Economic Production vs Environmental Destruction

Does American economic prosperity have an effect on environmental pollutants?

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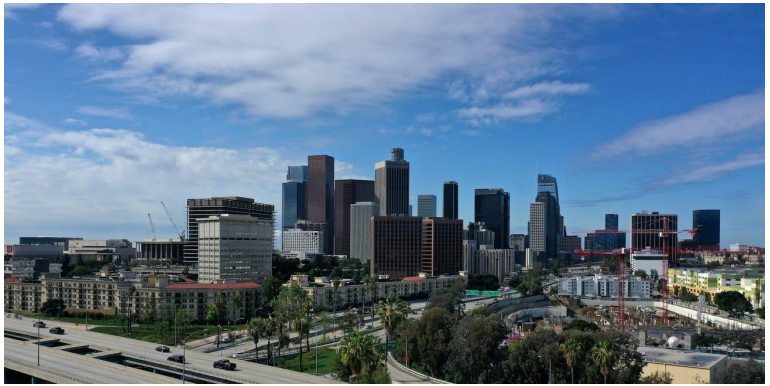
Motivation & Summary

Los Angeles CA - June 11, 2019



Los Angeles CA - April 7, 2020

Questions and Data

- Does American economic prosperity have an effect on environmental pollutants?
  - What are economic signifiers of prosperity?
    - GDP
    - Unemployment Rate
  - What factors will we look at for environmental pollutants?
    - Carbon Emissions
    - Nitrogen Dioxide, Sulfur Dioxide, Carbon Monoxide and Ozone
- Economic Data:
  - Unemployment by State U.S. Bureau of Labor Statistics
  - GDP by State: Bureau of Economic Analysis
- Environmental Pollutant Data:
  - State Carbon Dioxide Emissions Data: U.S. Energy Information Administration
    - Collected from Coal, Commercial, Electricity, Industrial, Natural gas, Petroleum, Residential, Transportation Sectors
  - U.S. Air Pollution Data: Data.World collected from Environmental Protection Agency

Hypotheses:

1) If there is a positive correlation between economic prosperity and pollution, then we would expect to see an decrease in the pollutants released into the atmosphere alongside an decrease in GDP.

2) If there is a positive correlation between economic prosperity and pollution, then we would expect to see a decrease in the pollutants released into the atmosphere alongside increases in unemployment.

3) If there is a positive correlation between economic prosperity and pollution, then we would expect to see decreases in the rate of carbon emissions alongside increases in rate of unemployment.

Data Cleanup & Exploration

Data Cleanup

```
#got rid of States that do not date back to 2005
states_df = pollutant_df2.loc[pollutant_df2['Year'] == 2005].reset_index()
pollutant_df3 = pollutant_df2[pollutant_df2.State.isin(states_df['State'])]
pollutant_df3.head(3)
```

	State	Year	Month	NO2 Units	Average of NO2 Mean	O3 Units	Average of O3 Mean	SO2 Units	Average of SO2 Mean	CO Units	Average of CO Mean
0	Arizona	2005	1	Parts per billion	22.674850	Parts per million	0.010018	Parts per billion	1.215276	Parts per million	0.661753
1	Arizona	2005	2	Parts per billion	19.542680	Parts per million	0.015479	Parts per billion	0.678611	Parts per million	0.466213
2	Arizona	2005	3	Parts per billion	19.674832	Parts per million	0.024243	Parts per billion	1.245270	Parts per million	0.523486

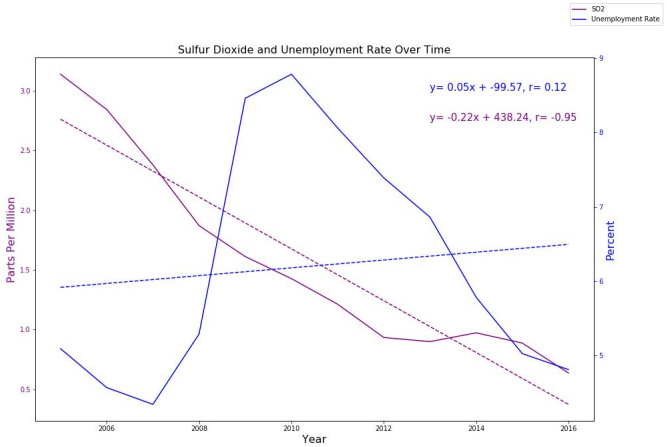
```
#Inner Joined Datasets, grouped by year for final dataset
employ_pollutant = pollutant_df2.merge(employ_df, how = "inner")
employ_pollutant_year = employ_pollutant.groupby(["Year"]).mean()
employ_pollutant_year = employ_pollutant_year.rename(columns = {"Value": "Unemployment"})
employ_pollutant_year.head(3)
```

