MR-HD-CHN

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Information:

Country: China | Country Tag: CHN | Data: Penn World Table |

Libraries & Data:

```
library(tidyverse)
```

```
## -- Attaching packages ---------------------------------------------------------------------------------
## v ggplot2 3.1.1     v purrr   0.3.2
## v tibble  2.1.1     v dplyr   0.8.3
## v tidyr   0.8.3     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.4.0
## -- Conflicts ------------------------------------------------------------------------------------------
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(pwt9)
data("pwt9.0")
```

Variable Definitions:

Y = rgdpna (real GDP) y = rgdpna/emp (real GDP per worker) Y_pc = (rgdpna/pop) (GDP per capita) L = emp (labor) h = hc (human capital) d = delta s = ((rdana - rconna)/rgdpna) (savings rate) k = rkna/emp (capital per worker) a = (1 - labsh) l_p = emp/pop (labor participation) A = y/(k^a*h^(1-a)) Z = 1/(1-a)*A Z_hat = Z - lag(Z)

Create Data Frame:

Next, mutate variables listed above using Penn World Table data. Using the data frame, filter for the specific country. In this case, years 1950 & 1951 are excluded due to NAs in data frame.

** NOTE: values for "a" (capital share of income) are inaccurate before the mid 1990s.

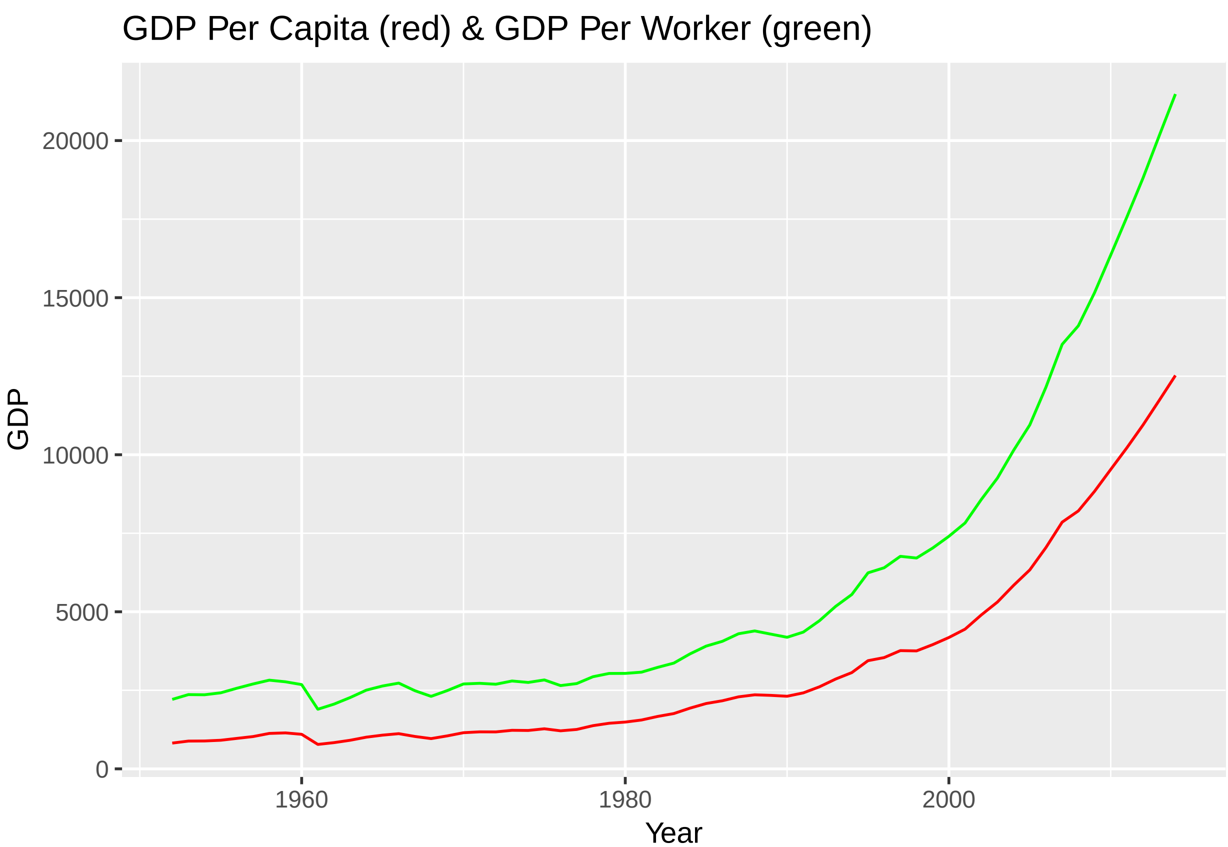
```
df <- pwt9.0 %>%
  mutate(Y = rgdpna, y = rgdpna/emp, k = rkna/emp, a = (1 - labsh)) %>%   #Question 4
  mutate(h = hc, d = delta, L = emp, s = (rdana - rconna)/rgdpna) %>%     #Question 4
  mutate(Y_pc = (rgdpna/pop), l_p = emp/pop, pop_hat = pop - lag(pop))

chn <- df %>%
  filter(isocode == "CHN") %>%
  mutate(A = y/(k^a*h^(1-a))) %>%   #Question 5
  mutate(Z = 1/(1-a)*A) %>%         #Question 5
  mutate(Z_hat = Z - lag(Z)) %>%
  mutate(L_hat = L - lag(L)) %>%
  mutate(mean_Z_hat = 0.01) %>%
  mutate(y_star = (s/(d + L_hat + mean_Z_hat))^(a/(1-a))*h) %>%
  mutate(exp1 = (s/(d + L_hat + mean_Z_hat))) %>%
```

```
  mutate(exp2 = (a/(1-a))*h) %>%
  mutate(y_star2 = (s/(d + L_hat + mean_Z_hat))^((h*a)/(1-a))) %>%
  filter(year != 1950) %>%
  filter(year != 1951)
```

