20250430_01

April 30, 2025

[41]:
```
import pandas as pd

data = pd.read_csv('cleaned_data.csv')
```

[43]:
```
data.head()
```

[43]:
```
  Country Name           year  Access to electricity (% of population)  \
0    Argentina  2016 [YR2016]                                 99.849579
1    Argentina  2017 [YR2017]                                100.000000
2    Argentina  2018 [YR2018]                                 99.989578
3    Argentina  2019 [YR2019]                                100.000000
4    Argentina  2020 [YR2020]                                100.000000

   CO2 emissions (metric tons per capita)  GDP (constant 2015 US$)
0                                4.201846             5.823766e+11
1                                4.071308             5.987909e+11
2                                3.975772             5.831181e+11
3                                3.740650             5.713045e+11
4                                     NaN             5.147724e+11
```

[45]:
```
# First we rename 'year' to 'Year', somehow I forgot it yesterday
data.rename(columns = {'year':'Year'}, inplace = True)
```

[47]:
```
# Then we make the year be just integers
data['Year'] = data['Year'].str.extract(r'(\d{4})')
data['Year'] = data['Year'].astype('int')
```

[49]:
```
data.head()
```

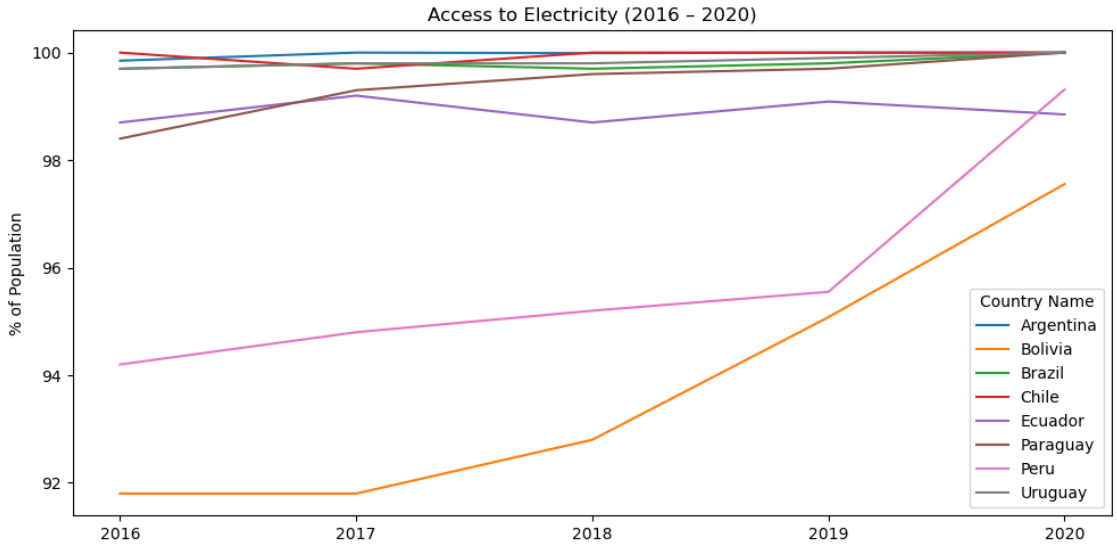
[49]:
```
  Country Name  Year  Access to electricity (% of population)  \
0    Argentina  2016                                 99.849579
1    Argentina  2017                                100.000000
2    Argentina  2018                                 99.989578
3    Argentina  2019                                100.000000
4    Argentina  2020                                100.000000

   CO2 emissions (metric tons per capita)  GDP (constant 2015 US$)
0                                4.201846             5.823766e+11
```

1	4.071308	5.987909e+11
2	3.975772	5.831181e+11
3	3.740650	5.713045e+11
4	NaN	5.147724e+11

[119]:
```
# Now we visualize, yipee.
import seaborn as sns
import matplotlib.pyplot as plt

plt.figure(figsize = (10, 5))
sns.lineplot(data = data, x = 'Year', y = 'Access to electricity (% of␣
 ↪population)', hue = 'Country Name')
plt.title('Access to Electricity (2016 - 2020)')
plt.ylabel('% of Population')
plt.xlabel('')
plt.xticks([2016, 2017, 2018, 2019, 2020])
plt.tight_layout()
plt.show()
```



