



Analysis of Average Working Hours and GDP around the world from 1970 - 2017

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1 Introduction

1.1 Research Question

How do the average annual hours worked relates to the GDP in different countries from the year of 1970 to 2017?

1.2 Background

Giattino and Ortiz-Ospina (2020) indicates that workers in rich countries tend to be shorter than workers in poor countries. Because in richer countries, workers per hour production capacity is higher, which means that people there have the higher income and less working hours. Therefore, the dramatic differences between different countries working time on how we look at the past two centuries of economic progress and the essence of the inequality between countries today has an important impact.

1.3 Structure of report

This report will compare different countries to analyze the relationship between GDP and working hours.

The first section will compare the countries between China and USA to analyze the relationship. The second section will choose the India and United Kingdom. Then we are going to see the country of France and Mexico because they are in two different income groups in the world. And the last part we will have a comparison between Indonesia and Australia.

2 China and USA

2.1 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
```

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

2.2 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))

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

```

2.3 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()
```

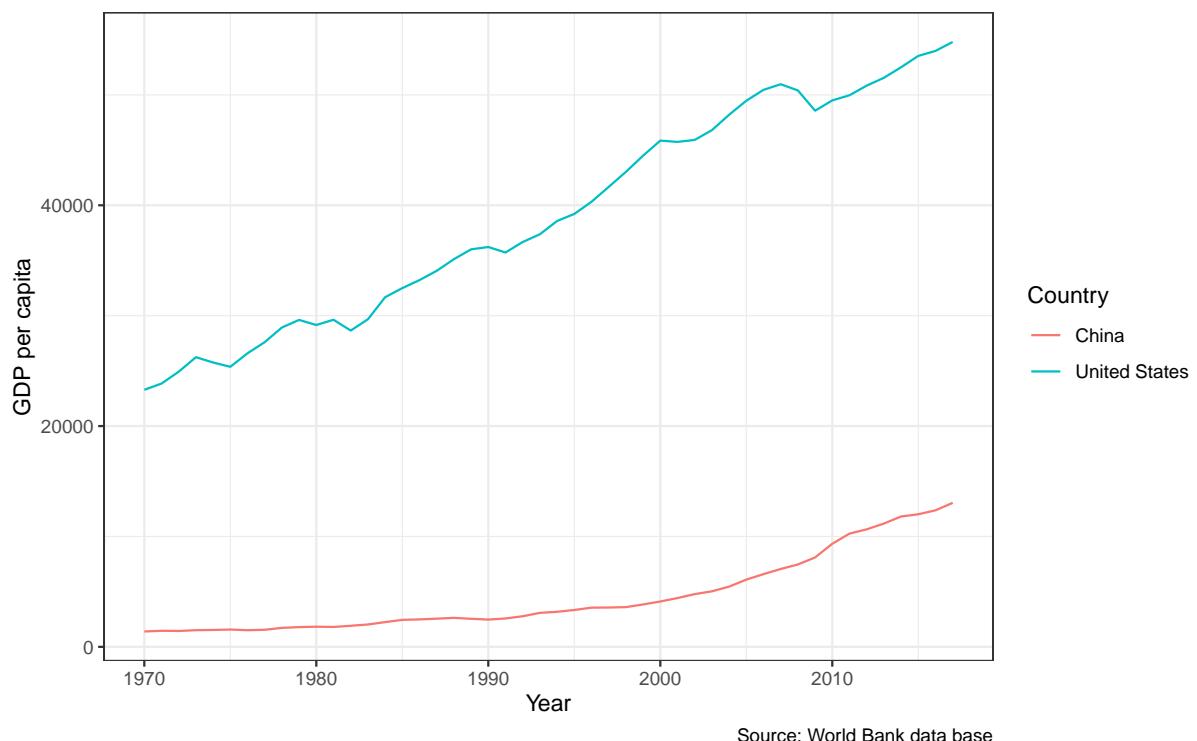


Figure 1: Trends in GDP per capita

