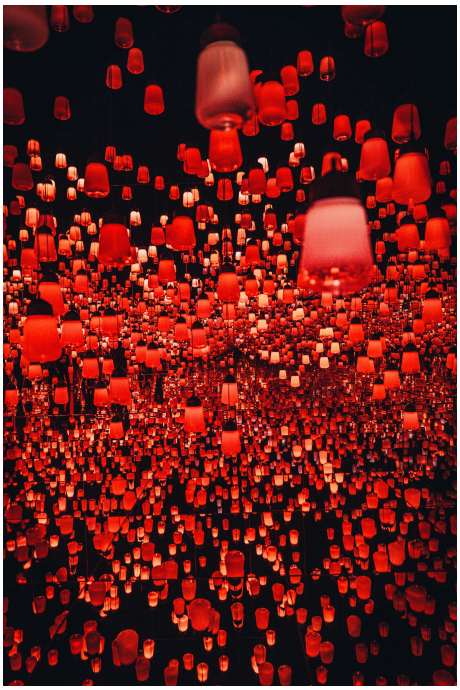

Analysis of CO2 Emission and Energy Consumption around the world

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Country China and USA

0.1 Read data

```
# filtering data from 1970 to 2017 for China and the United States
data <- Analysis_Data %>%
  filter(Entity %in% c("China","United States")) %>%
  filter(Year>=1970 & Year<=2017)
dim(data)
```

```
## [1] 96  7
```

0.2 Overall descriptive statistical analysis

```
data <- data %>%
  rename(Average.annual.hours.worked=
         "Average annual hours worked by persons engaged (avh) (PWT 9.1 (2019))",
         GDP.per.capita="Output-side real GDP per capita (gdppc_o) (PWT 9.1 (2019))",
         Population="Population (historical estimates)",
         Country=Entity)
 overall <- data %>%
    group_by(Country) %>%
    summarise_at(c("Average.annual.hours.worked","GDP.per.capita","Population"),
                 list(Minimum = ~min(.,na.rm=TRUE),
                      Median = ~median(.,na.rm=TRUE),
                      Mean = ~mean(.,na.rm=TRUE),
                      Maximum = ~max(.,na.rm=TRUE))) %>%
    pivot_longer(!Country, names_sep ="_",
                 names_to = c("Variable", ".value"))%>%
   mutate(Variable=ifelse(Variable=="Average.annual.hours.worked",
                          "Hours.worked",Variable))
```

Table 1: *Descriptive statistical analysis of China and the United States*

Country	Variable	Minimum	Median	Mean	Maximum
China	Hours.worked	1969.39	1.985480e+03	2.049810e+03	2.192350e+03
China	GDP.per.capita	1394.16	3.127290e+03	4.574760e+03	1.304265e+04
China	Population	827601385.00	1.224419e+09	1.179498e+09	1.421022e+09
United States	Hours.worked	1729.96	1.795140e+03	1.799270e+03	1.891410e+03
United States	GDP.per.capita	23285.58	3.797802e+04	3.904642e+04	5.479476e+04
United States	Population	209513340.00	2.608867e+08	2.645612e+08	3.250848e+08

```
knitr::kable(overall, digits = 2,
    caption = "Descriptive statistical analysis of China and the United States")
```

0.3 Trends in average annual hours worked and GDP per capita

```
ggplot(data,mapping = aes(x = Year,y=GDP.per.capita,
                          color=Country,group=Country)) +
  geom_line() +
  labs(y ="GDP per capita",
       caption = "Source: World Bank data base")+
    theme_bw()
```

```
ggplot(data,mapping = aes(x = Year,y=Average.annual.hours.worked,
                          color=Country,group=Country)) +
  geom_line() +
  labs(y ="Average annual hours worked",
       caption = "Source: World Bank data base")+
    theme_bw()
```

0.4 The relationship between average annual hours worked and GDP

```
data %>%
    filter(Country=="China")%>%
    ggplot(mapping = aes(x = Average.annual.hours.worked,
                         y=GDP.per.capita))+
```