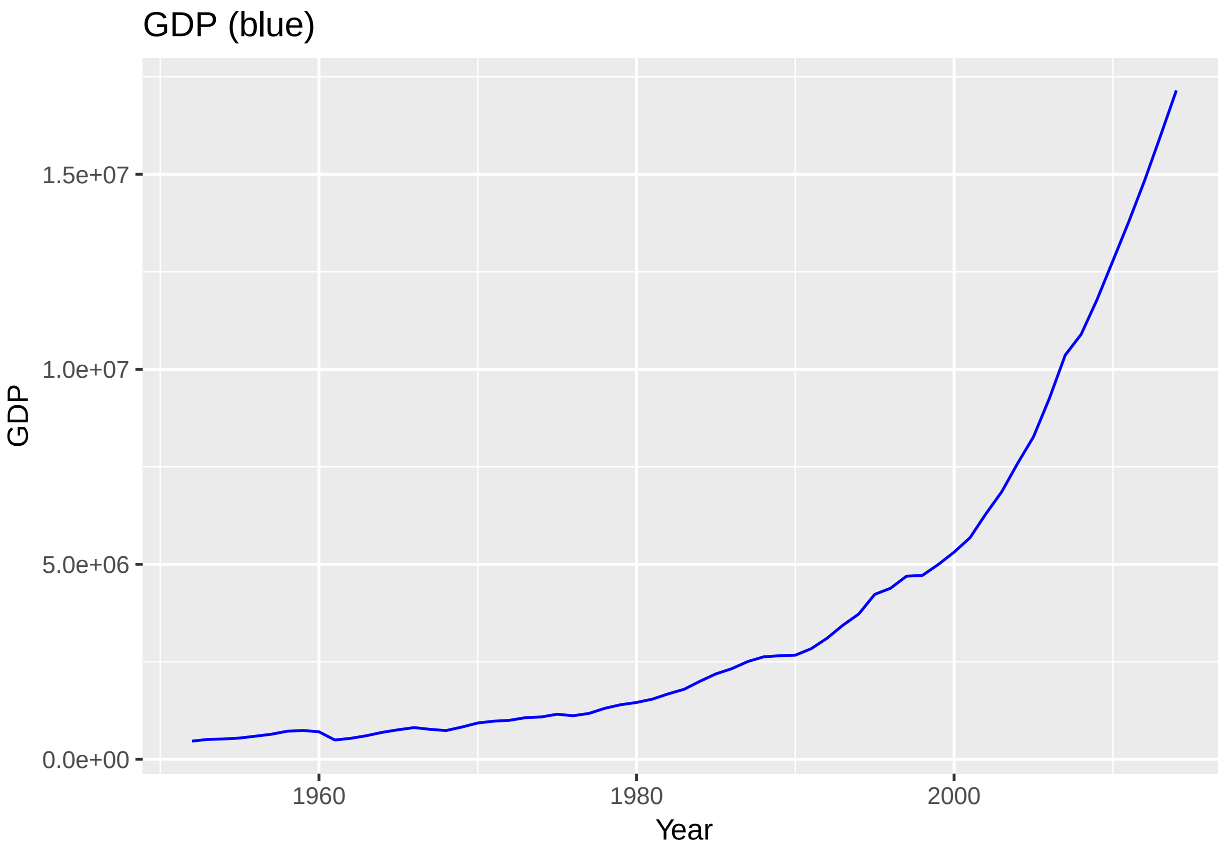
Graphing GDP Statistics:

Taking a look at China's GDP, GDP per capita, and GDP per worker.

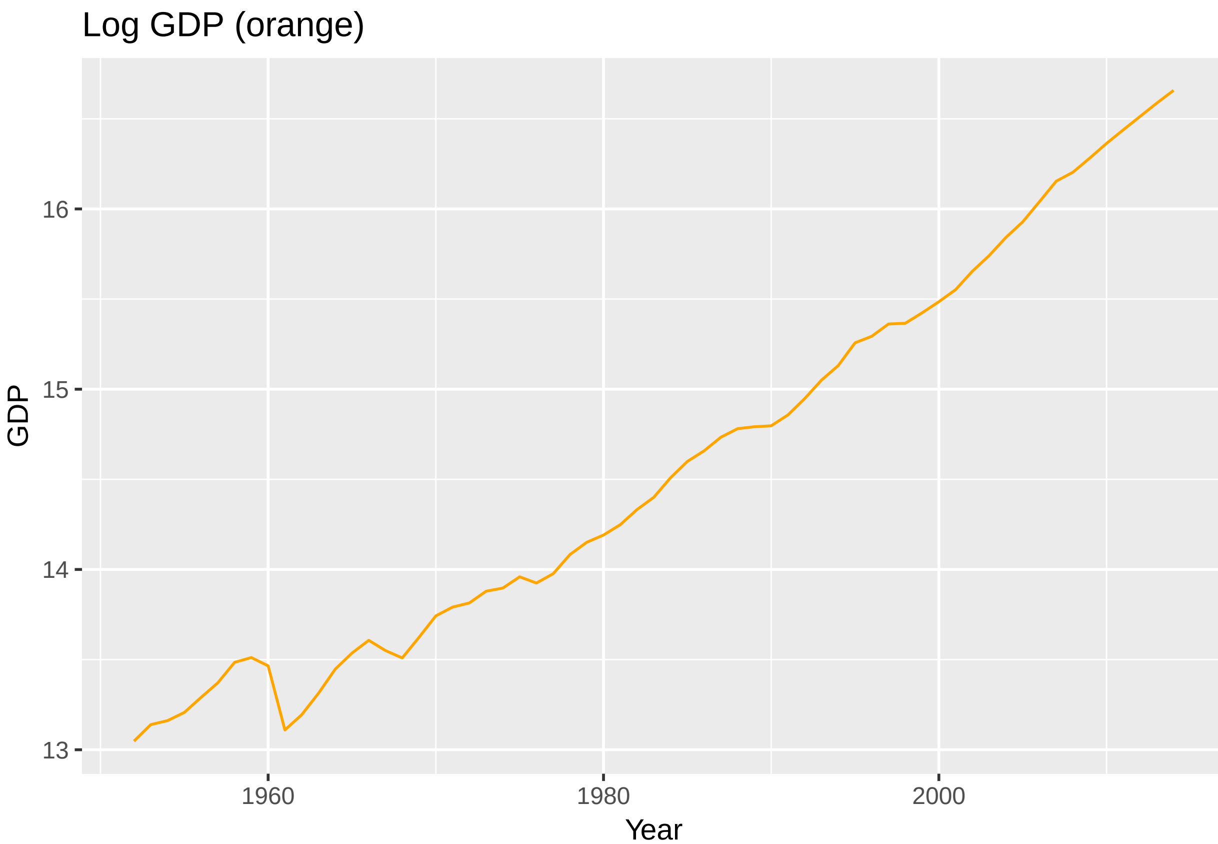
```
ggplot(chn) +
  geom_line(aes(x = year, y = Y_pc), color = "red") +
  geom_line(aes(x = year, y = y), color = "green") +
  xlab("Year") +
  ylab("GDP") +
  ggtitle("GDP Per Capita (red) & GDP Per Worker (green)")
```




```
ggplot(chn) +
  geom_line(aes(x = year, y = Y), color = "blue") +
  xlab("Year") +
  ylab("GDP") +
  ggtitle("GDP (blue)")
```




```r
ggplot(chn) +
  geom_line(aes(x = year, y = log(Y)), color = "orange") +
  xlab("Year") +
  ylab("GDP") +
  ggtitle("Log GDP (orange)")
```

