**Final Report**

Wenjia Ma

**Introduction**

In this project, I analyzed the relationship between energy usage and gross domestic product with data of 181 countries from 2004 to 2017. With both OLS regression and panel regressions, I found positive relationship between energy consumption and GDP.

The causality relationship between energy consumption and income is a well-studied topic in energy economics. Intuitively speaking, more energy consumption usually indicates more production and economic behavior. However, to testify this relationship, we need to understand the difference between comparison across countries and comparison within countries across time. Take Iceland as an example, due to the harsh environment, Icelanders tend to consume more energy on domestic heating. If we compare the energy usage per capita of Iceland to countries with less difficult climate, such as the United States, we will falsely draw the conclusion that Iceland has higher GDP per capita than the U.S.. In order to avoid this problem, I will use regression with fixed effects to control for variation across different countries and focus on the comparison within one country at different time point.

Moreover, when estimating the effect of energy consumption on GDP growth, there is also concerns of endogeneity. It is hard to determine whether the increase in energy consumption leads to more production, or higher GDP induces more energy consumption. I decide to use lagged independent variable as a proxy of the present value. The idea is that GDP this year is unlikely to affect the energy consumption last year.

**Data and Results**

I collected data on GDP per capita and energy consumption per capita from the World Bank. Both data sets cover 181 countries from 2004 to 2017. Before quantitative analysis, Figure 1 gives us a brief idea of what the data looks like. We can see from the graph that both Ethiopia (Green) and China (Red) show positive relationship between their GDP per capita and energy consumption per capita. On the other hand, the line of the United States (Blue) stagnated at the same place during this period. The line of New Zealand (Purple) shows negative relationship. Based on this fact, it is possible that countries during primary development have strong positive correlation between energy consumption and production, while well-developed countries may have different pattern. Thus, I decide to use quantile regression to capture the heterogeneous effects in different countries.

Figure : Log Plot of GDP per capita and Energy Consumption per capita

A close up of a map

Description automatically generated

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Description automatically generated From the regression results (please run the script to see), electric power consumption per capita has a positive relationship with GDP per capita, considering year fixed effect and country fixed effect. This relationship holds when we use lagged electricity consumption. With quantile regression, as shown in Figure 2, we can see that the coefficient of electricity consumption changes as the electricity reaches different level. More specifically, when the electricity consumption is very low or very high, the relationship is relatively weaker. The relationship is the strongest for country near the median level of electricity consumption.

Figure : Quantile Regression and OLS Regression

**Conclusion**

In this study, I use country-level panel data from the World Bank to analyze the relationship between energy consumption per capita and GDP per capita. Generally, more energy consumption leads to higher GDP per capita. This effect is consistent when I use lagged electricity consumption as a proxy for present energy consumption to counter endogeneity problem. Moreover, I am able to find differentially effect of electricity consumption on GDP per capita with different level of energy usage. With very low or high energy consumption, the positive relationship between electricity usage per capita and GDP per capita is weaker.

This study has several caveats: First, because of data limitation, I didn’t include other covariates to control for other factors that may affect GDP per capita. Second, the estimations suffer from the concern of non-stationery and autocorrelation as a time-series data. Future research should take these issues into consideration.