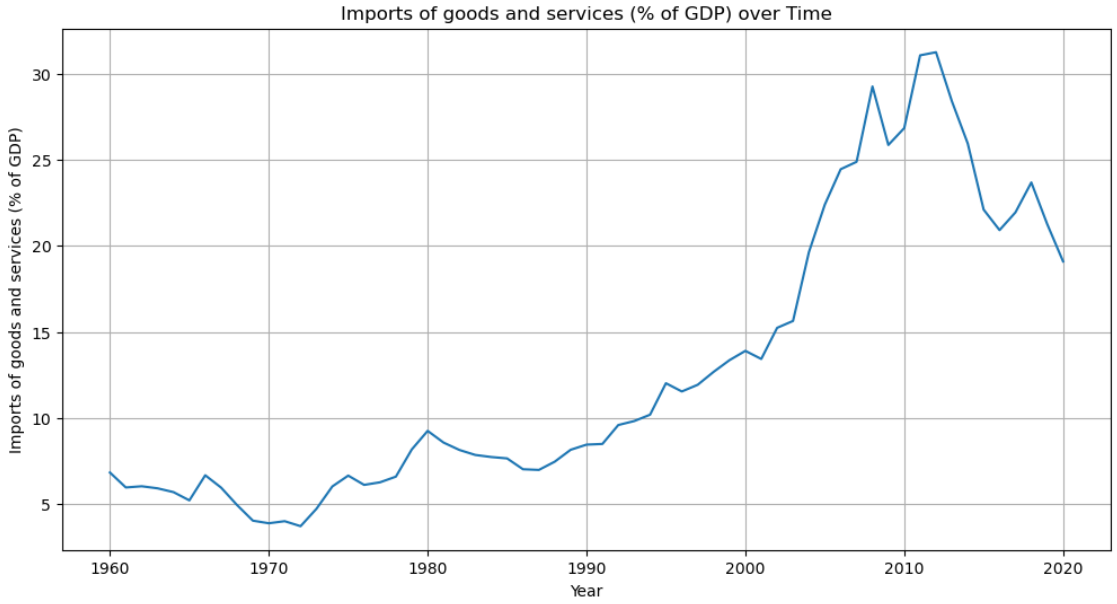
[14]:
```python
import matplotlib.pyplot as plt

# Assuming 'Year' is the x-axis for time
x = dataset['Year']

# List of variables to plot
variables = [
    'GDP (current US$) ',
    ' GDP per capita (current US$) ',
    'GDP growth (annual %)',
    'Imports of goods and services (% of GDP)',
    'Exports of goods and services (% of GDP)',
    ' Total reserves (includes gold, current US$) ',
    'Inflation, consumer prices (annual %)',
    'Population, total',
    'Population growth (annual %)',
    'Life expectancy at birth, total (years)'
```

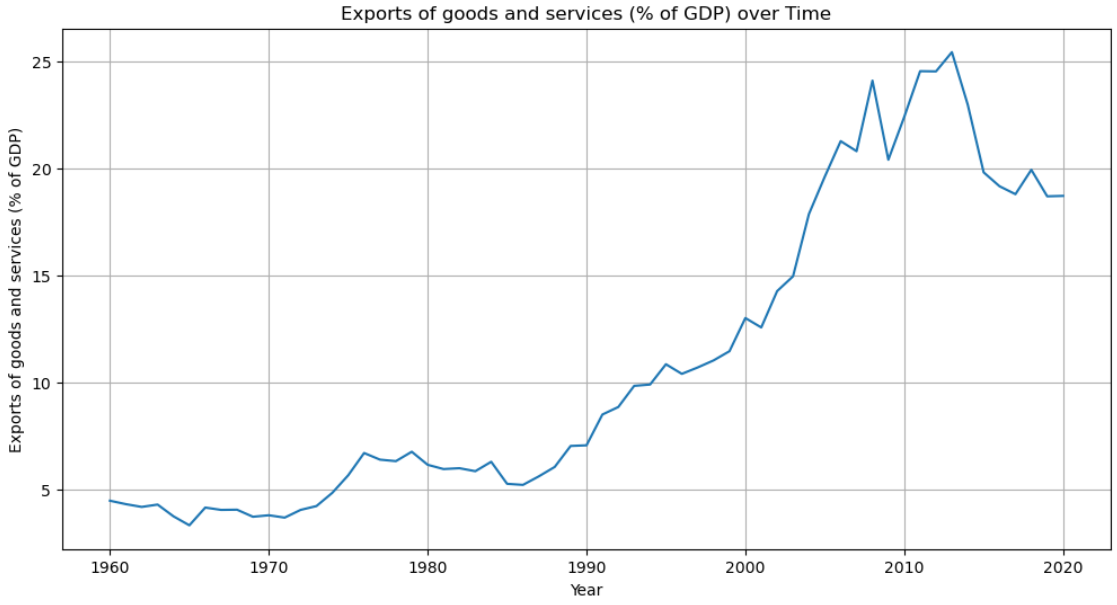
```
]

# Loop through variables and create subplots
for variable in variables:
    y = dataset[variable]

    plt.figure(figsize=(12, 6))
    plt.plot(x, y)
    plt.title(f'{variable} over Time')
    plt.xlabel('Year')
    plt.ylabel(variable)
    plt.grid(True)
    plt.show()
```

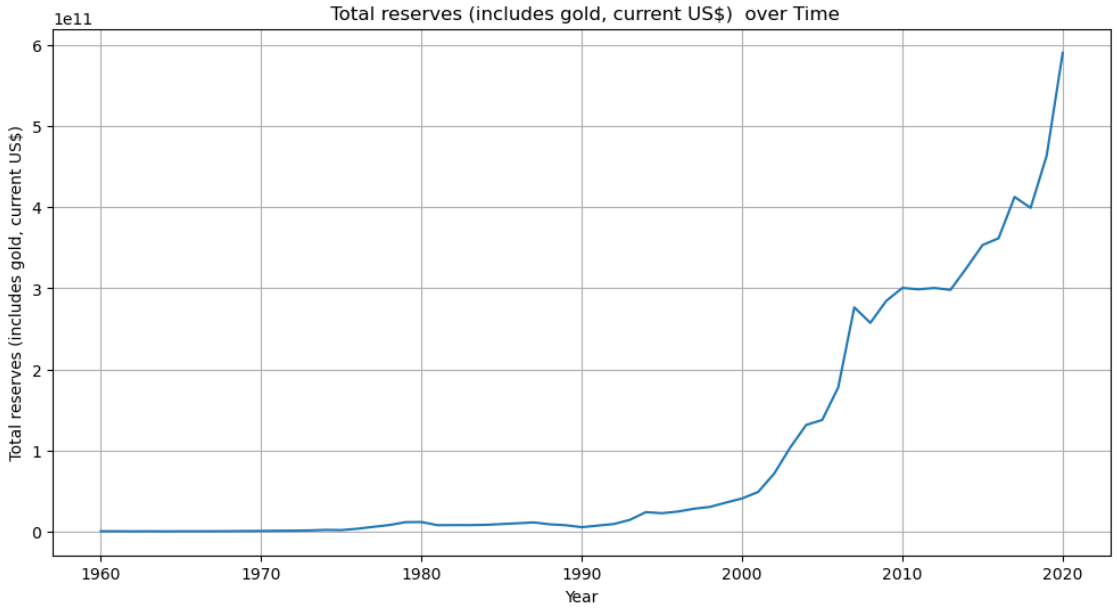


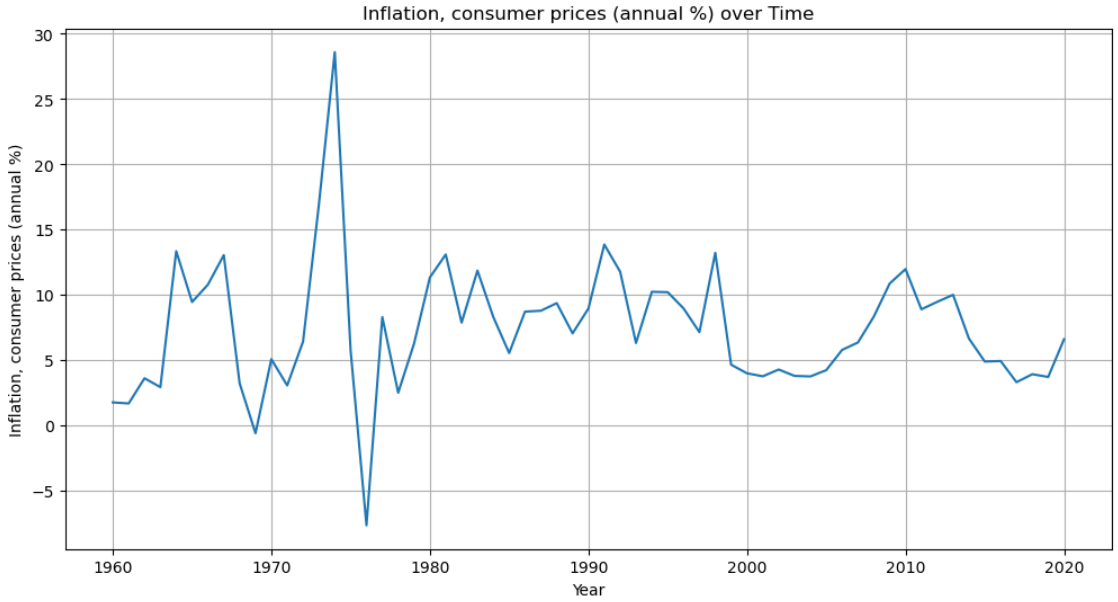

GDP per capita (current US$) over Time
GDP per capita (current US$)
Year
0
250
500
750
1000
1250
1500
1750
2000
1960
1970
1980
1990
2000
2010
2020