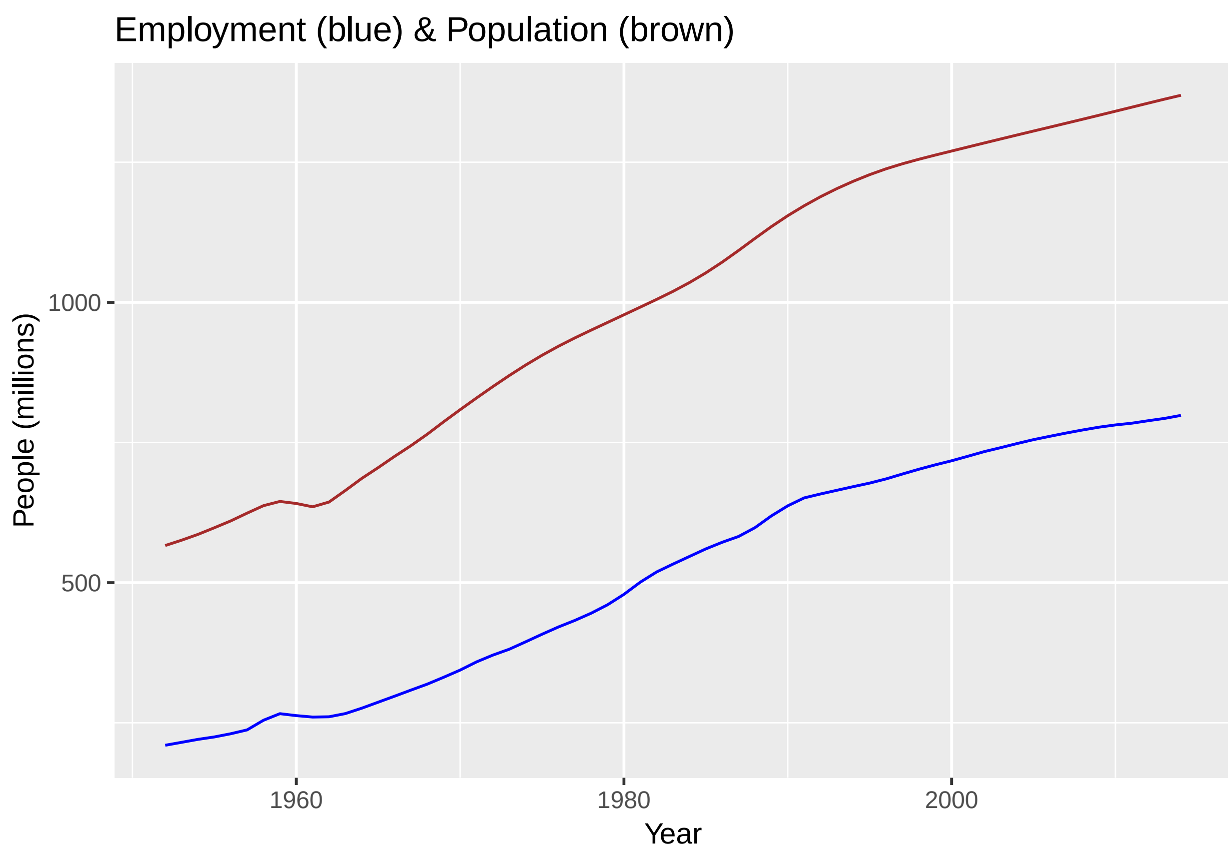


GDP in China has seen extremely consistent growth post early 1960s. In comparison to other European countrues in earlier research, China's expansion in 2000s is simply massive. Log GDP shows that GDP has continued to grow at a steady rate post early 1960s. As expected, GDP per worker will have a greater nomial value due to the employed population being smaller. In this case, GDP per worker is growing at a similar rate as GDP per capita.

Graphing Employment and Population Statistics:

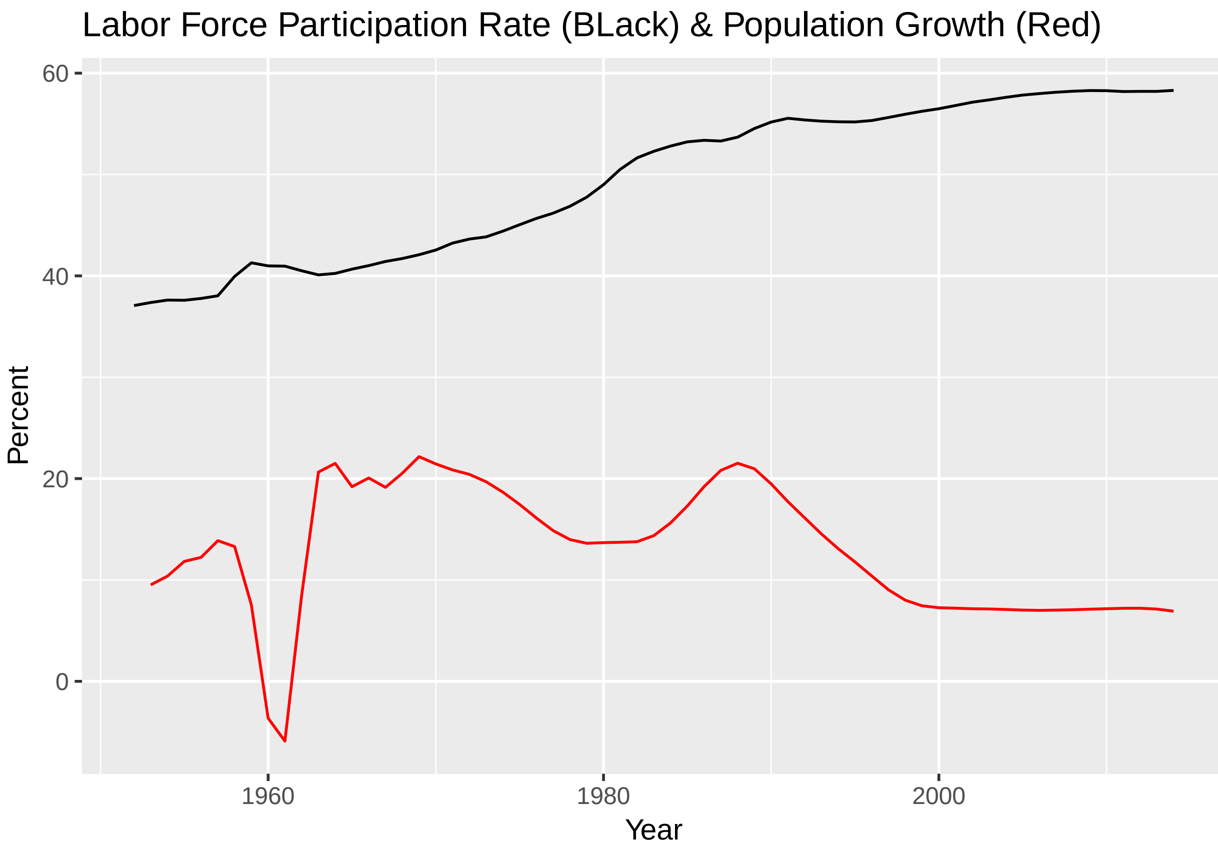
Taking a look at employment, population, population growth, and labor force participation rate.

```
ggplot(chn) +
  geom_line(aes(x = year, y = emp), color = "blue") +
  geom_line(aes(x = year, y = pop), color = "brown") +
  xlab("Year") +
  ylab("People (millions)") +
  ggtitle("Employment (blue) & Population (brown)")
```