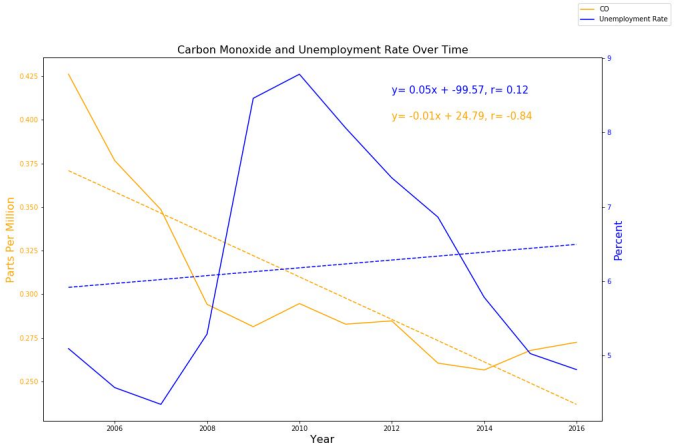
Year	Month	Average of NO2 Mean	Average of O3 Mean	Average of SO2 Mean	Average of CO Mean	Unemployment	1-Month % Change
2005	6.487047	15.707955	0.024888	3.139843	0.426073	5.089119	-0.473575
2006	6.468504	13.773114	0.025567	2.844463	0.376567	4.564173	-0.584252
2007	6.466667	12.507063	0.025739	2.380635	0.348483	4.337895	0.372982