```
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()
```

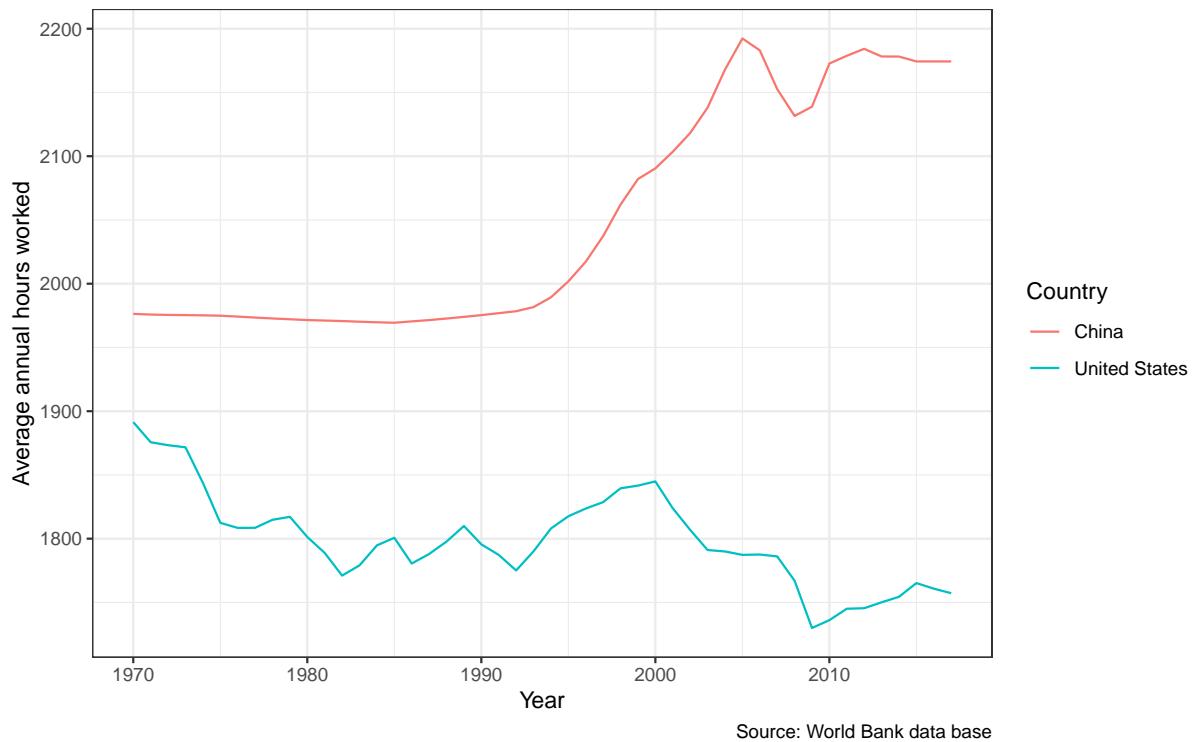


Figure 2: Trends in average annual hours worked

2.4 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))+
  geom_point() +
  stat_smooth(method=lm)+
  labs(x ="Average annual hours worked",
       y ="GDP per capita",
       caption = "Source: World Bank data base")+
  theme_bw()
```