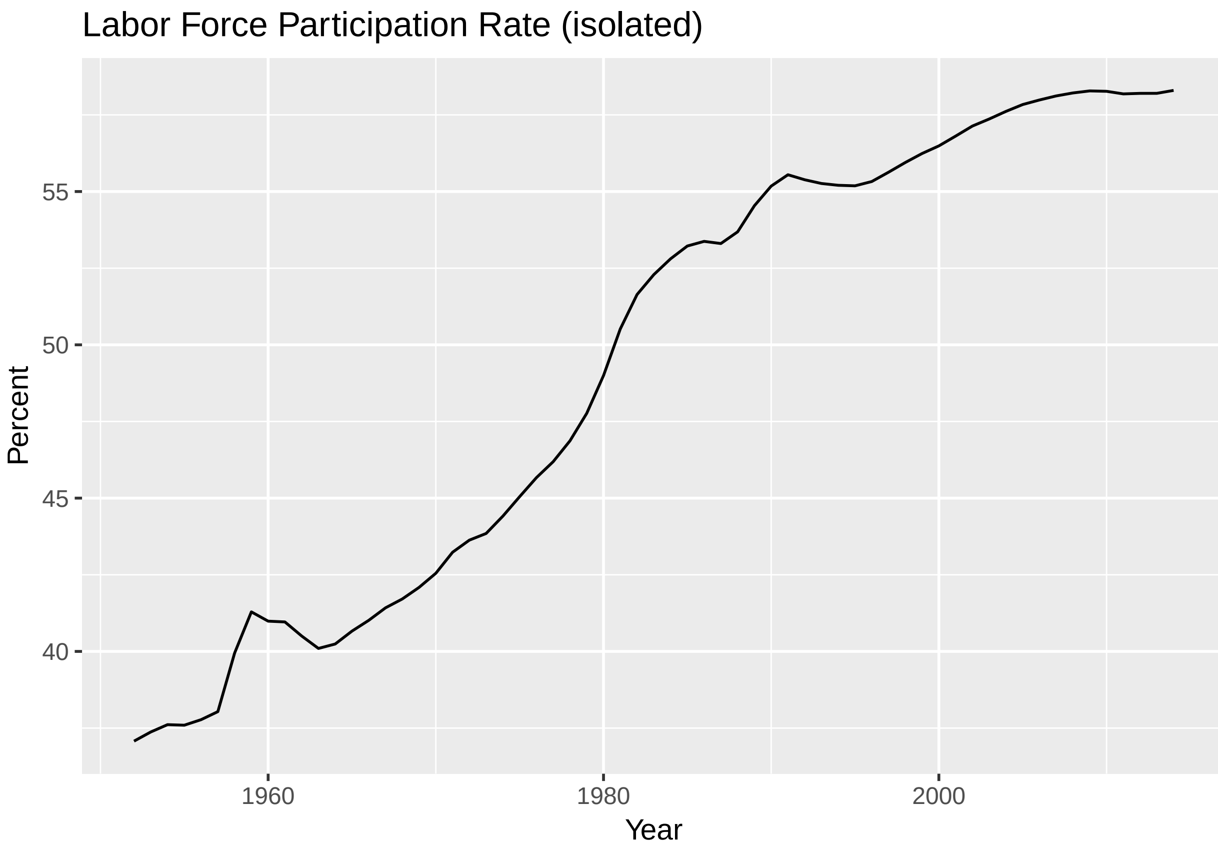



```r
ggplot(chn) +
  geom_line(aes(x = year, y = l_p * 100), color = "black") +
  geom_line(aes(x = year, y = pop_hat), color = "red") +
  xlab("Year") +
  ylab("Percent") +
  ggtitle("Labor Force Participation Rate (BLack) & Population Growth (Red)")
```

```
## Warning: Removed 1 rows containing missing values (geom_path).
```




```
ggplot(chn) +
  geom_line(aes(x = year, y = l_p * 100), color = "black") +
  xlab("Year") +
  ylab("Percent") +
  ggtitle("Labor Force Participation Rate (isolated)")
```



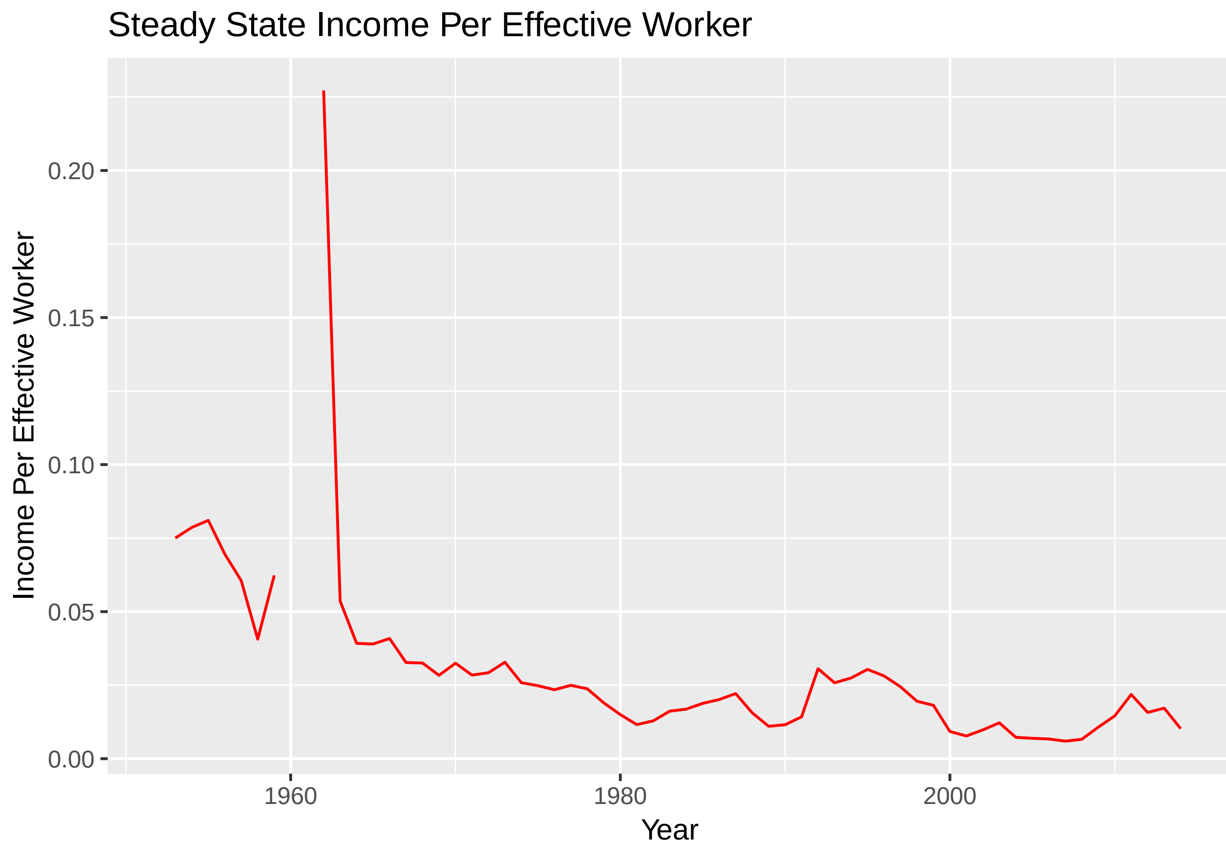
China's has had a massive population boom since the beginning of the 1960s. For the following 20 to 25 years, population growth rate was between 14-22% which is extremely high for a country of that population size. Even after a decline in the 1990s, the population growth rate remained close to 7%. Even crazier, China has been able to consistently grow their labor force participation rate to an extremely high percentage (~60%) even considering the massive boom in population.