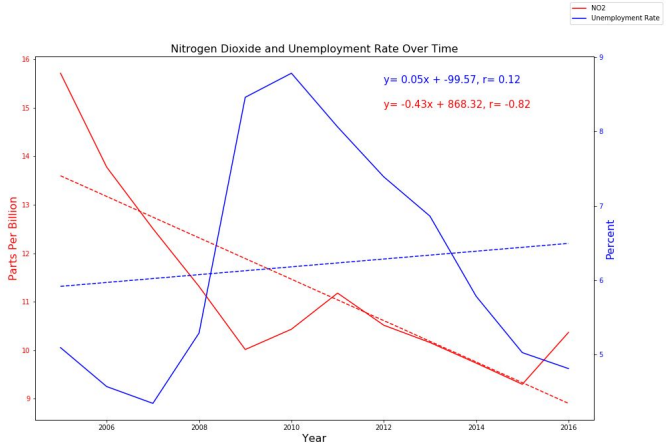
Data Cleanup & Exploration

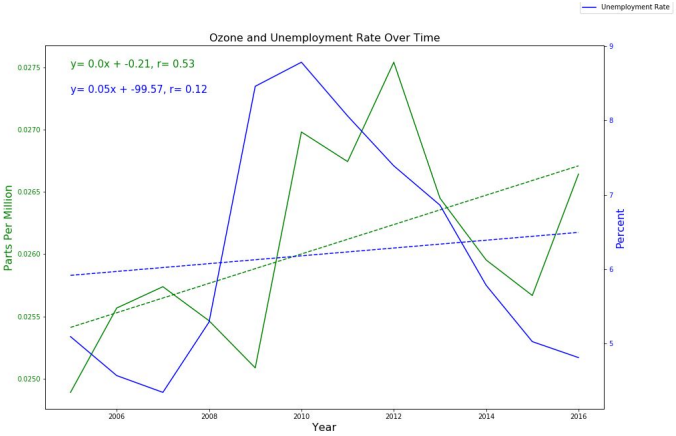
Data Analysis

Unemployment Rate vs Air Pollutants



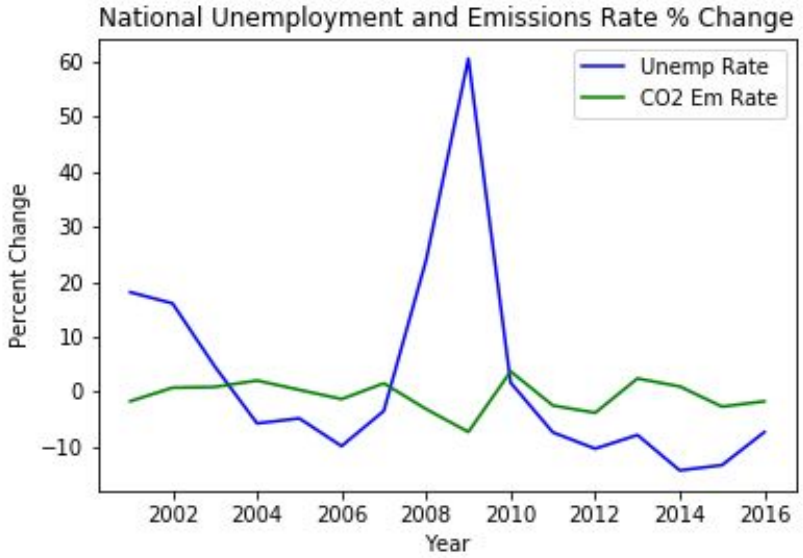






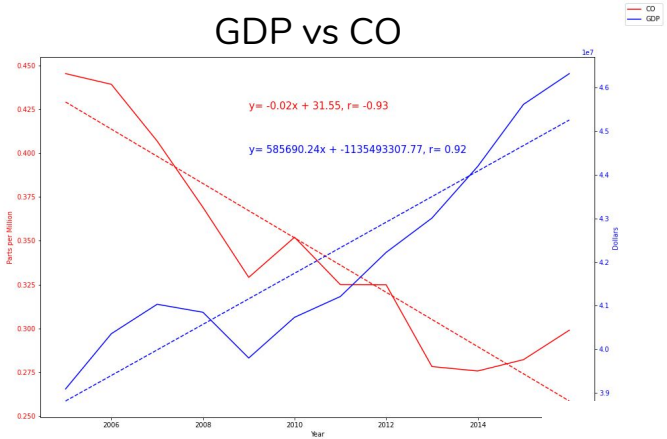
Change in Unemployment vs Change in Carbon Emissions

- Diagram displays percent change in rates
- Slight decline in CO2 emissions at the same there was an increase in unemployment rate
- Would have liked to dig more into CO2 producers by sector and by fuel type.