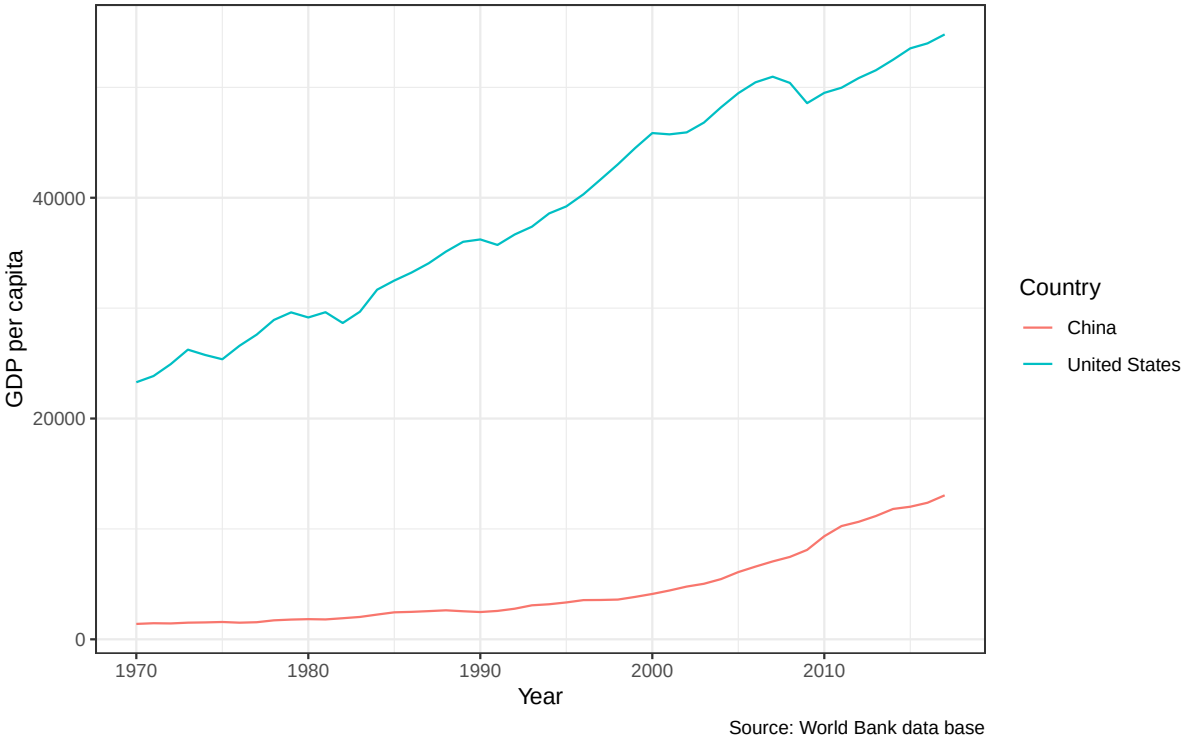

Figure 1: *Trends in GDP per capita*

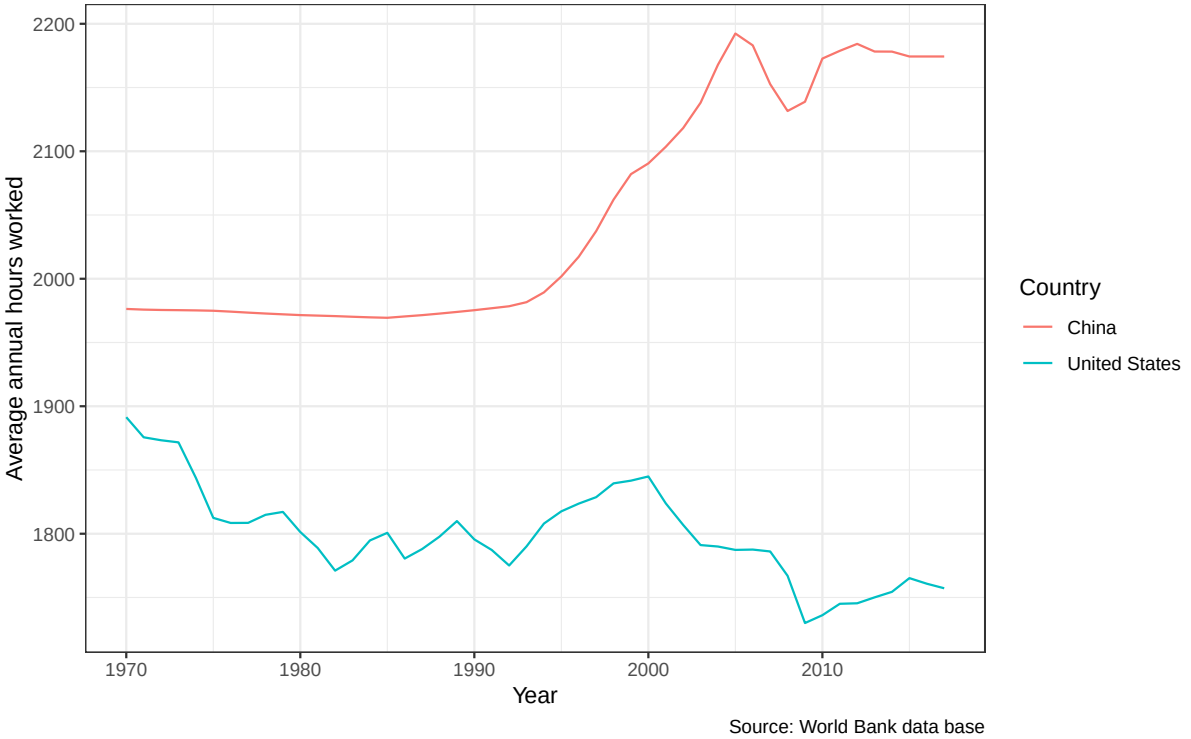

Figure 2: *Trends in average annual hours worked*

```
    geom_point() +
    stat_smooth(method=lm)+
  labs(x ="Average annual hours worked",
       y ="GDP per capita",
       caption = "Source: World Bank data base")+
    theme_bw()
```

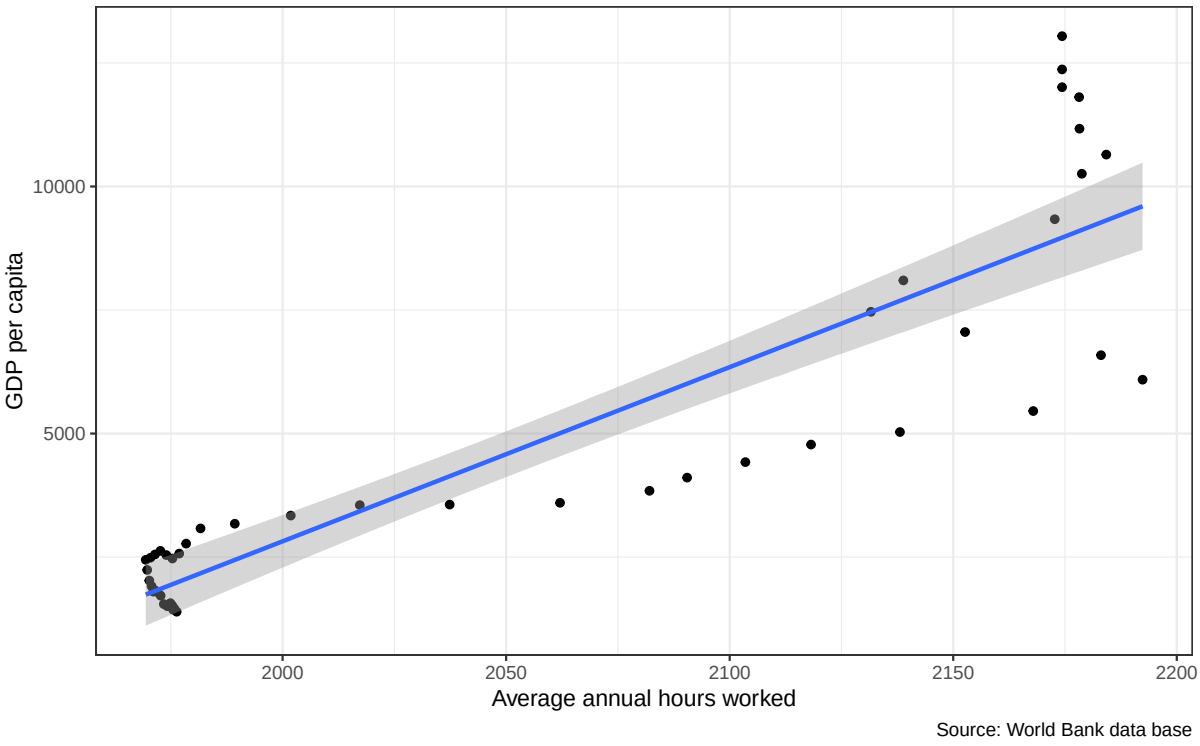

Figure 3: *Relationship between average annual hours worked and GDP (China)*

```
data %>%
    filter(Country=="United States")%>%
    ggplot(mapping = aes(x = Average.annual.hours.worked,
                         y=GDP.per.capita))+
    geom_point() +
    stat_smooth(method=lm)+
  labs(x ="Average annual hours worked",
       y ="GDP per capita",
       caption = "Source: World Bank data base")+
    theme_bw()
```