Steady State Income Per Effective Worker

Formula: y_star2 = (s/(d + L_hat + mean_Z_hat))^((h*a)/(1-a))

```
ggplot(chn) +
  geom_line(aes(x = year, y = y_star2), color = "red") +
  xlab("Year") +
  ylab("Income Per Effective Worker") +
  ggtitle("Steady State Income Per Effective Worker")
```

```
## Warning: Removed 1 rows containing missing values (geom_path).
```

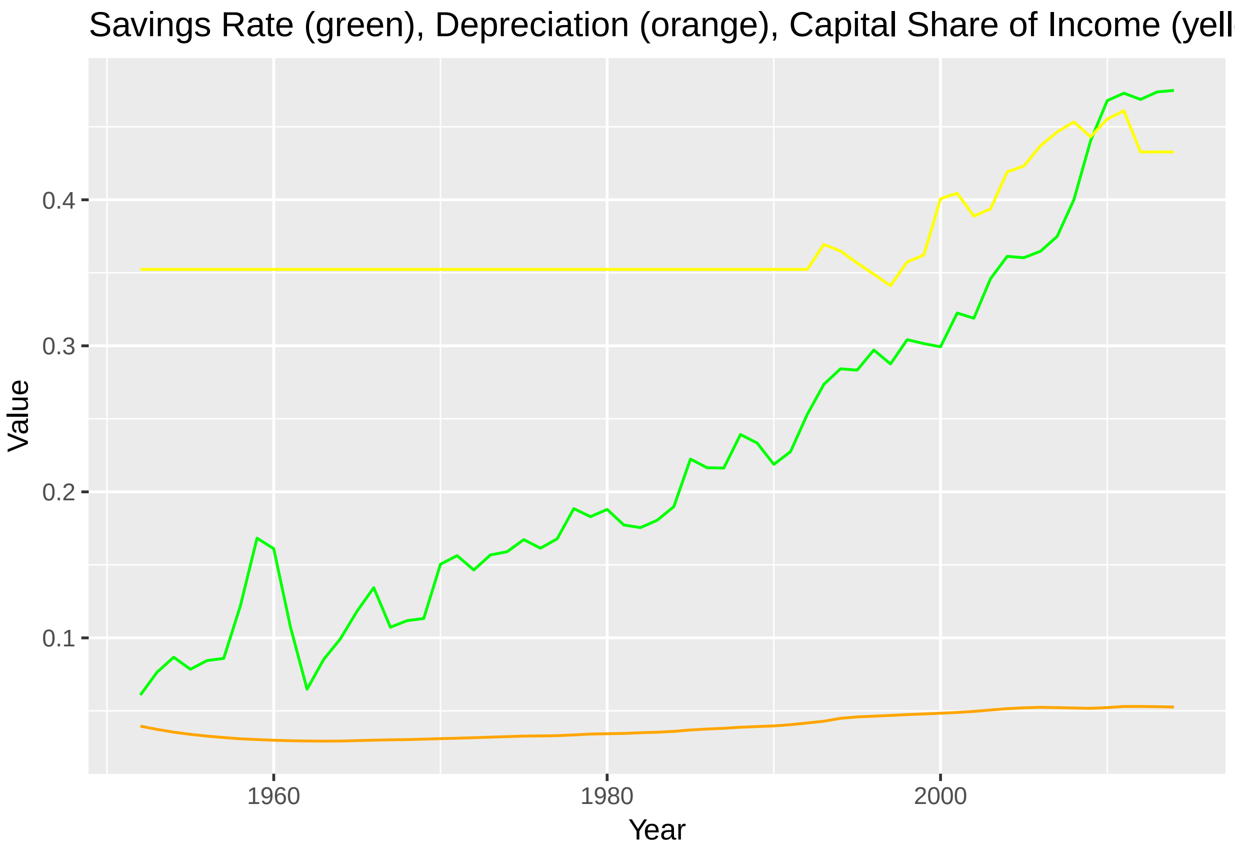


Due to missing data and other irregularities, it's difficult to draw a specific conclusion from the "SSIPEW" statistic.