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

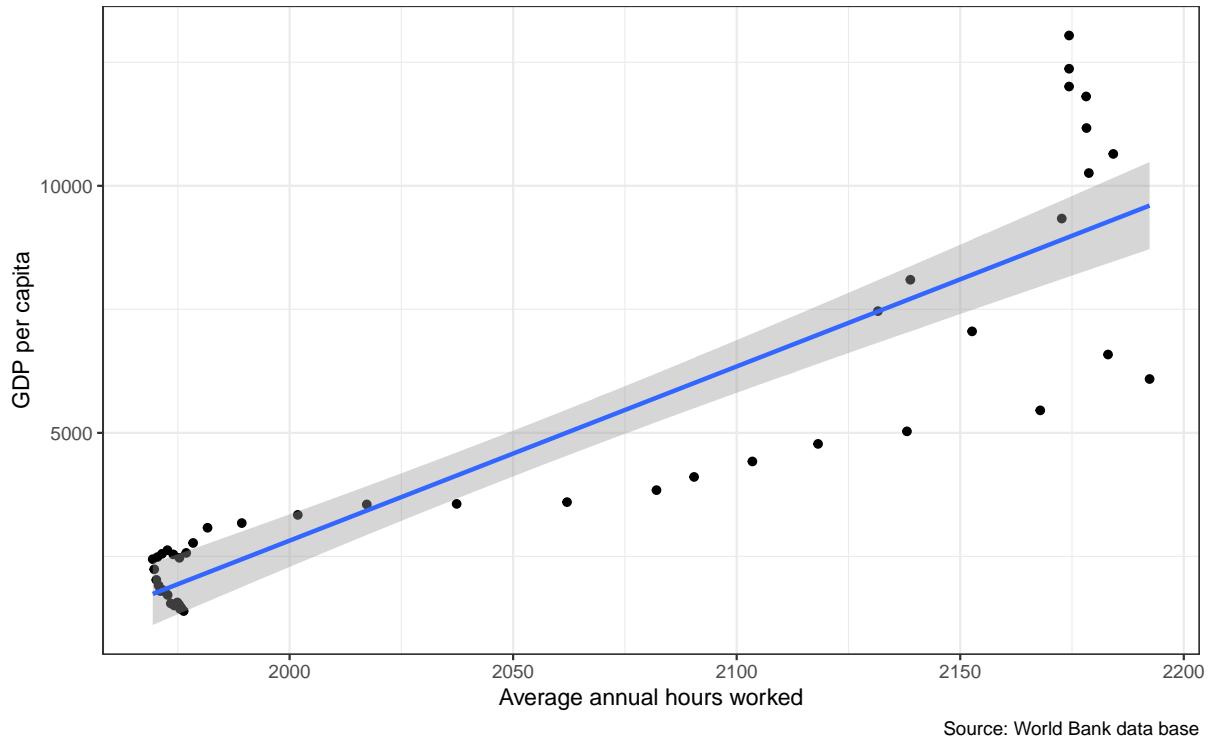


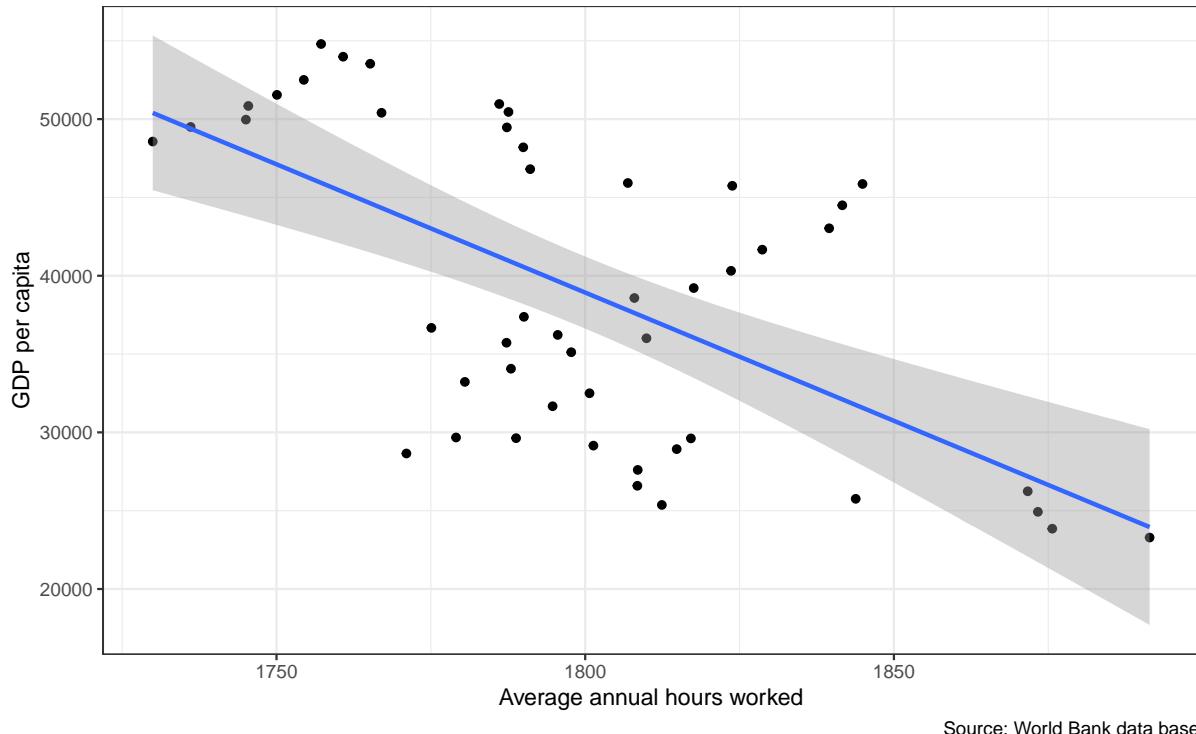
Figure 3: Relationship between average annual hours worked and GDP (China)