0.0.1 Observations

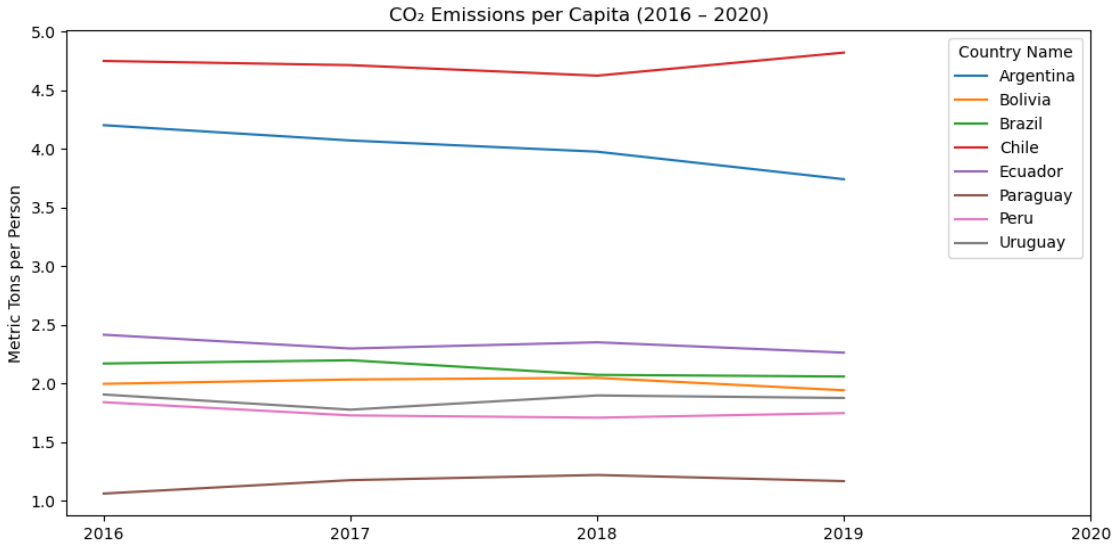
- **General Observation**: All 8 countries had high electricity access starting from 2016, with minimum levels around **92%**.
- **Bolivia**:
  - Significant improvement from around ~**92% in 2016** to almost ~**98% by 2020**.
- **Peru**:
  - Grew steadily from ~**94%** to ~**96%**, followed by a sudden surge in 2019 and reach around **99%** in 2020.
- **Ecuador**:

  - Maintained a high level between **98–99%**, with slight yearly fluctuations.
- **Paraguay**:
  - Improved from around ~**98%** to a full **100%** coverage.
- **Other countries (Argentina, Brazil, Chile, Uruguay)**:
  - Already had **99%** in 2016 and reached **100%** by 2020.

0.0.2 Summary:

South America has made strong progress in universal electricity access.
By 2020, most countries achieved or nearly achieved full national coverage.

[117]:
```
plt.figure(figsize = (10, 5))
sns.lineplot(data = data, x = 'Year', y = 'CO2 emissions (metric tons per␣
↪capita)', hue = 'Country Name')
plt.title('CO  Emissions per Capita (2016 - 2020)')
plt.ylabel('Metric Tons per Person')
plt.xlabel('')
plt.xticks([2016, 2017, 2018, 2019, 2020])
plt.tight_layout()
plt.show()
```



0.0.3 Observations

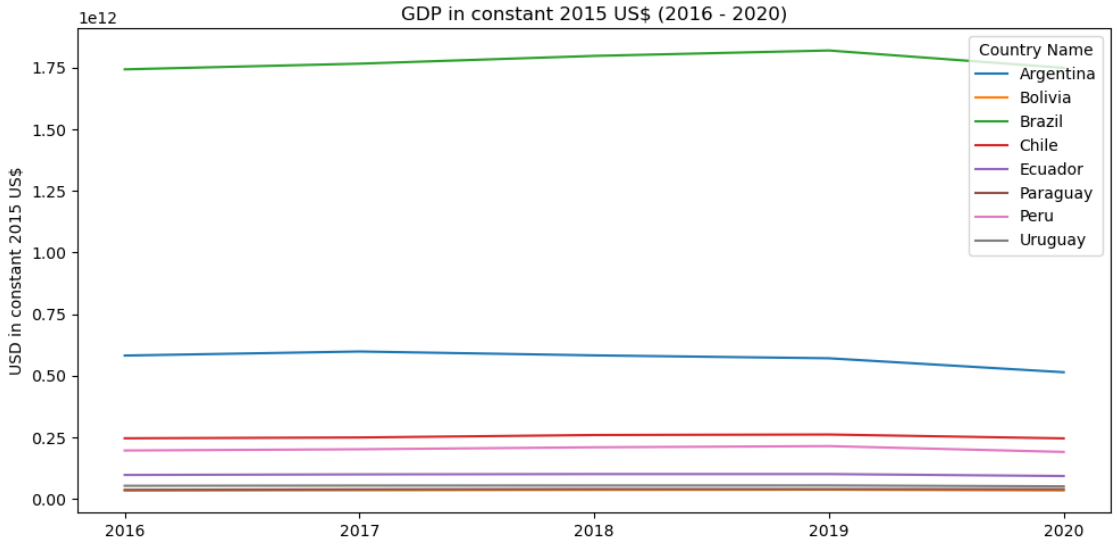
- **2020 data is completely missing**: All countries have `NaN` values for the year 2020.
- **Chile**:
  - Has the highest per capita CO emissions among the eight countries.
  - Emissions continued to increase up to 2019.
- **Argentina**:
  - Shows the second highest emission level.
  - Presents a consistent downward trend over the years.