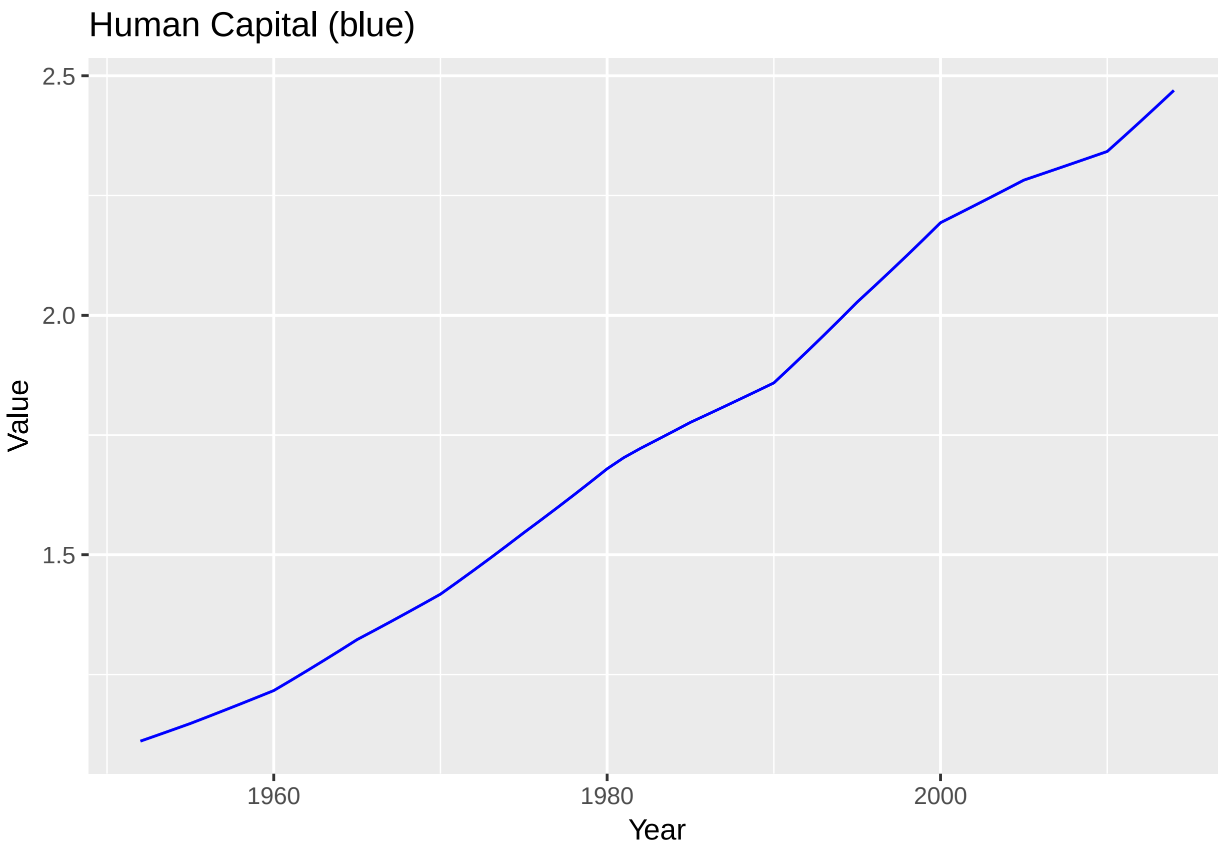
Capital Share of Income and Income Inequality Statistics:

** NOTE: values for "a" (capital share of income) are inaccurate before the mid 1990s

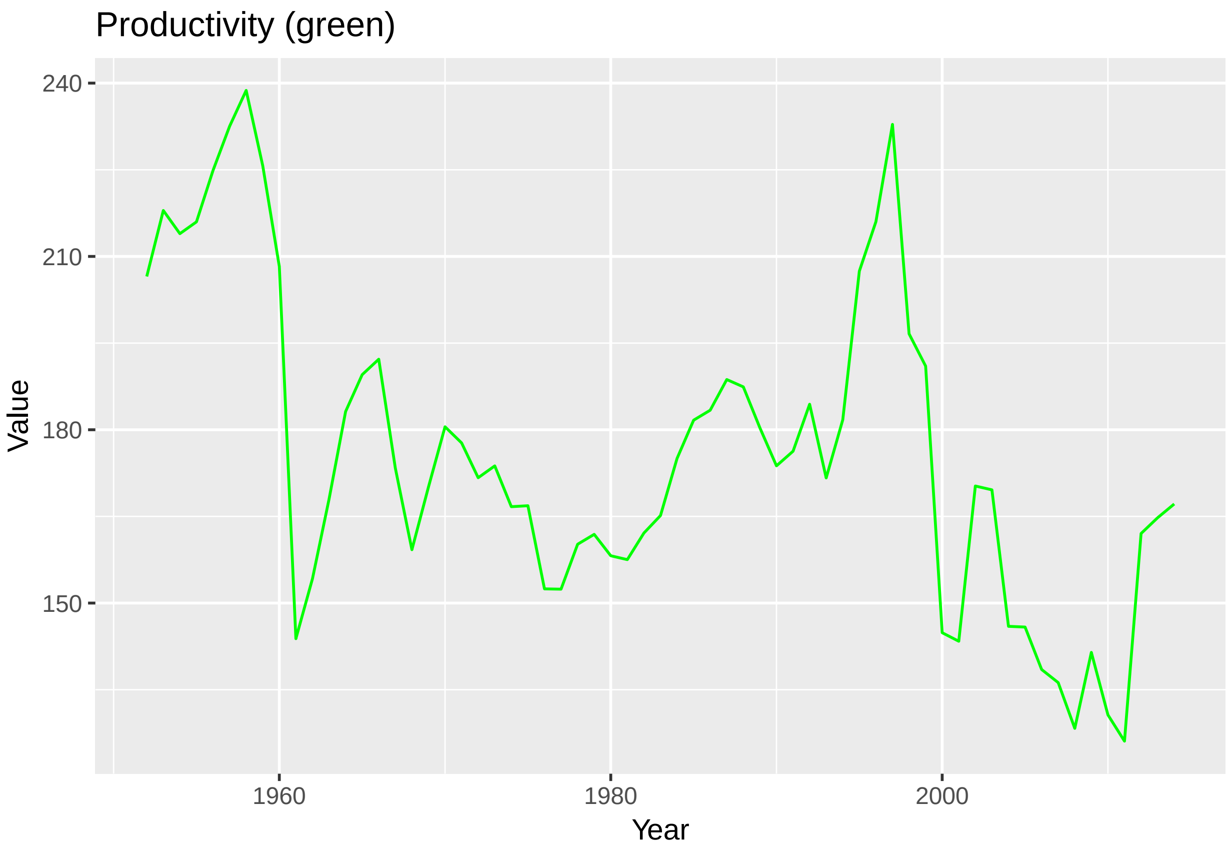
```
ggplot(chn) +
  geom_line(aes(x = year, y = s), color = "green") +
  geom_line(aes(x = year, y = d), color = "orange") +
  geom_line(aes(x = year, y = a), color = "yellow") +
  xlab("Year") +
  ylab("Value") +
  ggtitle("Savings Rate (green), Depreciation (orange), Capital Share of Income (yellow)")
```