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

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.



Source: World Bank data base

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

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.

3 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 Kingdom 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 value 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.

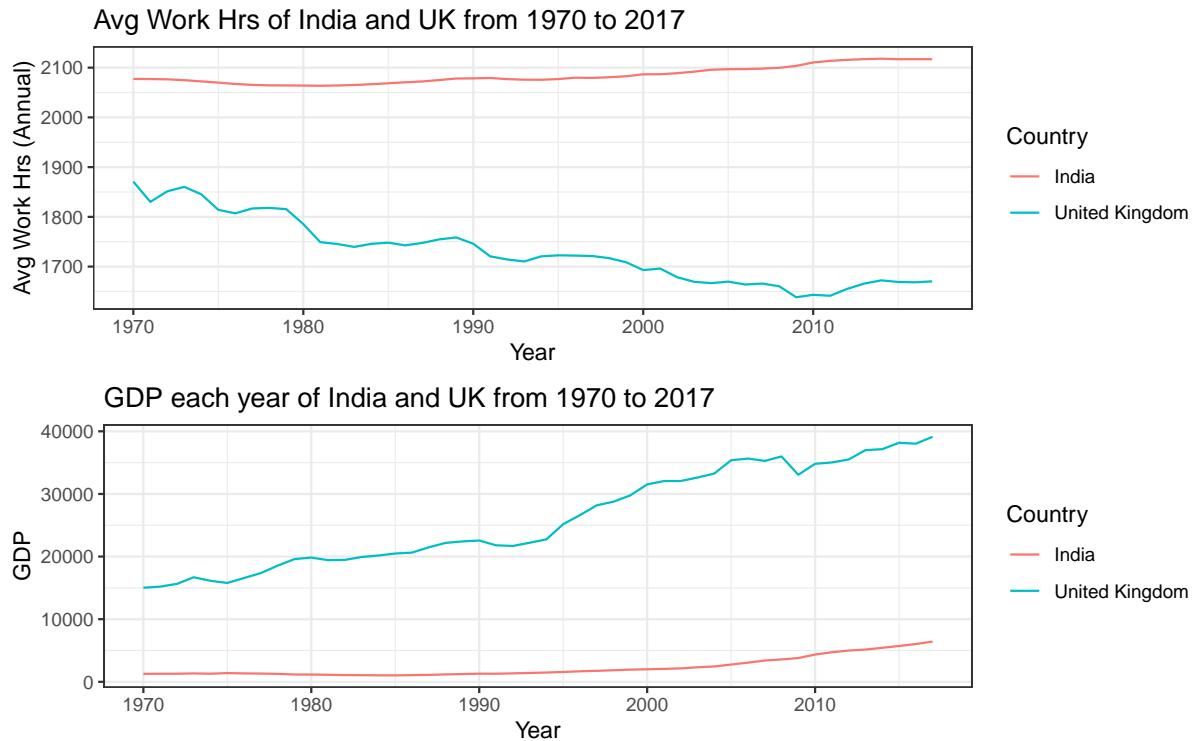


Figure 5: Average working hours and GDP of India and UK from 1970 to 2017

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.

4 France and Mexico

4.1 Background

Haller (2017) shows that France is a developed country. Ibarra and Ros (2019) indicates that Mexico is a developing country.

Therefore, this section chooses these two different income group countries to explore the relationship between working hours and GDP. And the report will be analyzed from two perspectives. On the one hand, the report will observe the developing trend with the changes of working hours and GDP within each country. On the other hand, it will also compare these two different countries to calculate their average working time and GDP.