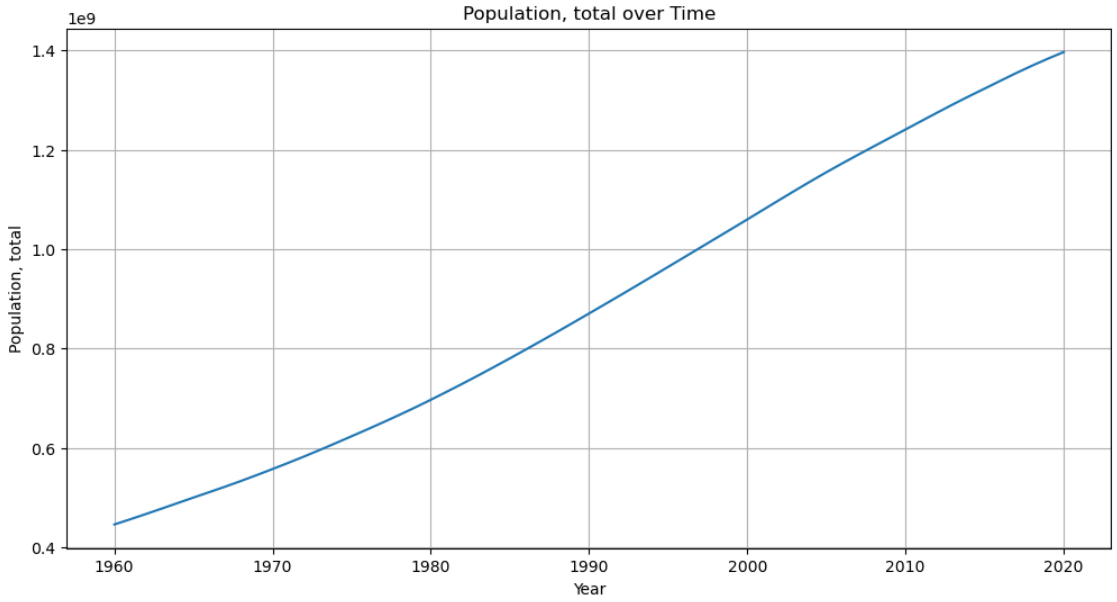

GDP growth (annual %) over Time
GDP growth (annual %)
Year
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
1960
1970
1980
1990
2000
2010
2020

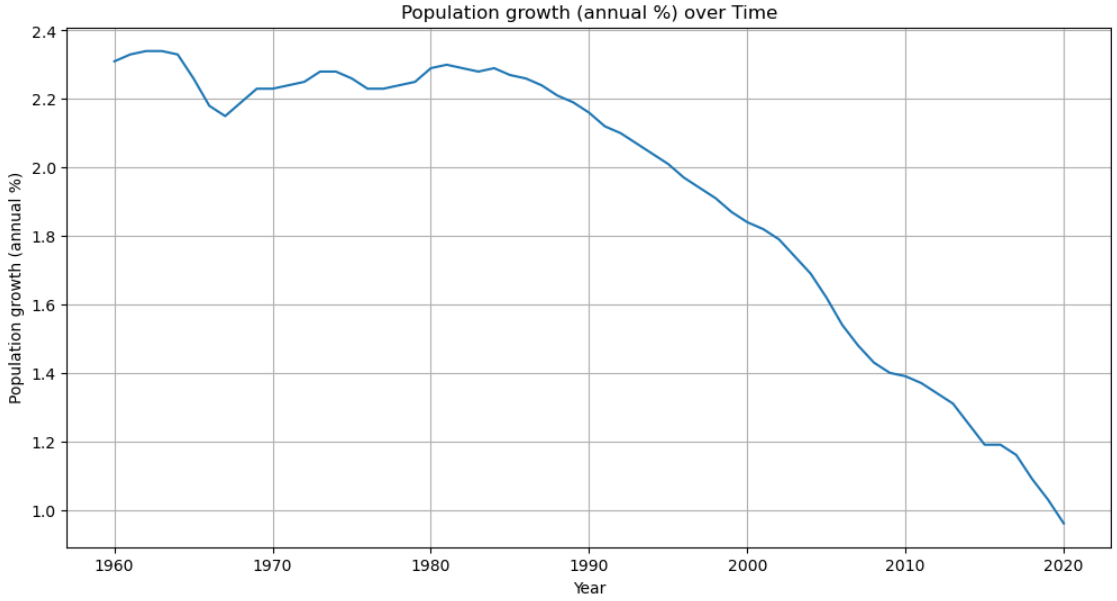

Imports of goods and services (% of GDP) over Time
Imports of goods and services (% of GDP)
30
25
20
15
10
5
1960
1970
1980
1990
2000
2010
2020
Year

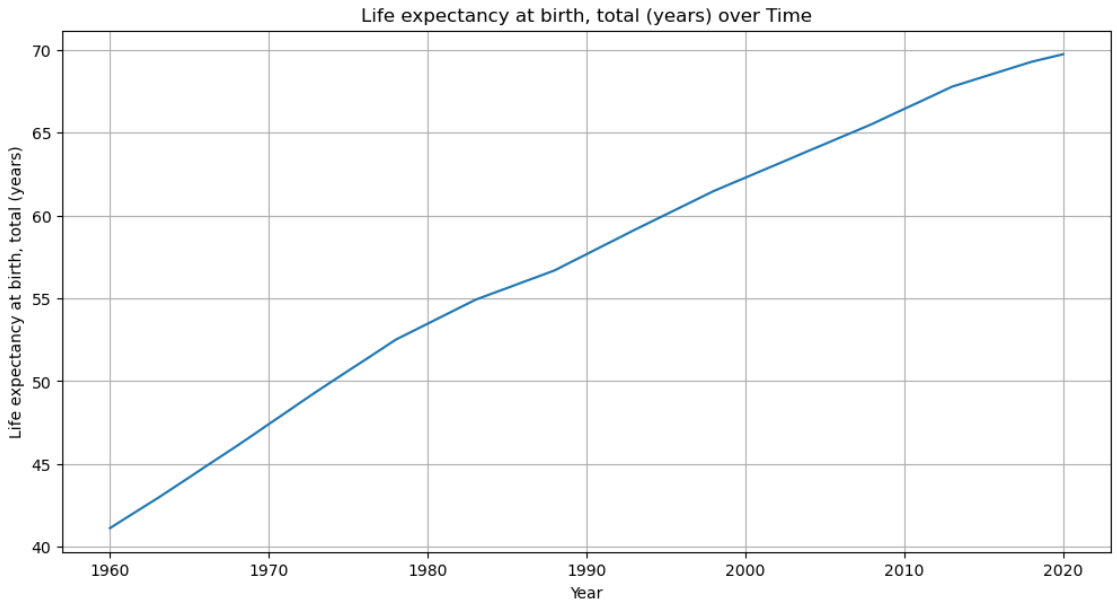

Exports of goods and services (% of GDP) over Time
Exports of goods and services (% of GDP)
25
20
15
10
5
1960
1970
1980
1990
2000
2010
2020
Year


Total reserves (includes gold, current US$) over Time
1e11
Total reserves (includes gold, current US$)
Year
0
1
2
3
4
5
6
1960
1970
1980
1990
2000
2010
2020


Inflation, consumer prices (annual %) over Time
Inflation, consumer prices (annual %)
Year
30
25
20
15
10
5
0
−5
1960
1970
1980
1990
2000
2010
2020

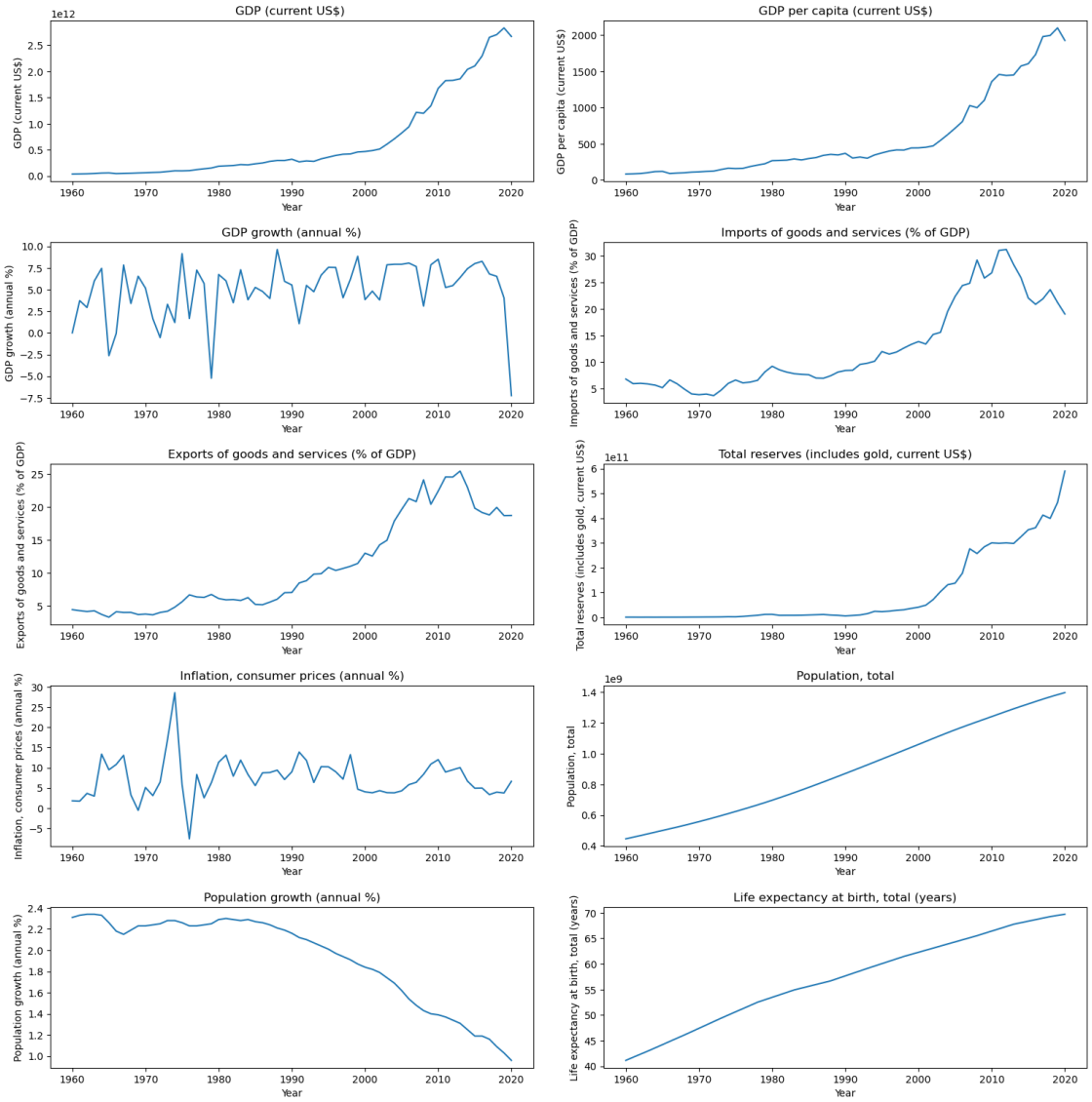

Population, total over Time
1e9
1.4
1.2
1.0
0.8
0.6
0.4
Population, total
1960
1970
1980
1990
2000
2010
2020
Year