- **Paraguay**:
  - Has the lowest emissions throughout the period.
  - Maintains a stable and low emission level.
- **Other countries (e.g., Brazil, Uruguay, Ecuador, etc.)**:
  - Remain in the mid-range.
  - No strong upward or downward trend observed.

0.0.4 Summary:

Argentina and Chile exhibit the most distinct patterns in CO emissions.
Paraguay remains consistently low, while other countries are relatively stable.

[125]:
```
plt.figure(figsize=(10, 5))
sns.lineplot(data = data, x = 'Year', y = 'GDP (constant 2015 US$)', hue =␣
↪'Country Name')
plt.title('GDP in constant 2015 US$ (2016 - 2020)')
plt.ylabel('USD in constant 2015 US$')
plt.xlabel('')
plt.xticks([2016, 2017, 2018, 2019, 2020])
plt.tight_layout()
plt.show()
```



0.0.5 Observations

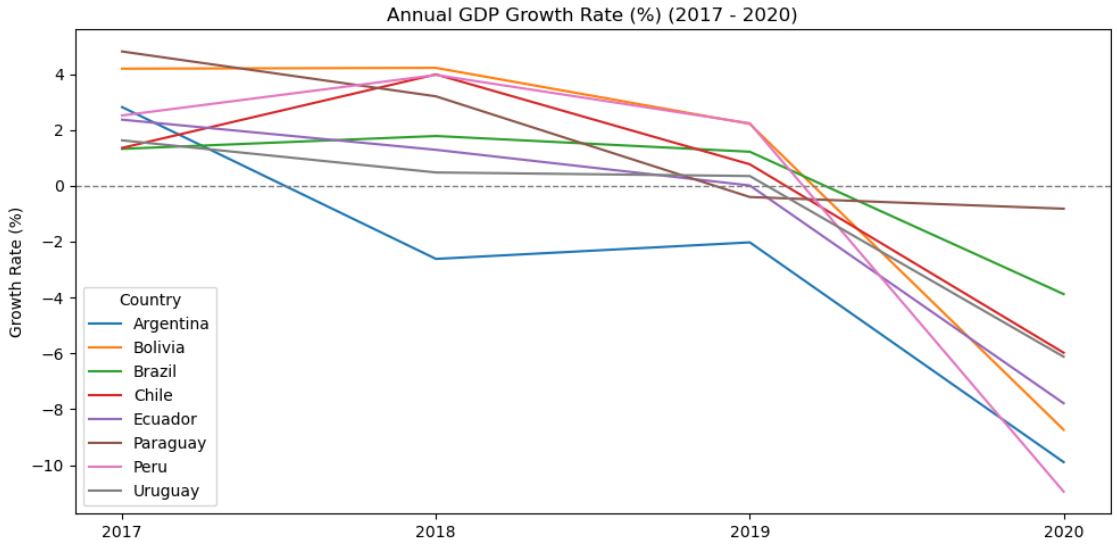
- Raw GDP values across countries vary significantly in scale, from tens of billions to over a trillion USD.
- Year-over-year changes appear minimal on the chart, likely due to the small percentage growth (typically within ±5%) relative to large absolute values.

0.0.6 Note:

The lack of visual fluctuation is expected in raw GDP charts.
Further insights may require log-scale transformation or growth rate analysis.