4.2 Analysis

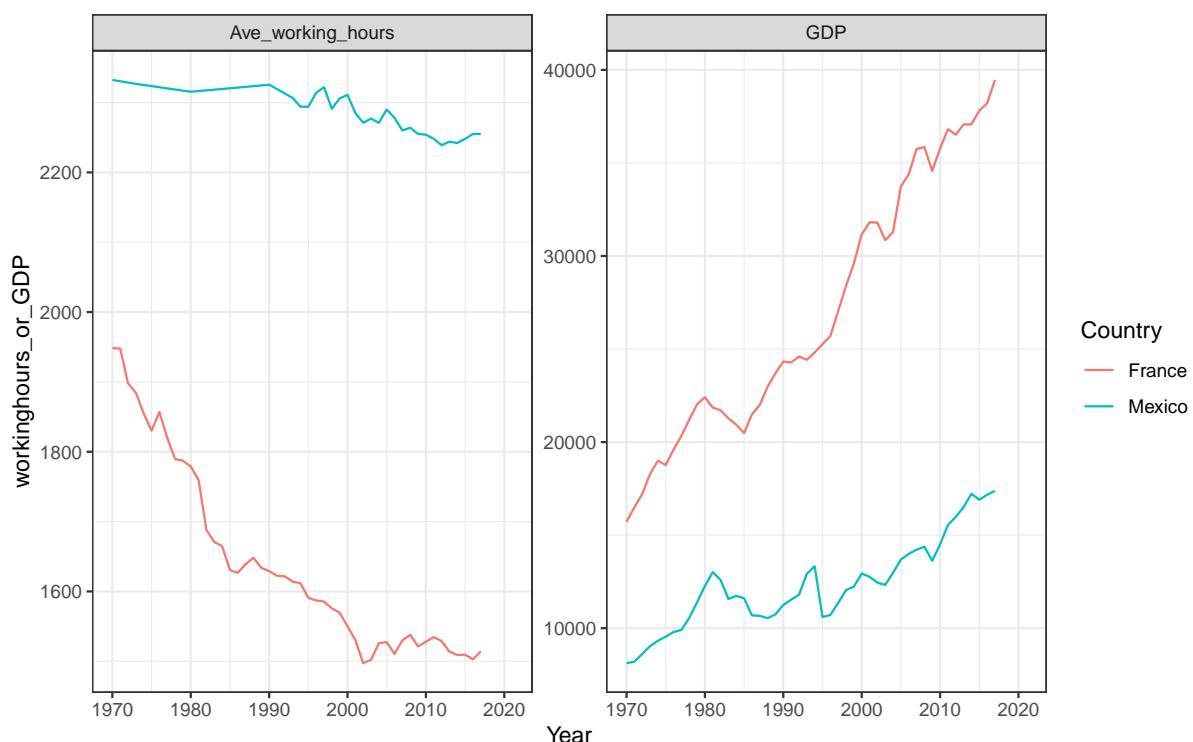


Figure 6: The Development of Average Working Hours and GDP with the Year Changes

From the Figure 6, we can observe an overall development of average working hours and GDP with the changes of year. The left part figure shows that the average annual hours worked by persons are gradually decreased in both of two countries from the year of 1970 to 2017. The right part figure indicates that the overall trend of the output-side real GDP per capita shows a continuous rise in the same period.

These two parts show an opposite trend, so we will further compare GDP and average working hours to observe the relationship between these two variables more intuitively.