Population growth (annual %) over Time
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
Population growth (annual %)
1960
1970
1980
1990
2000
2010
2020
Year



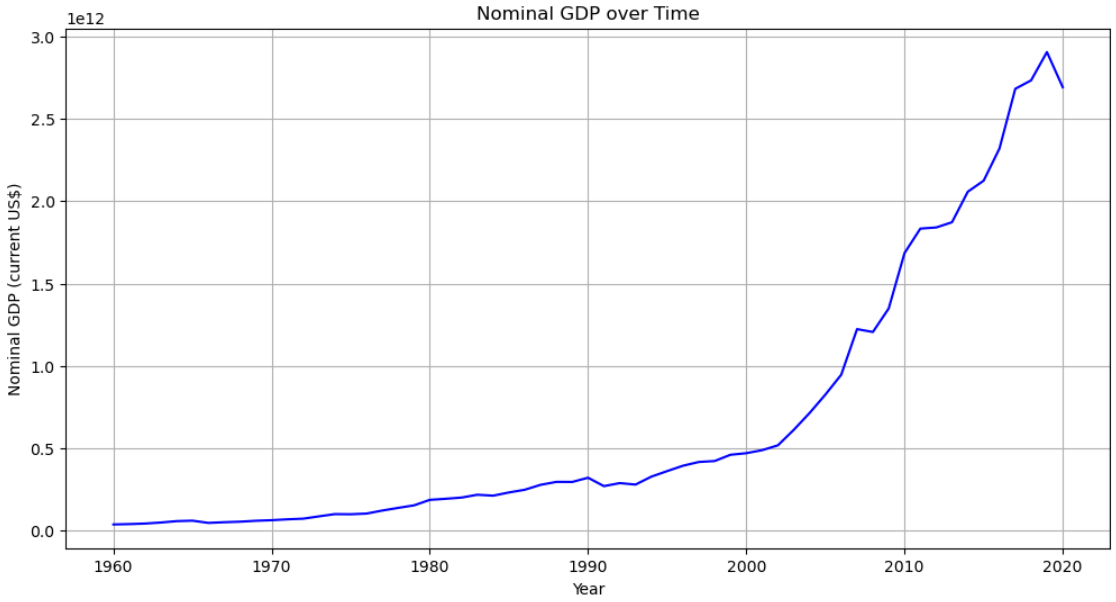
[15]:
```python
import matplotlib.pyplot as plt

# Assuming 'Year' is the x-axis for time
x = dataset['Year']

# List of variables to plot
variables = [
    'GDP (current US$) ',
    ' GDP per capita (current US$) ',
    'GDP growth (annual %)',
    'Imports of goods and services (% of GDP)',
    'Exports of goods and services (% of GDP)',
    ' Total reserves (includes gold, current US$) ',
    'Inflation, consumer prices (annual %)',
    'Population, total',
    'Population growth (annual %)',
    'Life expectancy at birth, total (years)'
]

# Define the number of rows and columns for the subplots
n_rows = 5
n_cols = 2

# Create a combined figure with subplots
fig, axes = plt.subplots(n_rows, n_cols, figsize=(16, 16))
fig.tight_layout(pad=4.0)  # Adjust subplot spacing
```

```
for i, variable in enumerate(variables):
    row = i // n_cols
    col = i % n_cols
    y = dataset[variable]
    ax = axes[row, col]

    ax.plot(x, y)
    ax.set_title(variable)
    ax.set_xlabel('Year')
    ax.set_ylabel(variable)

# Remove any unused subplots if the number of variables is less than n_rows *␣
 ↪n_cols
for i in range(len(variables), n_rows * n_cols):
    row = i // n_cols
    col = i % n_cols
    fig.delaxes(axes[row, col])

plt.show()
```



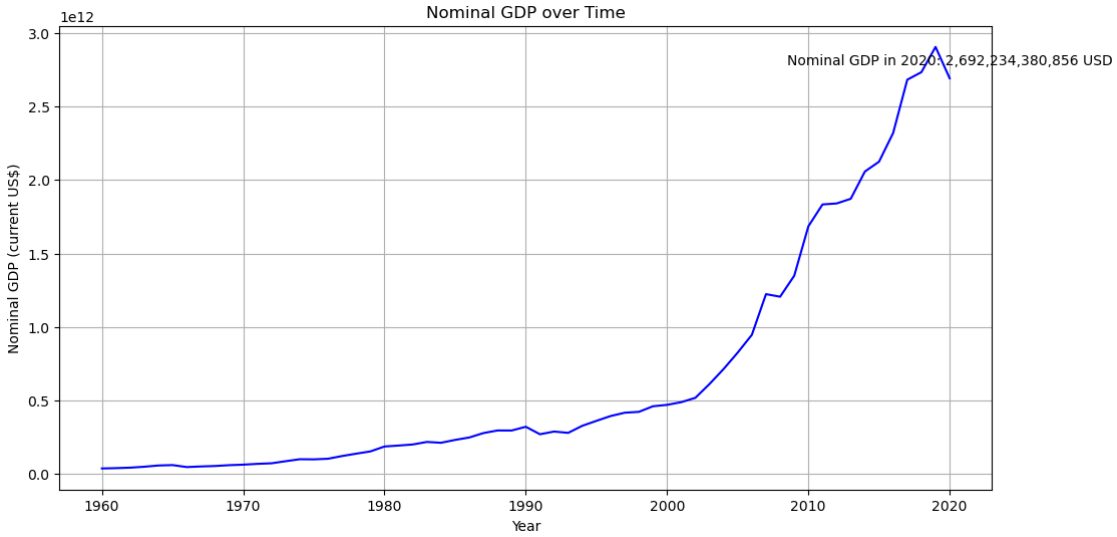
[16]:
```
import pandas as pd

# Assuming 'Year' is the x-axis for time
x = dataset['Year']

# Calculate nominal GDP
nominal_gdp = dataset[' GDP per capita (current US$) '] * dataset['Population,␣
 ↪total']

# Create a plot for nominal GDP
plt.figure(figsize=(12, 6))
plt.plot(x, nominal_gdp, label='Nominal GDP', color='b')
```

```
plt.title('Nominal GDP over Time')
plt.xlabel('Year')
plt.ylabel('Nominal GDP (current US$)')
plt.grid(True)
plt.show()
```



[17]:
```
import pandas as pd

# Assuming 'Year' is the x-axis for time
x = dataset['Year']

# Calculate nominal GDP
nominal_gdp = dataset[' GDP per capita (current US$) '] * dataset['Population, total']

# Create a plot for nominal GDP
plt.figure(figsize=(12, 6))
plt.plot(x, nominal_gdp, label='Nominal GDP', color='b')
plt.title('Nominal GDP over Time')
plt.xlabel('Year')
plt.ylabel('Nominal GDP (current US$)')
plt.grid(True)

# Annotate the graph with the value of nominal GDP in the final year (2020)
final_year = 2020
final_gdp = nominal_gdp[x == final_year].values[0]
```

```
plt.annotate(f'Nominal GDP in {final_year}: {final_gdp:,.0f} USD', (final_year,␣
 ↪final_gdp), textcoords="offset points", xytext=(0, 10), ha='center')

plt.show()
```



[18]:
```
# Add 'GDP growth (annual %)' to the list of features
features = [' GDP per capita (current US$) ',
            'Imports of goods and services (% of GDP)',
            'Exports of goods and services (% of GDP)',
            ' Total reserves (includes gold, current US$) ',
            'Inflation, consumer prices (annual %)', 'Population, total',
            'Population growth (annual %)',
            'Life expectancy at birth, total (years)',
            'GDP growth (annual %)']

# Set the target variable as 'Nominal GDP'
target = 'Nominal GDP'
```

[19]:
```
# Filter data from 1960 to 2020
dataset = dataset[(dataset['Year'] >= 1960) & (dataset['Year'] <= 2020)]

# Drop rows with missing values
dataset = dataset.dropna()

# Calculate 'Nominal GDP' based on the formula
dataset['Nominal GDP'] = dataset[' GDP per capita (current US$) '] *␣
 ↪dataset['Population, total']
```

```
# Define the features and target variable
features = [
    ' GDP per capita (current US$) ',
    'Imports of goods and services (% of GDP)',
    'Exports of goods and services (% of GDP)',
    ' Total reserves (includes gold, current US$) ',
    'Inflation, consumer prices (annual %)',
    'Population, total',
    'Population growth (annual %)',
    'Life expectancy at birth, total (years)',
    'GDP growth (annual %)'
]

target = 'Nominal GDP'
```

[44]:
```
# Load your dataset
dataset = pd.read_csv('indianEco.csv')  # Replace 'your_dataset.csv' with your␣
 ↪dataset file path

# Filter data from 1960 to 2020
dataset = dataset[(dataset['Year'] >= 1960) & (dataset['Year'] <= 2020)]

# Drop rows with missing values
dataset = dataset.dropna()

# Calculate 'Nominal GDP' based on the formula
dataset['Nominal GDP'] = dataset[' GDP per capita (current US$) '] *␣
 ↪dataset['Population, total']
```

[45]:
```
import pandas as pd

# Load and preprocess your dataset as previously described

# Define the feature to predict and the year for prediction
feature_to_predict = ' GDP per capita (current US$) '
year_to_predict = 2035

# Section 1: Filter data for the feature you want to predict
filtered_data = dataset[dataset['Year'] >= 1960]

# Section 2: Perform a linear regression model on the selected feature
# Assuming you have data for that feature, you can use a simple linear␣
 ↪regression model
from sklearn.linear_model import LinearRegression
model = LinearRegression()
model.fit(filtered_data[['Year']], filtered_data[feature_to_predict])
```

```
# Section 3: Predict the feature value for 2035
predicted_feature_value_2035 = model.predict([[year_to_predict]])[0]

# Section 4: Print the predicted feature value for 2035
print(f'Predicted {feature_to_predict} for 2035: {predicted_feature_value_2035:
  ↪,.2f} USD')
```

```
Predicted  GDP per capita (current US$)  for 2035: 1,856.28 USD
```