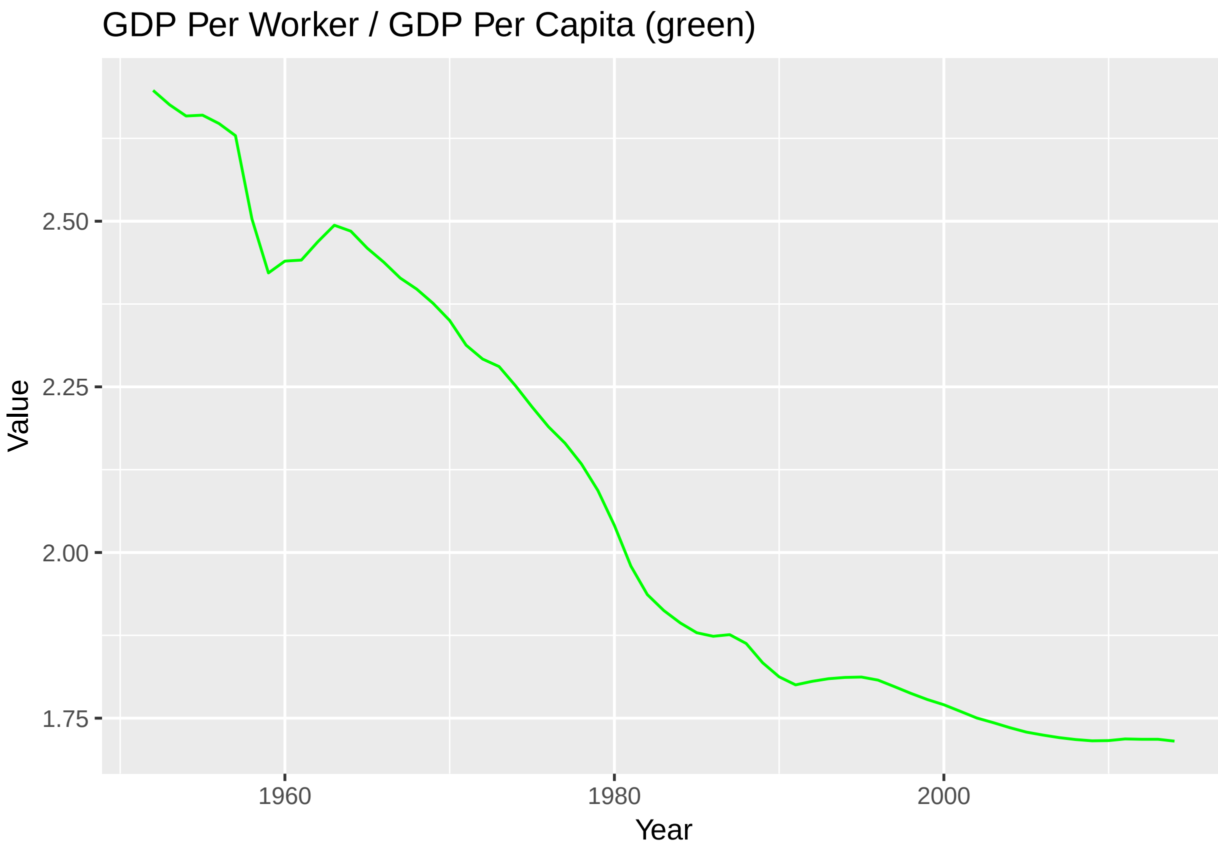

```r
ggplot(chn) +
  geom_line(aes(x = year, y = h), color = "blue") +
  xlab("Year") +
  ylab("Value") +
  ggtitle("Human Capital (blue)")
```




```
ggplot(chn) +
  geom_line(aes(x = year, y = Z), color = "green") +
  xlab("Year") +
  ylab("Value") +
  ggtitle("Productivity (green)")
```



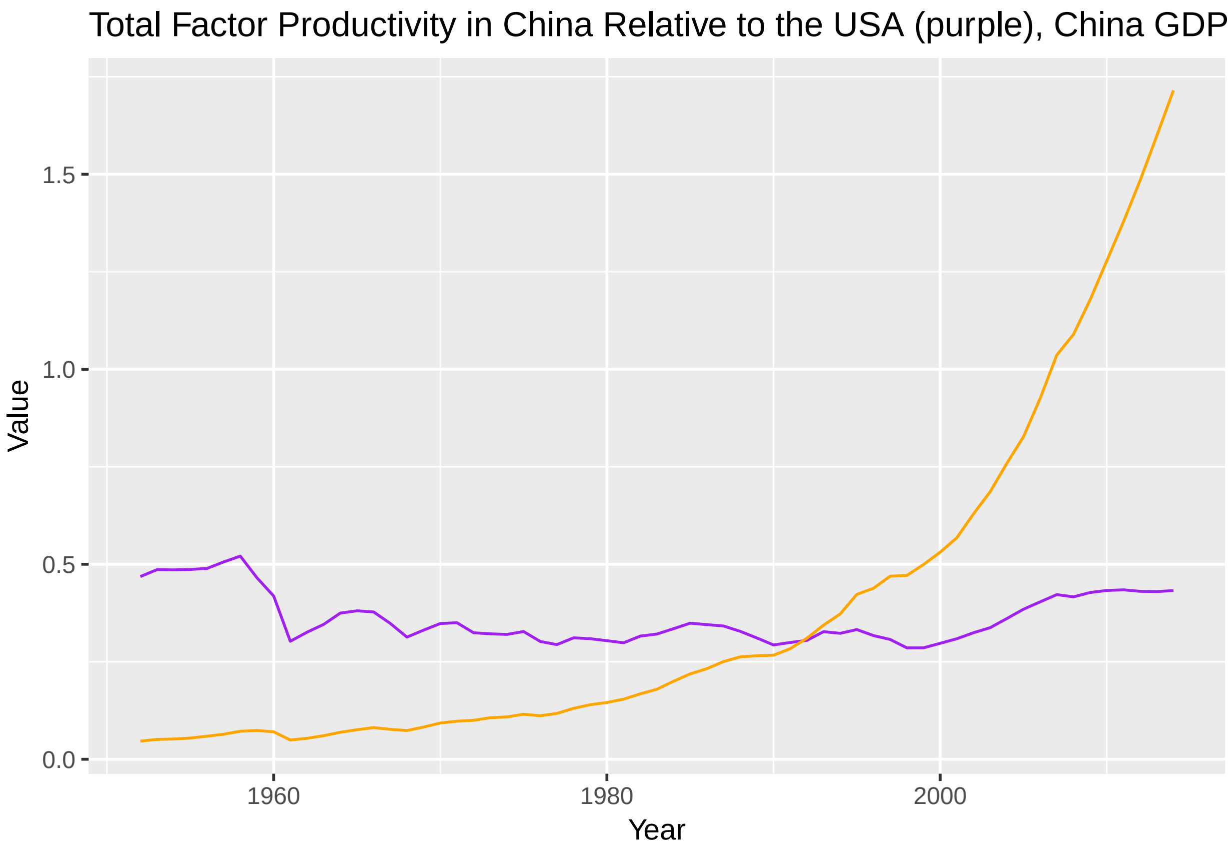

```r
ggplot(chn) +
  geom_line(aes(x = year, y = y / Y_pc), color = "green") +
  xlab("Year") +
  ylab("Value") +
  ggtitle("GDP Per Worker / GDP Per Capita (green)")
```



Looking at the graphs, depreciation is predictably flat (and even slightly decreasing). Savings rate has seen a massive increase since the 1950s, close to 40%. Capital share of income has inaccurate data up through the mid 1990s, however in the period after it appears to rise. "Productivity" has an extremely volatile pattern. The statistic is not necessarily indicative of true productivity and may be flawed. Looking at the GDP per capita / GDP per worker graph, the graph has a negative slope because a smaller percentage of the population was working at that point, until they saw a massive expansion in labor force participation.