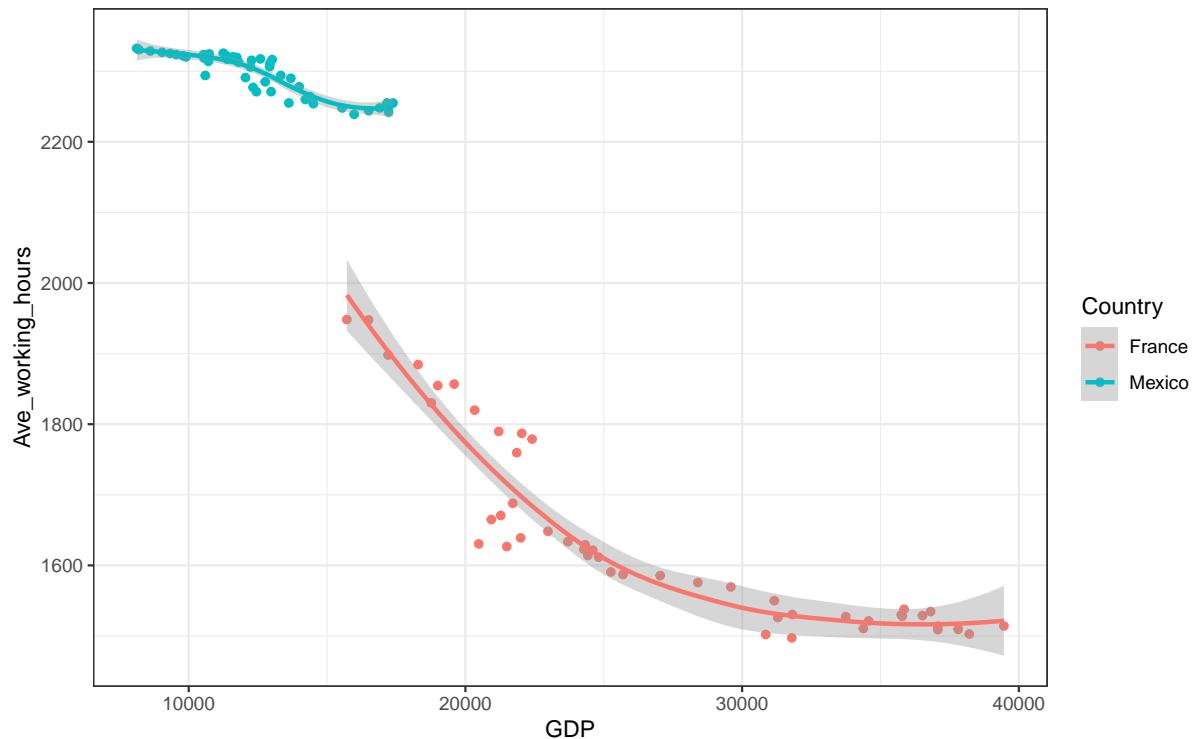


Figure 7: The Comparison between Average Working Hours and GDP

The Figure 7 shows the relationship between the average annual hours worked by persons and the output-side real GDP per capita.

In general, we can observe that the per capita working hours in France and Mexico show a declining trend as GDP increases. As a result, working hours in these two different types of countries declined as GDP grew.

Table 3: *The Comparation of Average Working Hours and GDP between France and Mexico*

Country	Working_hours	GDP
France	1640	26998
Mexico	2297	12339

The Table 3 above compares the the average annual hours worked by persons and the average output-side real GDP per capita between France and Mexico.

And we can find from the table that the France has a lower working hours and a higher GDP compared with Mexico with 1,640 hours and 26,998 dollars respectively. And people in Mexico work around 2,297 hours and GDP per capita is around 12,339 dollars.

Therefore, it can be concluded from these two countries that while average earnings have risen, hours worked have fallen. And working hours tend to decrease as countries become richer.

5 Australia and Indonesia

According to Charlie Giattino and Roser (2020), in over 100 years, the average working hours have drastically decreased for many countries. However, around the world, there are still significant gaps between countries where poorer countries with lower GDP (Gross domestic product) tend to work much more than workers in wealthier countries with higher GDP. Hence, this section will look at mainly two countries: **Australia** (having a higher GDP) and **Indonesia** (which has a lower GDP).



Figure 8: Comparison of Average annual hours worked by workers in Australia and Indonesia

Figure 8 and figure 9 show how the Average annual working hours and the GDP change over the years 1970 to 2017 in Australia and Indonesia. From figure 8, we can see that Indonesia's Average working hours have fluctuated with a significant drop in the mid-1980s and have been increasing for the next few years. In comparison, Australia has an overall decreasing trend over time.