[46]:
```
import pandas as pd

# Load and preprocess your dataset as previously described

# Define the features to predict and the year for prediction
features_to_predict = [
    ' GDP per capita (current US$) ',
    'Imports of goods and services (% of GDP)',
    'Exports of goods and services (% of GDP)',
    ' Total reserves (includes gold, current US$) ',
    'Inflation, consumer prices (annual %)',
    'Population, total',
    'Population growth (annual %)',
    'Life expectancy at birth, total (years)',
    'GDP growth (annual %)'
]

year_to_predict = 2035

# Initialize a dictionary to store the predicted feature values
predicted_features_2035 = {}

# Section 1: Filter data for the features you want to predict
filtered_data = dataset[dataset['Year'] >= 1960]

# Section 2: Predict each feature using a linear regression model
from sklearn.linear_model import LinearRegression

for feature in features_to_predict:
    # Create a linear regression model for the current feature
    model = LinearRegression()
    model.fit(filtered_data[['Year']], filtered_data[feature])

    # Predict the feature value for 2035
    predicted_feature_value_2035 = model.predict([[year_to_predict]])[0]

    # Store the predicted feature value in the dictionary
    predicted_features_2035[feature] = predicted_feature_value_2035
```

```
# Section 3: Print the predicted feature values for 2035
for feature, value in predicted_features_2035.items():
    print(f'Predicted {feature} for 2035: {value:,.2f}')
```

```
Predicted  GDP per capita (current US$)  for 2035: 1,856.28
Predicted Imports of goods and services (% of GDP) for 2035: 30.81
Predicted Exports of goods and services (% of GDP) for 2035: 27.16
Predicted  Total reserves (includes gold, current US$)  for 2035:
407,157,220,633.08
Predicted Inflation, consumer prices (annual %) for 2035: 6.95
Predicted Population, total for 2035: 1,643,499,887.00
Predicted Population growth (annual %) for 2035: 0.96
Predicted Life expectancy at birth, total (years) for 2035: 78.49
Predicted GDP growth (annual %) for 2035: 7.30
```

[47]:
```
import pandas as pd
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score
from sklearn.model_selection import train_test_split

# Load your dataset
dataset = pd.read_csv('indianEco.csv')  # Replace 'your_dataset.csv' with your␣
 ↪dataset file path

# Section 1: Data Preprocessing
# Filter data from 1960 to 2020
dataset = dataset[(dataset['Year'] >= 1960) & (dataset['Year'] <= 2020)]

# Drop rows with missing values
dataset = dataset.dropna()

# Calculate 'Nominal GDP' based on the formula
dataset['Nominal GDP'] = dataset[' GDP per capita (current US$) '] *␣
 ↪dataset['Population, total']

# Define the features and target variable
features = [
    ' GDP per capita (current US$) ',
    'Imports of goods and services (% of GDP)',
    'Exports of goods and services (% of GDP)',
    ' Total reserves (includes gold, current US$) ',
    'Inflation, consumer prices (annual %)',
    'Population, total',
    'Population growth (annual %)',
    'Life expectancy at birth, total (years)',
    'GDP growth (annual %)'
```

```
]

target = 'Nominal GDP'

# Section 2: Train and Test the Model
X = dataset[features]
y = dataset[target]

# Split the data into training and testing sets (e.g., 80% training, 20%␣
 ↪testing)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)

# Create a linear regression model
model = LinearRegression()

# Fit the model on the training data
model.fit(X_train, y_train)

# Make predictions on the testing set
y_pred = model.predict(X_test)

# Calculate the Mean Squared Error (MSE)
mse = mean_squared_error(y_test, y_pred)

# Calculate the R-squared (coefficient of determination) to assess model fit
r2 = r2_score(y_test, y_pred)

# Print the evaluation metrics
print(f'Mean Squared Error: {mse}')
print(f'R-squared (R2): {r2}')

# Section 3: Predict Single Feature for 2035 (e.g., GDP per capita)
feature_to_predict = ' GDP per capita (current US$) '
year_to_predict = 2035

# Filter data for the feature you want to predict
filtered_data = dataset[dataset['Year'] >= 1960]

# Create a linear regression model for the current feature
model = LinearRegression()
model.fit(filtered_data[['Year']], filtered_data[feature_to_predict])

# Predict the feature value for 2035
predicted_feature_value_2035 = model.predict([[year_to_predict]])[0]

# Print the predicted feature value for 2035
```

```
print(f'Predicted {feature_to_predict} for 2035: {predicted_feature_value_2035:
  ↪,.2f} USD')

# Section 4: Predict Multiple Features for 2035
features_to_predict = [
    'Imports of goods and services (% of GDP)',
    'Exports of goods and services (% of GDP)',
    ' Total reserves (includes gold, current US$) ',
    'Inflation, consumer prices (annual %)',
    'Population, total',
    'Population growth (annual %)',
    'Life expectancy at birth, total (years)',
    'GDP growth (annual %)'
]

# Initialize a dictionary to store the predicted feature values
predicted_features_2035 = {}

# Predict each feature using a linear regression model
for feature in features_to_predict:
    # Create a linear regression model for the current feature
    model = LinearRegression()
    model.fit(filtered_data[['Year']], filtered_data[feature])

    # Predict the feature value for 2035
    predicted_feature_value_2035 = model.predict([[year_to_predict]])[0]

    # Store the predicted feature value in the dictionary
    predicted_features_2035[feature] = predicted_feature_value_2035

# Print the predicted feature values for 2035
for feature, value in predicted_features_2035.items():
    print(f'Predicted {feature} for 2035: {value:,.2f}')
```

```
Mean Squared Error: 2.4394273351821794e+20
R-squared (R2): 0.9996800026831436
Predicted  GDP per capita (current US$)  for 2035: 1,856.28 USD
Predicted Imports of goods and services (% of GDP) for 2035: 30.81
Predicted Exports of goods and services (% of GDP) for 2035: 27.16
Predicted  Total reserves (includes gold, current US$)  for 2035:
407,157,220,633.08
Predicted Inflation, consumer prices (annual %) for 2035: 6.95
Predicted Population, total for 2035: 1,643,499,887.00
Predicted Population growth (annual %) for 2035: 0.96
Predicted Life expectancy at birth, total (years) for 2035: 78.49
Predicted GDP growth (annual %) for 2035: 7.30
```

[48]:
```
import pandas as pd
from sklearn.linear_model import Ridge
from sklearn.preprocessing import StandardScaler, PolynomialFeatures
from sklearn.model_selection import train_test_split, cross_val_score
from sklearn.metrics import mean_squared_error, r2_score
from sklearn.ensemble import RandomForestRegressor

# Load your dataset
dataset = pd.read_csv('indianEco.csv')  # Replace 'your_dataset.csv' with your␣
 ↪dataset file path

# Filter data from 1960 to 2020
dataset = dataset[(dataset['Year'] >= 1960) & (dataset['Year'] <= 2020)]

# Drop rows with missing values
dataset = dataset.dropna()

# Calculate 'Nominal GDP' based on the formula
dataset['Nominal GDP'] = dataset[' GDP per capita (current US$) '] *␣
 ↪dataset['Population, total']

# Define the features and target variable
features = [
    ' GDP per capita (current US$) ',
    'Imports of goods and services (% of GDP)',
    'Exports of goods and services (% of GDP)',
    ' Total reserves (includes gold, current US$) ',
    'Inflation, consumer prices (annual %)',
    'Population, total',
    'Population growth (annual %)',
    'Life expectancy at birth, total (years)',
    'GDP growth (annual %)'
]

target = 'Nominal GDP'

# Split the data into training and testing sets (e.g., 80% training, 20%␣
 ↪testing)
X = dataset[features]
y = dataset[target]

# Feature Engineering
poly = PolynomialFeatures(degree=2)
X_poly = poly.fit_transform(X)

# Standardize the features
scaler = StandardScaler()
```

```
X_scaled = scaler.fit_transform(X_poly)

X_train, X_test, y_train, y_test = train_test_split(X_scaled, y, test_size=0.2,␣
 ↪random_state=42)

# Hyperparameter Tuning (Ridge Regression)
alphas = [0.1, 1.0, 10.0]
best_alpha = None
best_mse = float('inf')

for alpha in alphas:
    model = Ridge(alpha=alpha)
    scores = -cross_val_score(model, X_train, y_train, cv=5,␣
 ↪scoring='neg_mean_squared_error')
    avg_mse = scores.mean()

    if avg_mse < best_mse:
        best_mse = avg_mse
        best_alpha = alpha

# Train Ridge Regression with the best alpha
final_model = Ridge(alpha=best_alpha)
final_model.fit(X_train, y_train)

# Make predictions on the testing set
y_pred = final_model.predict(X_test)

# Calculate the Mean Squared Error (MSE)
mse = mean_squared_error(y_test, y_pred)

# Calculate the R-squared (coefficient of determination) to assess model fit
r2 = r2_score(y_test, y_pred)

# Print the evaluation metrics
print(f'Best Ridge Alpha: {best_alpha}')
print(f'Mean Squared Error: {mse}')
print(f'R-squared (R2): {r2}')

# Predict Nominal GDP for 2035
# Assuming you have predicted values for all features in a dictionary named␣
 ↪'predicted_values_2035'
predicted_values_2035 = {
    ' GDP per capita (current US$) ': 1856.28,
    'Imports of goods and services (% of GDP)': 30.81,
    'Exports of goods and services (% of GDP)': 27.16,
    ' Total reserves (includes gold, current US$) ': 407157220633.08,
    'Inflation, consumer prices (annual %)': 6.95,
```

```
    'Population, total': 1643499887.00,
    'Population growth (annual %)': 0.96,
    'Life expectancy at birth, total (years)': 78.49,
    'GDP growth (annual %)': 7.30
}

# Feature Engineering for Prediction
predicted_features = poly.transform([[predicted_values_2035[feature] for␣
 ↪feature in features]])
predicted_features_scaled = scaler.transform(predicted_features)

# Predict Nominal GDP for 2035
predicted_gdp_2035 = final_model.predict(predicted_features_scaled)[0]

# Convert the predicted Nominal GDP to trillions
predicted_gdp_trillions = predicted_gdp_2035 / 1_000_000_000_000

# Print the predicted Nominal GDP for 2035 in trillions
print(f'Predicted Nominal GDP for 2035: {predicted_gdp_trillions:.2f} trillion␣
 ↪USD')
```

```
Best Ridge Alpha: 0.1
Mean Squared Error: 2.525078960472175e+19
R-squared (R2): 0.9999668767140325
Predicted Nominal GDP for 2035: 2.94 trillion USD
```