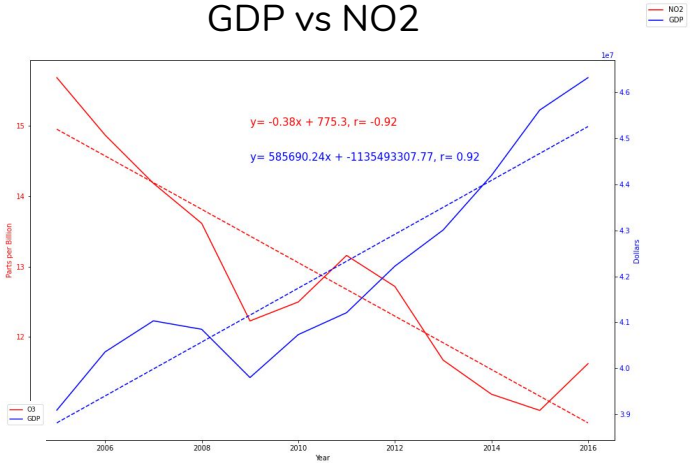


GDP vs Air Pollutants

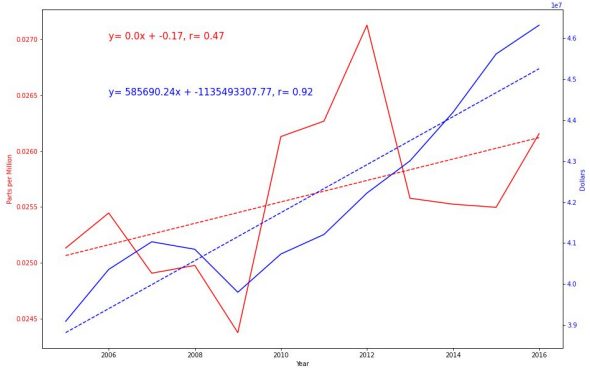
GDP vs CO



GDP vs NO2

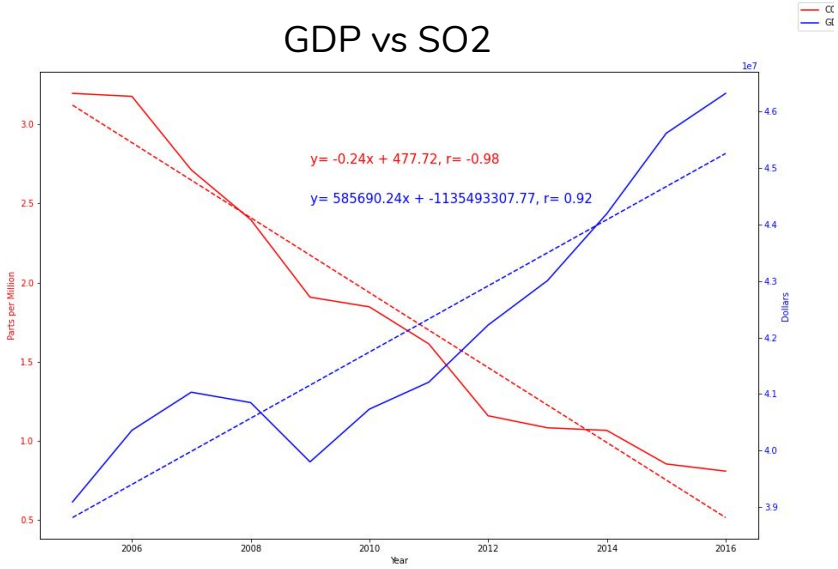


GDP vs O3

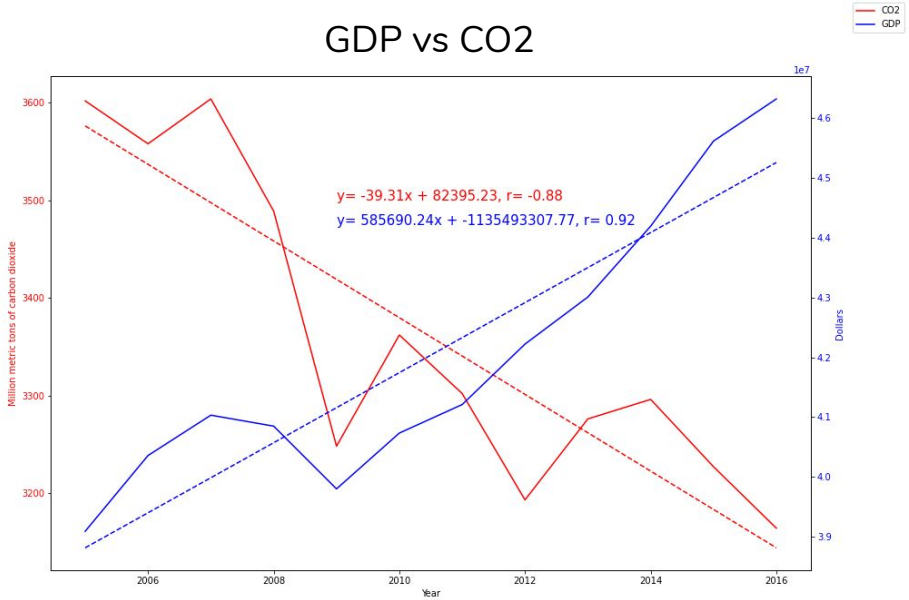


GDP vs Air Pollutants

GDP vs SO2



GDP vs CO2



T-Test: Pollutants 2007 vs 2010

In [27]:
```
Year1 = emiss_df[emiss_df["Sample Year"] == 2007]
Year2 = emiss_df[emiss_df["Sample Year"] == 2010]
```

In [34]:
```
from scipy.stats import ttest_ind

ttest_ind(Year1["Average of NO2 Mean"], Year2["Average of NO2 Mean"])
```

Out[34]:
```
Ttest_indResult(statistic=3.8486221100890963, pvalue=0.00013087470415294478)
```

In [31]:
```
Year1 = emiss_df[emiss_df["Sample Year"] == 2007]
Year2 = emiss_df[emiss_df["Sample Year"] == 2010]
```

In [33]:
```
stats.ttest_ind(Year1["Average of SO2 Mean"], Year2["Average of SO2 Mean"], equal_var=False)
```

Out[33]:
```
Ttest_indResult(statistic=7.400755724292351, pvalue=4.86791088198715e-13)
```

In [ ]:
```

```

Conclusion

- The majority of environmental pollutants seem to be decreasing over time regardless of economic productivity (with the exception of ozone, which increases minimally). However, during peak times of economic recession, they decrease at a faster rate.

Therefore: We reject hypotheses 1 and 2, and accept hypotheses 3.

Closing Thoughts

- Difficulties:
  - Finding more current data, along with a larger timespan to analyze more than one recession.
- Additional Research Opportunities:
  - Given the current state of the economy and more specifically, unemployment, it would be interesting to see 2020 Q1 data for air pollutants and see how significantly the Stay-In-Place orders affected the amount of pollutants in the air
  - Compare on a state by state level. Compare states that rely on alternative energy or offer energy incentives to states that are more carbon reliant.
  - Focusing on specific industries
  - If we had access, having environmental data going back decades to track changes through other economic declines

Questions?