Total Factor Productivity in China Relative to the USA:

```
ggplot(chn) +
  geom_line(aes(x = year, y = ctfp), color = "purple") +
  geom_line(aes(x = year, y = Y / 10000000), color = "orange") +
  xlab("Year") +
  ylab("Value") +
  ggtitle("Total Factor Productivity in China Relative to the USA (purple), China GDP / 10000000")
```




```
quantile(chn$ctfp)
```

```
##        0%       25%       50%       75%      100%
## 0.2856013 0.3122838 0.3348229 0.4175909 0.5208984
```

```
mean(chn$ctfp)
```

```
## [1] 0.3619588
```

China, compared to the U.S, has had a consistent total factor productivity typically between 31% and 41% with the quantile and mean listed above. This makes sense considering their orverall size compared to the U.S, and a significantly smaller total gdp.

Technology Relative to Economic Efficiency:

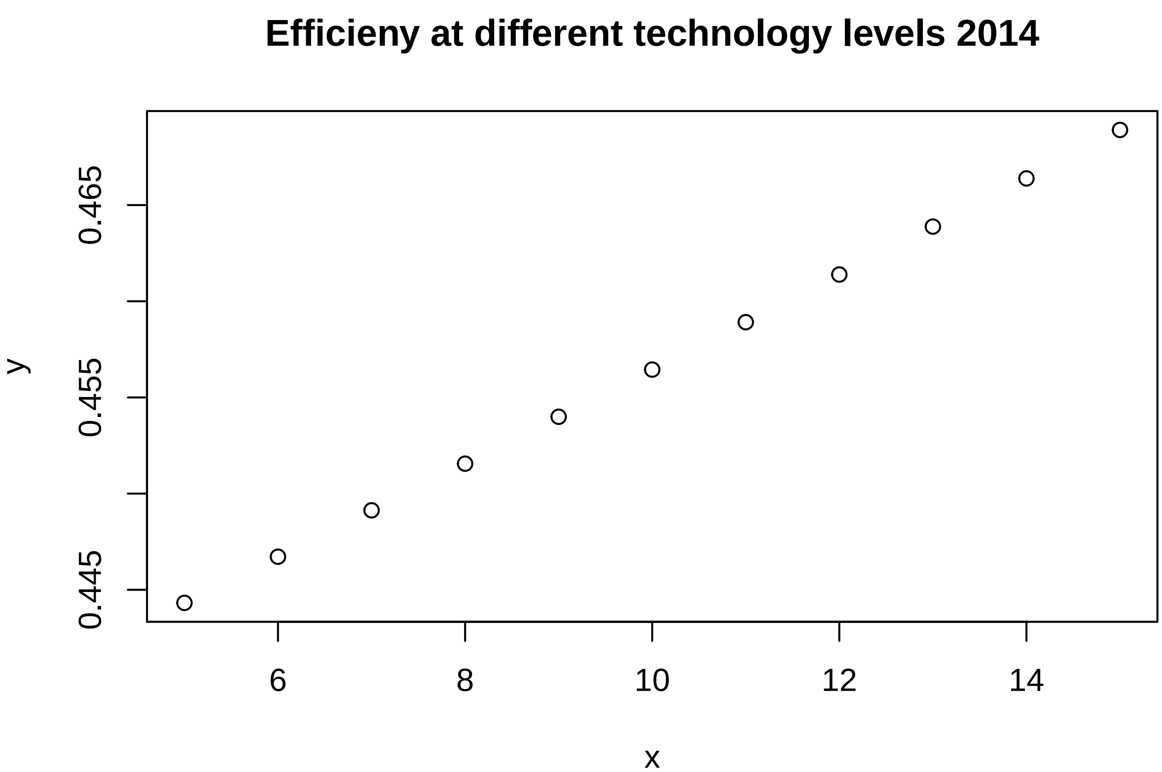
The Global Creativity Index is a study that looks to compare countries in terms of their technology and overall "creativity". They rank countries in a "Global Technology Index" based on said countries' R&D investments, researchers, and overall innovation. In this category, the USA ranks third in the world, while China ranks sixty-second. With that in mind, I would assume that China is likely at least five years behind the United States in terms of actual technology. So, we will calculate China's efficiency relative to the United States making the assumption that China is between 5 and 15 years behind the USA.

In this case the evaluation is looking at how efficient the Portugese economy is compared to the United States given a certain amount of years "behind" the counrty is in technology.

** Using data from 2014 (most recent)

```
chn2 <- df %>%
  filter(isocode == "CHN") %>%
  filter(year == 2014)
```

```
productivity <- chn2$ctfp                #Total Factor Productivity

tech_1yr <- (1.0054)^(-5)                #Technology where G = 5
tech_2yr <- (1.0054)^(-6)                #Technology where G = 6
tech_3yr <- (1.0054)^(-7)                #Technology where G = 7
tech_4yr <- (1.0054)^(-8)                #Technology where G = 8
tech_5yr <- (1.0054)^(-9)                #Technology where G = 9
tech_6yr <- (1.0054)^(-10)                #Technology where G = 10
tech_7yr <- (1.0054)^(-11)                #Technology where G = 11
tech_8yr <- (1.0054)^(-12)                #Technology where G = 12
tech_9yr <- (1.0054)^(-13)                #Technology where G = 13
tech_10yr <- (1.0054)^(-14)              #Technology where G = 14
tech_11yr <- (1.0054)^(-15)              #Technology where G = 15

efficiency_1 <- productivity / tech_1yr
efficiency_2 <- productivity / tech_2yr
efficiency_3 <- productivity / tech_3yr
efficiency_4 <- productivity / tech_4yr
efficiency_5 <- productivity / tech_5yr
efficiency_6 <- productivity / tech_6yr
efficiency_7 <- productivity / tech_7yr
efficiency_8 <- productivity / tech_8yr
efficiency_9 <- productivity / tech_9yr
efficiency_10 <- productivity / tech_10yr
efficiency_11 <- productivity / tech_11yr

x <- c(5,6,7,8,9,10,11,12,13,14,15)
y <- c(efficiency_1, efficiency_2, efficiency_3, efficiency_4, efficiency_5, efficiency_6, efficiency_7
plot(x,y, main = "Efficieny at different technology levels 2014")
```



Looking at the graph, the model estimates that China is somewhere between 44% and 47% as efficient that the U.S dependent on their level of technology.