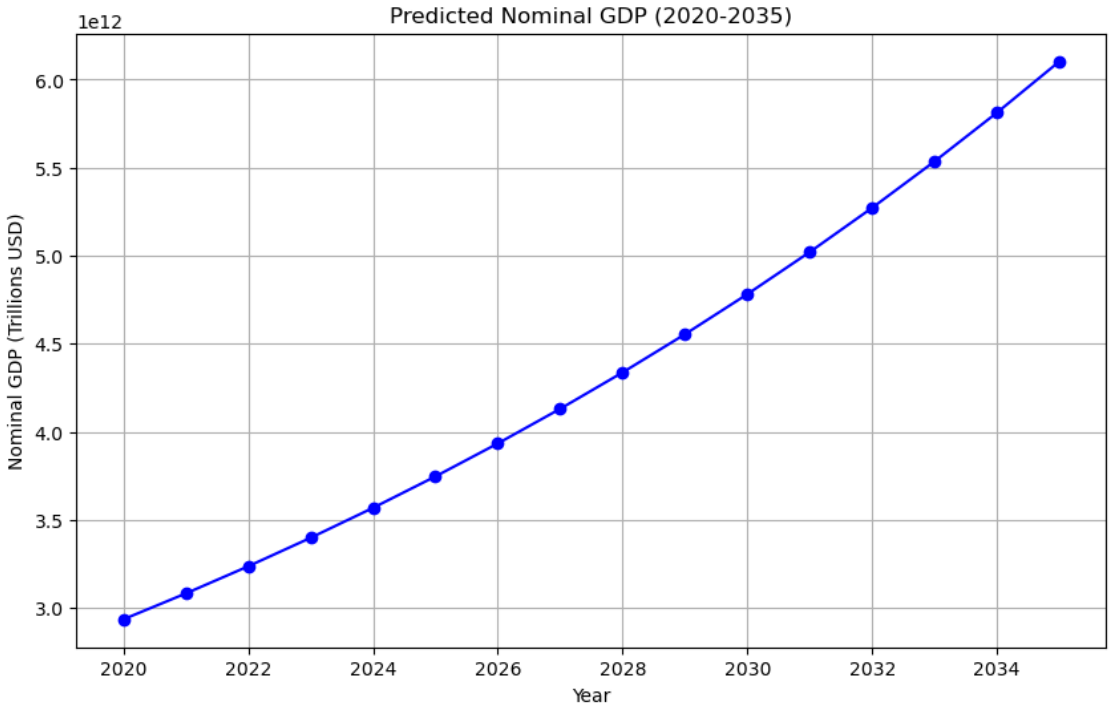
[49]:
```
import pandas as pd

# Assuming you have a DataFrame with the provided columns
# Sort the data by year if it's not already sorted
dataset = dataset.sort_values(by='Year')

# Specify the column you want to calculate the growth rate for
column_name = ' GDP per capita (current US$) '

# Find the beginning and ending values
beginning_value = dataset[column_name].iloc[0]
ending_value = dataset[column_name].iloc[-1]

# Calculate the number of years
number_of_years = dataset['Year'].max() - dataset['Year'].min()

# Calculate the annual growth rate
annual_growth_rate = ((ending_value / beginning_value) ** (1 / number_of_years)␣
 ↪- 1) * 100
```

```
print(f"Annual Growth Rate of {column_name}: {annual_growth_rate:.2f}% per␣
 ↪year")
```

```
Annual Growth Rate of  GDP per capita (current US$) : 5.40% per year
```

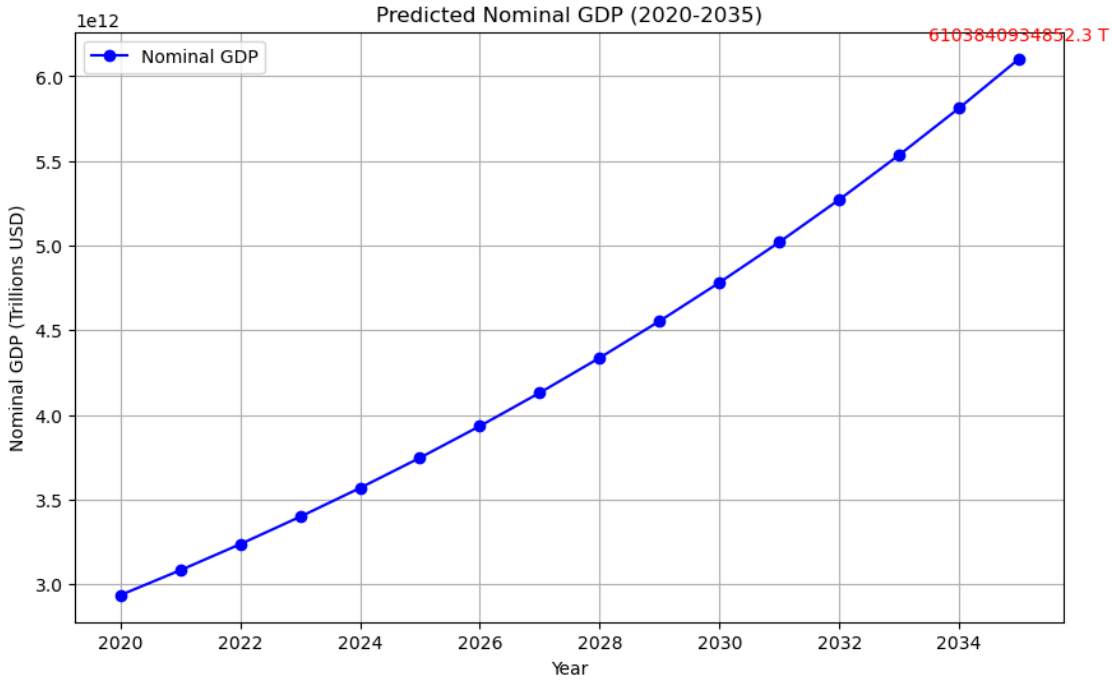
[50]:
```
import matplotlib.pyplot as plt

# Define years from 2020 to 2035
years = range(2020, 2036)

# Define the predicted Nominal GDP values for each year
predicted_gdp_values = [predicted_gdp_2035]  # Replace with your actual␣
 ↪prediction for 2020

# Placeholder annual growth rate (5% per year)
annual_growth_rate = 0.05

for _ in range(2021, 2036):
    predicted_gdp_values.append(predicted_gdp_values[-1] * (1 +␣
 ↪annual_growth_rate))

# Create the plot
plt.figure(figsize=(10, 6))
plt.plot(years, predicted_gdp_values, marker='o', linestyle='-', color='b')
plt.title('Predicted Nominal GDP (2020-2035)')
plt.xlabel('Year')
plt.ylabel('Nominal GDP (Trillions USD)')
plt.grid(True)

# Display the plot
plt.show()
```

```
<Figure size 1000x600 with 0 Axes>
```



[51]:
```
import matplotlib.pyplot as plt

# Define years from 2020 to 2035
years = range(2020, 2036)

# Define the predicted Nominal GDP values for each year
predicted_gdp_values = [predicted_gdp_2035]  # Replace with your actual␣
 ↪prediction for 2020

# Placeholder annual growth rate (5% per year)
annual_growth_rate = 0.05

for _ in range(2021, 2036):
    predicted_gdp = predicted_gdp_values[-1] * (1 + annual_growth_rate)
    predicted_gdp_values.append(predicted_gdp)

# Create the plot
plt.figure(figsize=(10, 6))
plt.plot(years, predicted_gdp_values, marker='o', linestyle='-', color='b',␣
 ↪label='Nominal GDP')
plt.title('Predicted Nominal GDP (2020-2035)')
plt.xlabel('Year')
plt.ylabel('Nominal GDP (Trillions USD)')
```

```
plt.grid(True)

# Label data points on the graph for 2035 with red color
for year, gdp in zip(years, predicted_gdp_values):
    if year == 2035:
        plt.annotate(f'{gdp:.1f} T', (year, gdp), textcoords="offset points",␣
 ↪xytext=(0, 10), ha='center', color='red')

# Display the plot
plt.legend()
plt.show()

# Print the predicted Nominal GDP value for 2035 in the output
for year, gdp in zip(years, predicted_gdp_values):
    if year == 2035:
        print(f'Nominal GDP in {year}: {gdp:.1f} T')
```




```
Nominal GDP in 2035: 6103840934852.3 T
```

[64]:
```
import pandas as pd
from sklearn.linear_model import Ridge
from sklearn.preprocessing import StandardScaler, PolynomialFeatures

# Load your dataset
```