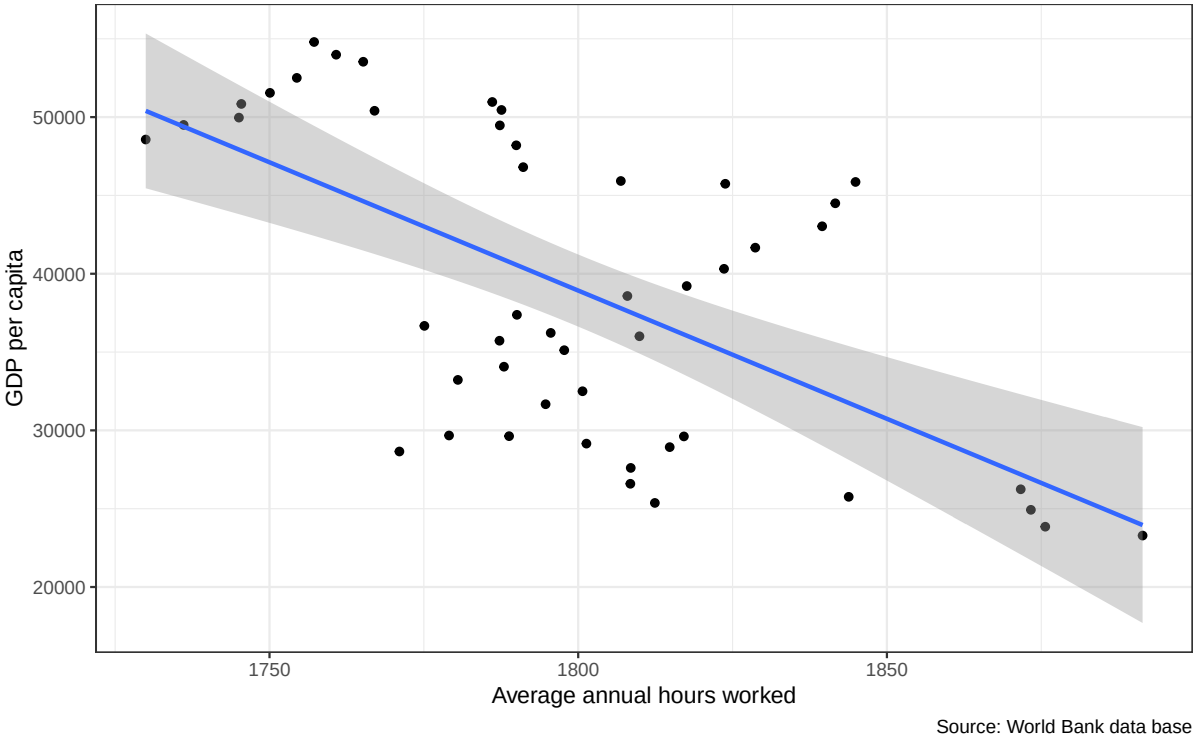

Figure 4: *Relationship between average annual hours worked and GDP (United States)*

In this section, I analyzed data from China and the United States. First, I filtered out the data for these two countries from 1970 to 2017. Then I performed an overall descriptive statistical analysis of the primary variables (Average.annual.hours.worked, GDP.per.capita and Population).

As shown in Table11, the mean or median population in China is significantly larger than in the United States. But in GDP per capita, China is significantly less than the United States. And the average annual hours worked is slightly higher in China than in the United States.

The trends of GDP in China and USA in Figure1 shows that GDP per capita in both China and the U.S. is rising year by year, but the upward trend is more obvious in the United States. And for the average annual hours worked shown in Figure2, I found a clear upward trend of average annual hours worked in China, while the United States has fluctuated but declined slightly overall.

Finally, I compared the relationship between average annual hours worked and GDP per capita. In The United States Figure4, as the annual work hours going down the trend of GDP per capita will going up. But for China Figure3 is completely opposite. When the annual work hours going up, The GDP per capital will also going up. I think it due to the high-speed development of economic in China. Furthermore, Banister and Zhang (2005) also mentioned that in 21 of the 24 years from 1978 to

2001, China's per capita GDP grew in real terms between 6% and 14%. China's per capita living standards (measured by real GDP per capita) nearly quadrupled between 1978 and 2001.

1 INDIA and UNITED KINGDOM

For **India and United Kingdom**, GDP and Annual working hours data from 1970 to 2017, lets calculate average of GDP and Working hours from 1970 to 2017 in 2

Table 2: *Average GDP and Working hours of India and United Kingdrom from 1970 to 2017*

Country	avg_GDP	avg_working_hrs
India	2295.446	2084.478
United Kingdom	26122.861	1729.940

From the above table 2, we see that despite India has more average working hours than United Kingdom, the average vale of GDP of United Kingdom is very high than India which means, for India and United Kingdom, GDP does not depend on Working hours solely, there are other factors as well.