[141]:
```
# We use growth rate
gdp_growth_pivot = data.pivot_table(index = 'Year', columns = 'Country Name',␣
 ↪values = 'GDP (constant 2015 US$)')
gdp_growth = gdp_growth_pivot.pct_change() * 100
gdp_growth_melt = gdp_growth.reset_index().melt(id_vars = 'Year', var_name =␣
 ↪'Country', value_name = 'GDP Growth Rate (%)')
```

[149]:
```
plt.figure(figsize=(10, 5))
sns.lineplot(data = gdp_growth_melt, x = 'Year', y = 'GDP Growth Rate (%)', hue␣
 ↪= 'Country')
plt.title('Annual GDP Growth Rate (%) (2017 - 2020)') # Since 2016 is NaN
plt.ylabel('Growth Rate (%)')
plt.xlabel('')
plt.xticks([2017, 2018, 2019, 2020])
plt.axhline(0, color = 'gray', linestyle = '--', linewidth = 1)  # We add 0%␣
 ↪line for reference
plt.tight_layout()
plt.show()
```



0.0.7 Observations

- **Argentina**:
  - Showed negative GDP growth starting from 2017.
  - Declined further in 2020, likely because the pandemic.
- **Paraguay**:

  - Also declined in 2020, but the drop was much smaller compared to other countries.
  - The 2020 GDP growth rate stayed close to 0%, indicating relatively better economic.
- **Other countries** (e.g., Brazil, Chile, Ecuador, etc.):
  - Maintained relatively stable positive growth from 2017 to 2019.
  - Experienced sharp declines in 2020 due to the COVID-19 pandemic.

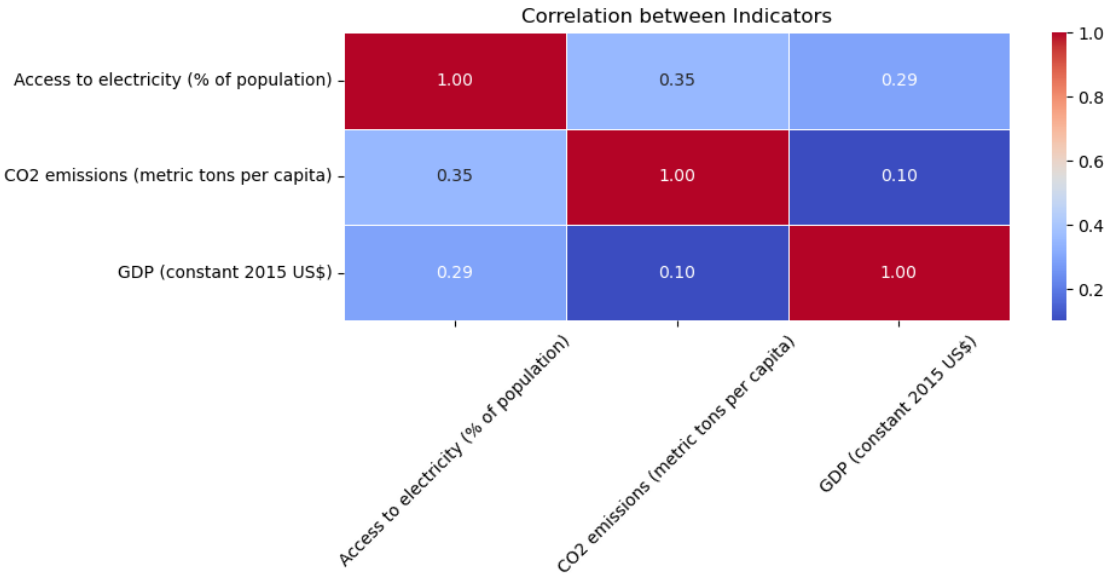
0.0.8 Summary:

Most South American countries experienced pandemic-driven economic contraction in 2020.
Argentina faced prolonged recession, while Paraguay showed relative stability.

[169]:
```
corr_data = data[['Access to electricity (% of population)',
                  'CO2 emissions (metric tons per capita)',
                  'GDP (constant 2015 US$)']]

# Calculating Pearson correlation
corr_matrix = corr_data.corr(method = 'pearson')

# Making heatmap
plt.figure(figsize = (10, 5))
sns.heatmap(corr_matrix, annot = True, cmap = 'coolwarm', fmt = ".2f",␣
 ↪linewidths = 0.5)
plt.title('Correlation between Indicators')
plt.xticks(rotation = 45)
plt.tight_layout()
plt.show()
```



0.0.9 Observation:

Surprisingly, all three pairs show only **weak correlations**.
Despite intuitive expectations (e.g., higher GDP leading to higher emissions),
the data does not support strong linear relationships across the 8 countries during 2016–2020.