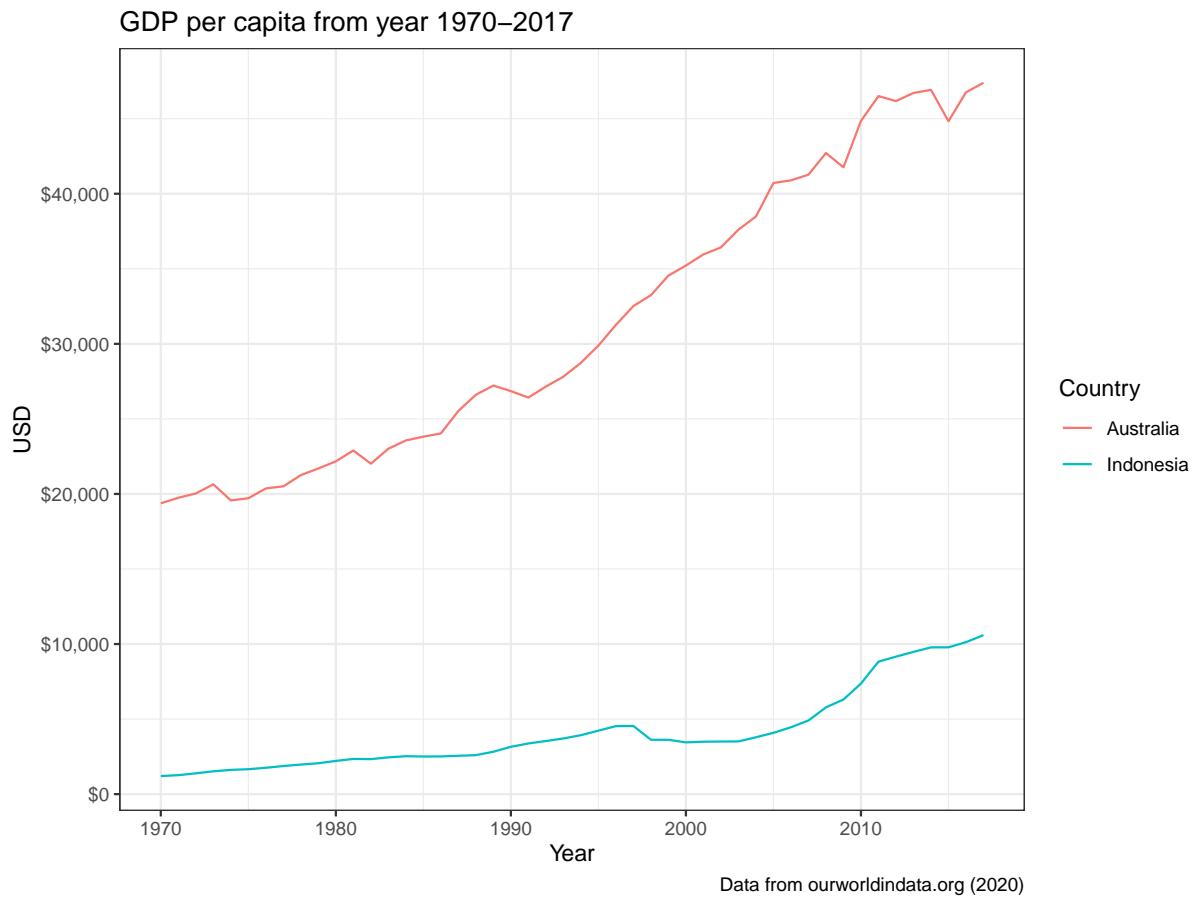


Figure 9: Comparison of Australia's and Indoensia's GDP per capita

The figure 9 demonstrates that Australia's GDP has risen significantly, while Indonesia's GDP just slightly increased with a slight drop in the late 1990s. From these figures, we can see that despite working fewer hours over the years, Australia's GDP kept increasing while Indonesia's GDP did not grow as much despite having more average working hours.