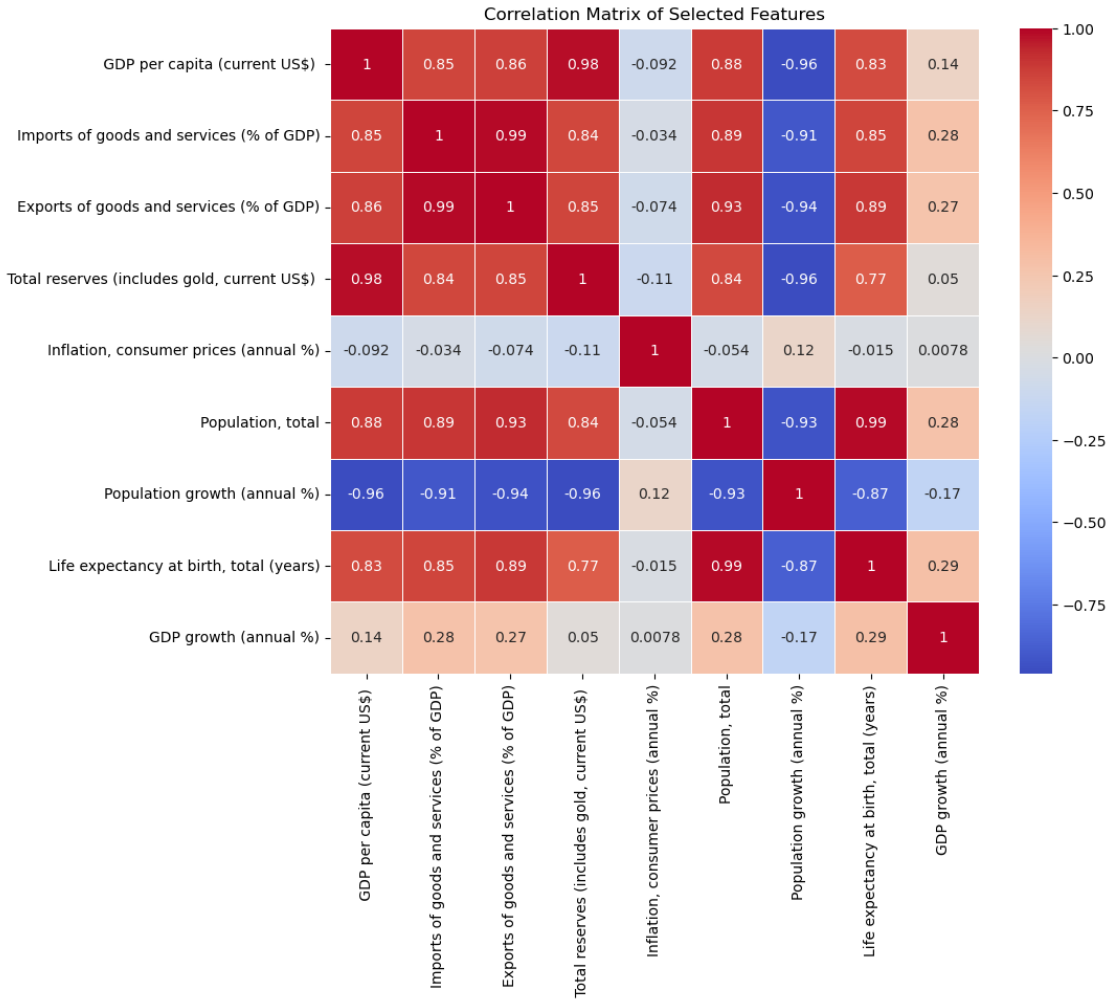
```
dataset = pd.read_csv('indianEco.csv')  # Replace 'your_dataset.csv' with your␣
 ↪dataset file path

# Filter data from 1960 to 2020
dataset = dataset[(dataset['Year'] >= 1960) & (dataset['Year'] <= 2020)]

# Drop rows with missing values
dataset = dataset.dropna()

# Calculate 'Nominal GDP' based on the formula
dataset['Nominal GDP'] = dataset[' GDP per capita (current US$) '] *␣
 ↪dataset['Population, total']

# Define the features and target variable
features = [
    ' GDP per capita (current US$) ',
    'Imports of goods and services (% of GDP)',
    'Exports of goods and services (% of GDP)',
    ' Total reserves (includes gold, current US$) ',
    'Inflation, consumer prices (annual %)',
    'Population, total',
    'Population growth (annual %)',
    'Life expectancy at birth, total (years)',
    'GDP growth (annual %)'
]

target = 'Nominal GDP'

# Feature Engineering
poly = PolynomialFeatures(degree=2)
X_poly = poly.fit_transform(dataset[features])

# Standardize the features
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X_poly)

# Train Ridge Regression
model = Ridge(alpha=1.0)
model.fit(X_scaled, dataset[target])

# Define the values for features in 2035
predicted_values_2035 = {
    ' GDP per capita (current US$) ': 1856.28,
    'Imports of goods and services (% of GDP)': 30.81,
    'Exports of goods and services (% of GDP)': 27.16,
    ' Total reserves (includes gold, current US$) ': 407157220633.08,
    'Inflation, consumer prices (annual %)': 6.95,
```

```
    'Population, total': 1643499887.00,
    'Population growth (annual %)': 0.96,
    'Life expectancy at birth, total (years)': 78.49,
    'GDP growth (annual %)': 7.30
}

# Feature Engineering for Prediction
predicted_features = poly.transform([[predicted_values_2035[feature] for␣
 ↪feature in features]])
predicted_features_scaled = scaler.transform(predicted_features)

# Predict Nominal GDP for 2035 using the model
predicted_gdp_2035 = model.predict(predicted_features_scaled)[0]

# Simulate the growth with a 5% annual growth rate
annual_growth_rate = 0.05
years_until_2035 = 2035 - 2020
for _ in range(years_until_2035):
    predicted_gdp_2035 *= (1 + annual_growth_rate)

# Convert the predicted Nominal GDP to trillions
predicted_gdp_trillions = predicted_gdp_2035 / 1_000_000_000_000

# Print the predicted Nominal GDP for 2035
print(f'Predicted Nominal GDP for 2035: {predicted_gdp_trillions:.1f} trillion␣
 ↪USD')
```

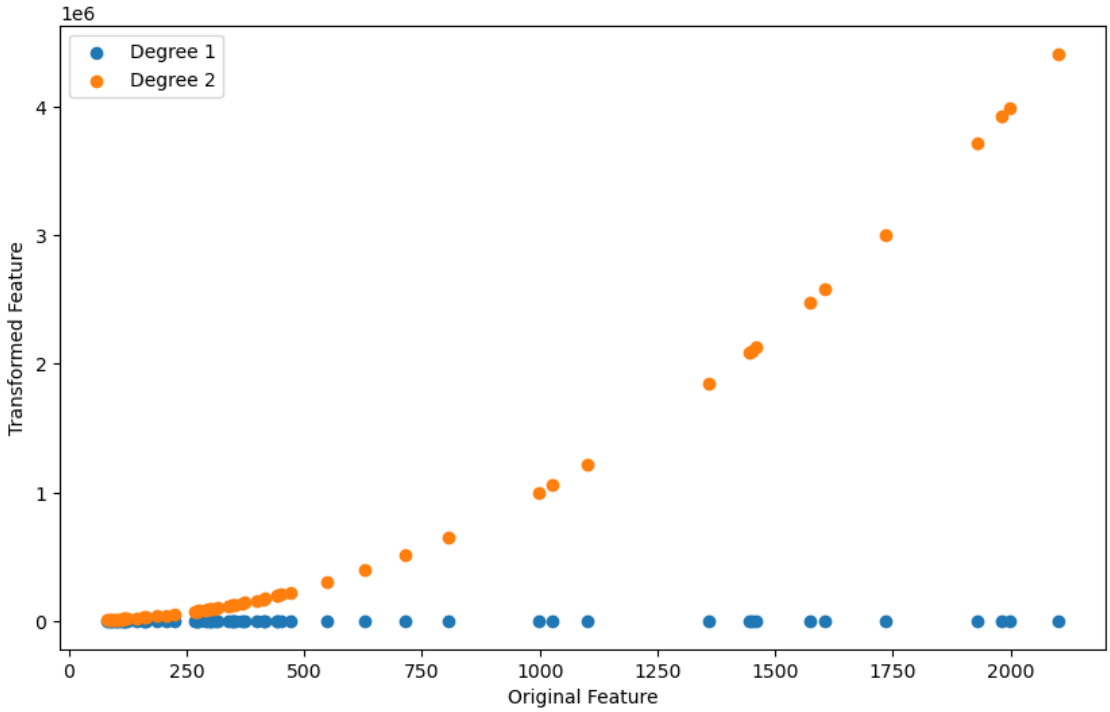
```
Predicted Nominal GDP for 2035: 6.0 trillion USD
```

[53]:
```
import seaborn as sns
import matplotlib.pyplot as plt
import pandas as pd

# Load your dataset
dataset = pd.read_csv('indianEco.csv')

# Select relevant features for correlation matrix
selected_features = [
    ' GDP per capita (current US$) ',
    'Imports of goods and services (% of GDP)',
    'Exports of goods and services (% of GDP)',
    ' Total reserves (includes gold, current US$) ',
    'Inflation, consumer prices (annual %)',
    'Population, total',
    'Population growth (annual %)',
    'Life expectancy at birth, total (years)',
    'GDP growth (annual %)'
```

```
]

# Subset the dataset with selected features
selected_data = dataset[selected_features]

# Calculate the correlation matrix
correlation_matrix = selected_data.corr()

# Create a heatmap
plt.figure(figsize=(10, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', linewidths=.5)
plt.title('Correlation Matrix of Selected Features')
plt.show()
```



[55]:
```
from sklearn.preprocessing import PolynomialFeatures
import matplotlib.pyplot as plt

# Assuming X is your input feature (e.g., ' GDP per capita (current US$) ')
X = dataset[' GDP per capita (current US$) '].values.reshape(-1, 1)

# Create polynomial features up to degree 2
poly = PolynomialFeatures(degree=2)
X_poly = poly.fit_transform(X)

# Plot the original and transformed features
plt.figure(figsize=(10, 6))
plt.scatter(X, X_poly[:, 1], label='Degree 1')
plt.scatter(X, X_poly[:, 2], label='Degree 2')
plt.xlabel('Original Feature')
plt.ylabel('Transformed Feature')
plt.legend()
plt.show()
```



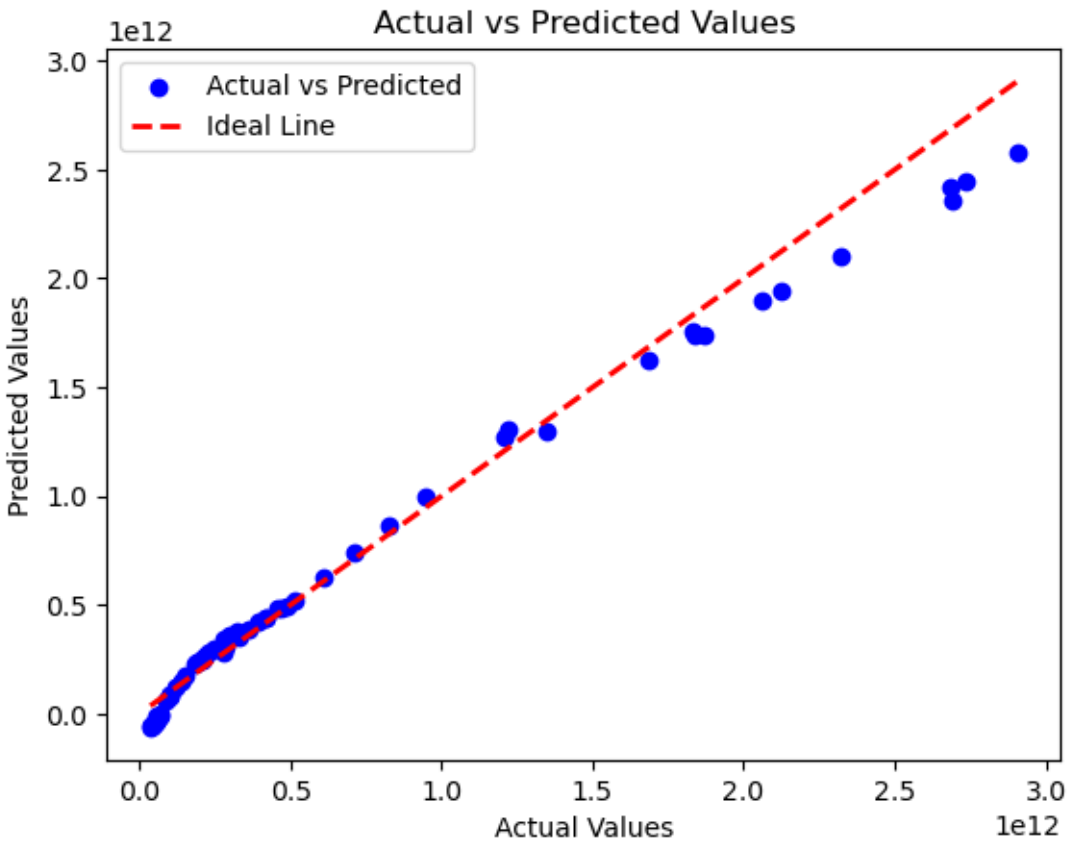
[57]:
```
pip install graphviz
```

```
Collecting graphviz
  Downloading graphviz-0.20.1-py3-none-any.whl (47 kB)
     ---------------------------------------- 47.0/47.0 kB 2.3 MB/s eta 0:00:00
```

```
Installing collected packages: graphviz
Successfully installed graphviz-0.20.1
Note: you may need to restart the kernel to use updated packages.
```