To understand this, let's create a figure and see the trend in GDP and average working hours in India and United Kingdom.

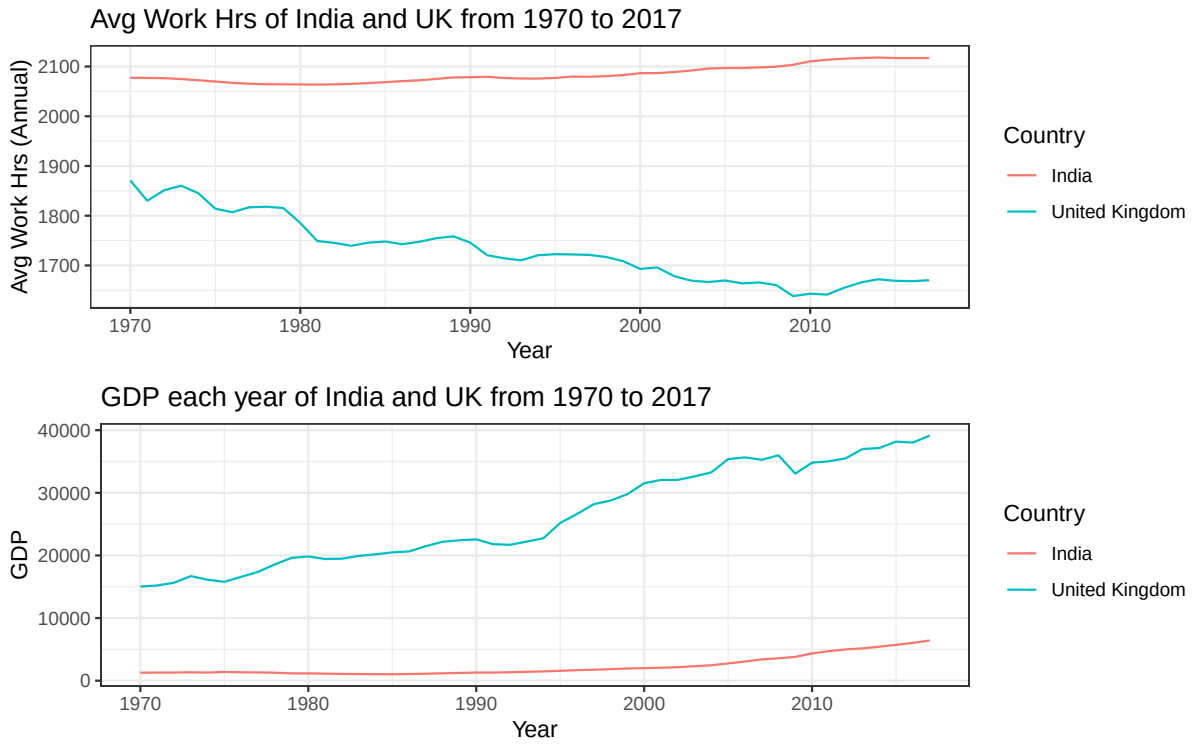

Figure 5: *Average working hours and GDP of India and UK from 1970 to 2017*

From the above Figure 5, it is clear that in India, the Average working hours and GDP both are increasing but not as compared to UK. On the other hand, in UK, Average working hours are decreasing continuously while GDP is going up. Therefore, GDP does not solely depend on working hours or we can say that, in richer country, UK, people work for lesser number of hours as compared to India with low GDP. In India, the population has increased to a great extent and in UK, the increase has not been that much, therefore this huge increase in population might be another reason for India's falling short in GDP growth.

To understand GDP further and how the GDP is affected and what are the macroeconomics factors affecting GDP growth, I also read an article Syed and Shaikh (2013) which discusses about the macroeconomics factors which affect the GDP growth.

2 COnclusion

For this study, we took 8 countries (China, USA, India, UK, France, Mexico, Australia & Indonesia) and analysed their respective GDP growth with respect to Hours of Work which each person does on an average in one year. After the analyzation, we found that GDP growth does not solely depend on Working hours and also, people in richer countries work for lesser number of hours. There can be many factors for this like population and how efficiently people are working and what are the resources available for people in rich countries with the help of which they are able to complete more work in less number of hours.

References

Banister, J and X Zhang (2005). China, Economic Development and Mortality Decline. *World Development* **33**(1), 21–41.

Syed, AASG and FM Shaikh (2013). Effects of Macroeconomic Variables on Gross Domestic Product (GDP) in Pakistan. *Procedia Economics and Finance* **5**. International Conference On Applied Economics (ICOAE) 2013, 703–711.