Table 4: The Comparation of Average Annual Working Hours and GDP between Australia and Indonesia

Country	Average of the Average Annual Working Hours (hours)	Average of GDP per capita (USD)
Australia	1847.69	31320.31
Indonesia	1977.30	4120.22

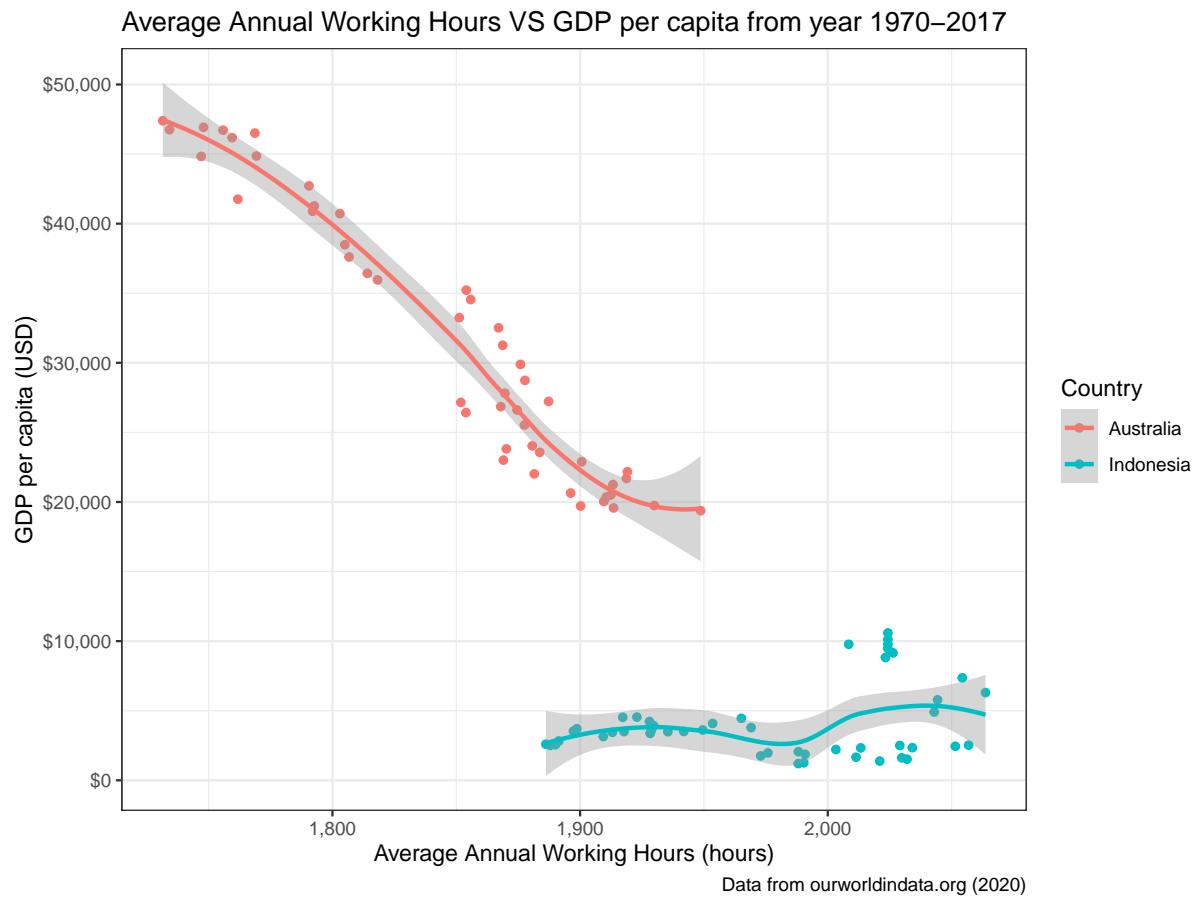


Figure 10: Inverse Correlation between Average Annual Working Hours and GDP per capita in Australia and Indonesia

Furthermore, looking at the comparison table 4 here, we can see that on average, from the year 1970 to 2017, Australia has around 100 Average Working Hours less than Indonesia, but the GDP is seven times higher than Indonesia's GDP. Therefore, we can conclude an inverse correlation between Australia and Indonesia's average working hours and GDP per capita, as seen in figure 10, in which fewer Average working hours contributed to higher GDP. In comparison, more working hours resulted in a lower overall GDP

6 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 analysis, 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.

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