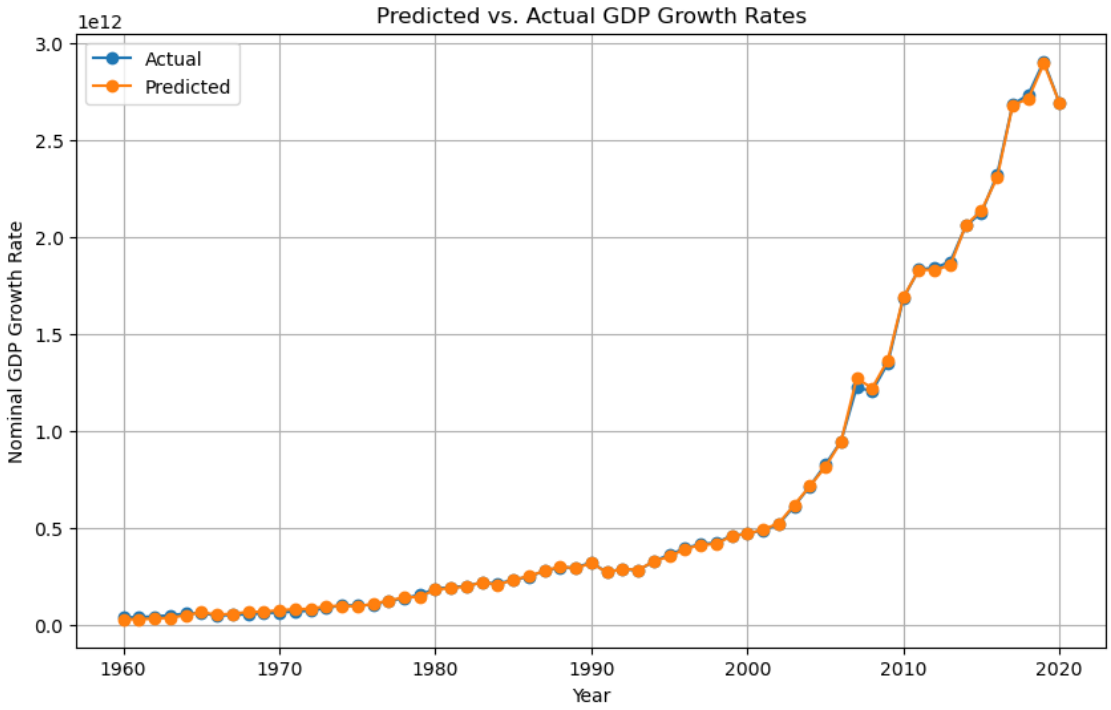
[62]:
```python
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import cross_val_predict
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score

# Assuming X and y are your feature matrix and target variable
# Replace this with your actual data
# X, y = ...

# Create a Linear Regression model
model = LinearRegression()

# Perform cross-validation
y_pred = cross_val_predict(model, X, y, cv=5)  # Assuming 5-fold␣
 ↪cross-validation

# Calculate performance metrics
mse = mean_squared_error(y, y_pred)
r_squared = r2_score(y, y_pred)

# Print the metrics
print(f'Mean Squared Error: {mse}')
print(f'R-squared: {r_squared}')

# Create a chart comparing actual vs predicted values with different colors
plt.scatter(y, y_pred, color='blue', label='Actual vs Predicted')
plt.plot([min(y), max(y)], [min(y), max(y)], color='red', linestyle='--',␣
 ↪linewidth=2, label='Ideal Line')
plt.xlabel('Actual Values')
plt.ylabel('Predicted Values')
plt.title('Actual vs Predicted Values')
plt.legend()
plt.show()
```

```
Mean Squared Error: 1.0968637680792994e+22
R-squared: 0.9835508837332054
```

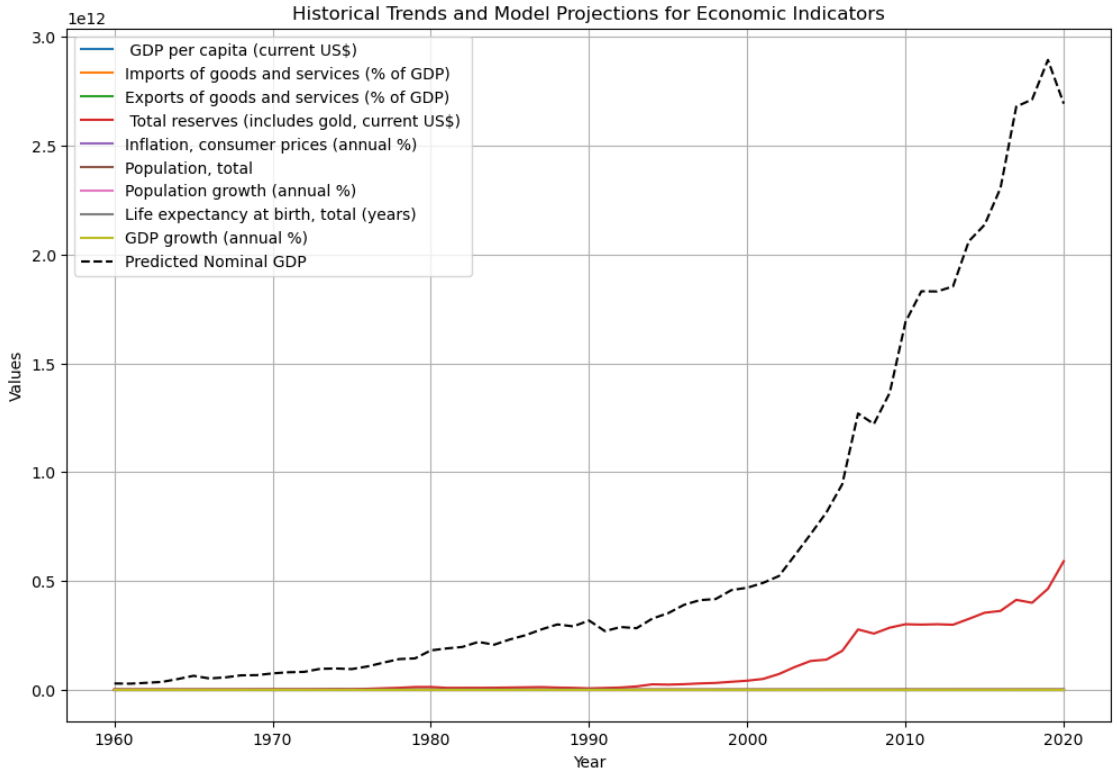


[65]:
```
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.linear_model import Ridge
from sklearn.preprocessing import StandardScaler, PolynomialFeatures
import numpy as np

# Load your dataset
dataset = pd.read_csv('indianEco.csv')  # Replace 'your_dataset.csv' with your␣
 ↪dataset file path

# Filter data from 1960 to 2020
dataset = dataset[(dataset['Year'] >= 1960) & (dataset['Year'] <= 2020)]

# Drop rows with missing values
dataset = dataset.dropna()

# Calculate 'Nominal GDP' based on the formula
dataset['Nominal GDP'] = dataset[' GDP per capita (current US$) '] *␣
 ↪dataset['Population, total']
```

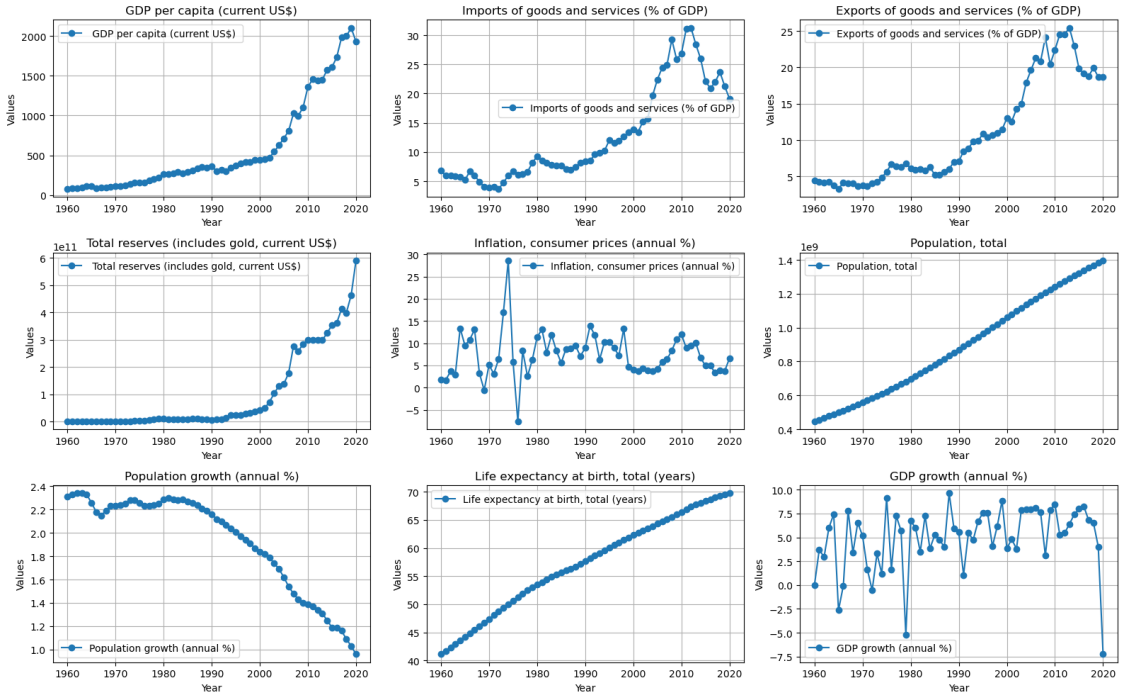
```
# Define the features and target variable
features = [
    ' GDP per capita (current US$) ',
    'Imports of goods and services (% of GDP)',
    'Exports of goods and services (% of GDP)',
    ' Total reserves (includes gold, current US$) ',
    'Inflation, consumer prices (annual %)',
    'Population, total',
    'Population growth (annual %)',
    'Life expectancy at birth, total (years)',
    'GDP growth (annual %)'
]

target = 'Nominal GDP'

# Feature Engineering
poly = PolynomialFeatures(degree=2)
X_poly = poly.fit_transform(dataset[features])

# Standardize the features
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X_poly)

# Train Ridge Regression
model = Ridge(alpha=1.0)
model.fit(X_scaled, dataset[target])

# Predict Nominal GDP for the years in the dataset
dataset['Predicted Nominal GDP'] = model.predict(X_scaled)

# Plot the predicted vs. actual GDP growth rates over different years
plt.figure(figsize=(10, 6))
plt.plot(dataset['Year'], dataset[target], label='Actual', marker='o')
plt.plot(dataset['Year'], dataset['Predicted Nominal GDP'], label='Predicted',␣
 ↪marker='o')
plt.title('Predicted vs. Actual GDP Growth Rates')
plt.xlabel('Year')
plt.ylabel('Nominal GDP Growth Rate')
plt.legend()
plt.grid(True)
plt.show()
```



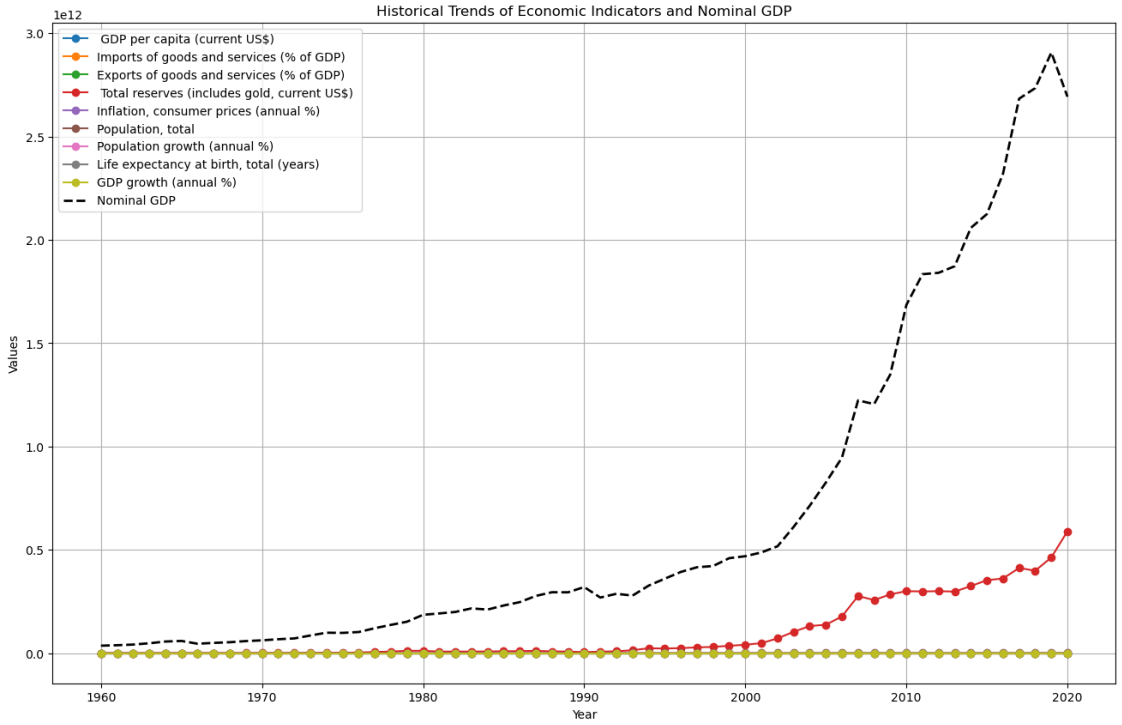
[71]:
```
# Line Charts
plt.figure(figsize=(12, 8))

# Plot each feature over the years
for feature in features:
    plt.plot(dataset['Year'], dataset[feature], label=feature)

# Plot the predicted Nominal GDP
plt.plot(dataset['Year'], dataset['Predicted Nominal GDP'], label='Predicted␣
 ↪Nominal GDP', linestyle='--', color='black')

plt.title('Historical Trends and Model Projections for Economic Indicators')
plt.xlabel('Year')
plt.ylabel('Values')
plt.legend()
plt.grid(True)
plt.show()
```



[72]:
```
# Line Charts with all attributes and y-axis labels
plt.figure(figsize=(16, 10))

# Create a subplot with a specified number of rows and columns
num_rows = 3  # You can adjust the number of rows based on your preference
num_cols = 3  # You can adjust the number of columns based on your preference

# Iterate through features and create subplots
for i, feature in enumerate(features):
    plt.subplot(num_rows, num_cols, i + 1)
    plt.plot(dataset['Year'], dataset[feature], label=feature, marker='o')
    plt.title(feature)
    plt.xlabel('Year')
    plt.ylabel('Values')
    plt.legend()
    plt.grid(True)

# Adjust layout for better spacing
plt.tight_layout()
plt.show()
```

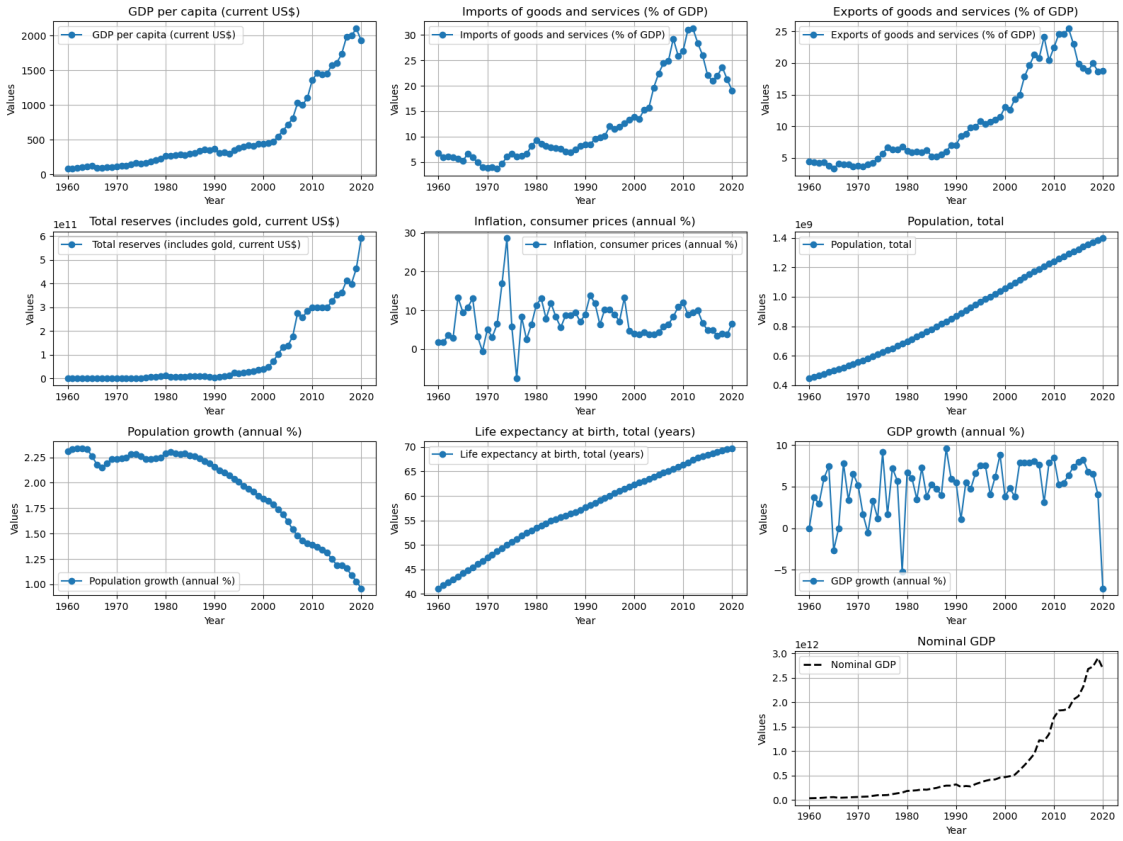


[75]:
```
# Line Charts with all attributes, including Nominal GDP, in a single graph
plt.figure(figsize=(16, 10))

# Plot all features along with Nominal GDP
for i, feature in enumerate(features):
    plt.plot(dataset['Year'], dataset[feature], label=feature, marker='o')

# Plot Nominal GDP
plt.plot(dataset['Year'], dataset['Nominal GDP'], label='Nominal GDP',␣
 ↪linestyle='--', color='black', linewidth=2)

plt.title('Historical Trends of Economic Indicators and Nominal GDP')
plt.xlabel('Year')
plt.ylabel('Values')
plt.legend()
plt.grid(True)
plt.show()
```



[76]:
```
# Line Charts with all attributes and Nominal GDP in a 3x4 grid
plt.figure(figsize=(16, 12))

# Create a subplot with a specified number of rows and columns
num_rows = 4  # 3 rows for features and 1 row for Nominal GDP
num_cols = 3  # You can adjust the number of columns based on your preference

# Iterate through features and create subplots
for i, feature in enumerate(features):
    plt.subplot(num_rows, num_cols, i + 1)
    plt.plot(dataset['Year'], dataset[feature], label=feature, marker='o')
    plt.title(feature)
    plt.xlabel('Year')
    plt.ylabel('Values')
    plt.legend()
    plt.grid(True)

# Plot Nominal GDP in the last row
plt.subplot(num_rows, num_cols, num_cols * num_rows)
plt.plot(dataset['Year'], dataset['Nominal GDP'], label='Nominal GDP',␣
 ↪linestyle='--', color='black', linewidth=2)
plt.title('Nominal GDP')
plt.xlabel('Year')
```

```
plt.ylabel('Values')
plt.legend()
plt.grid(True)

# Adjust layout for better spacing
plt.tight_layout()
plt.show()
```



[ ]: