MR-HD-PRT

Braeden Kuether

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Information:

Country: Portugal | Country Tag: PRT | 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/(kˆa*hˆ(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.

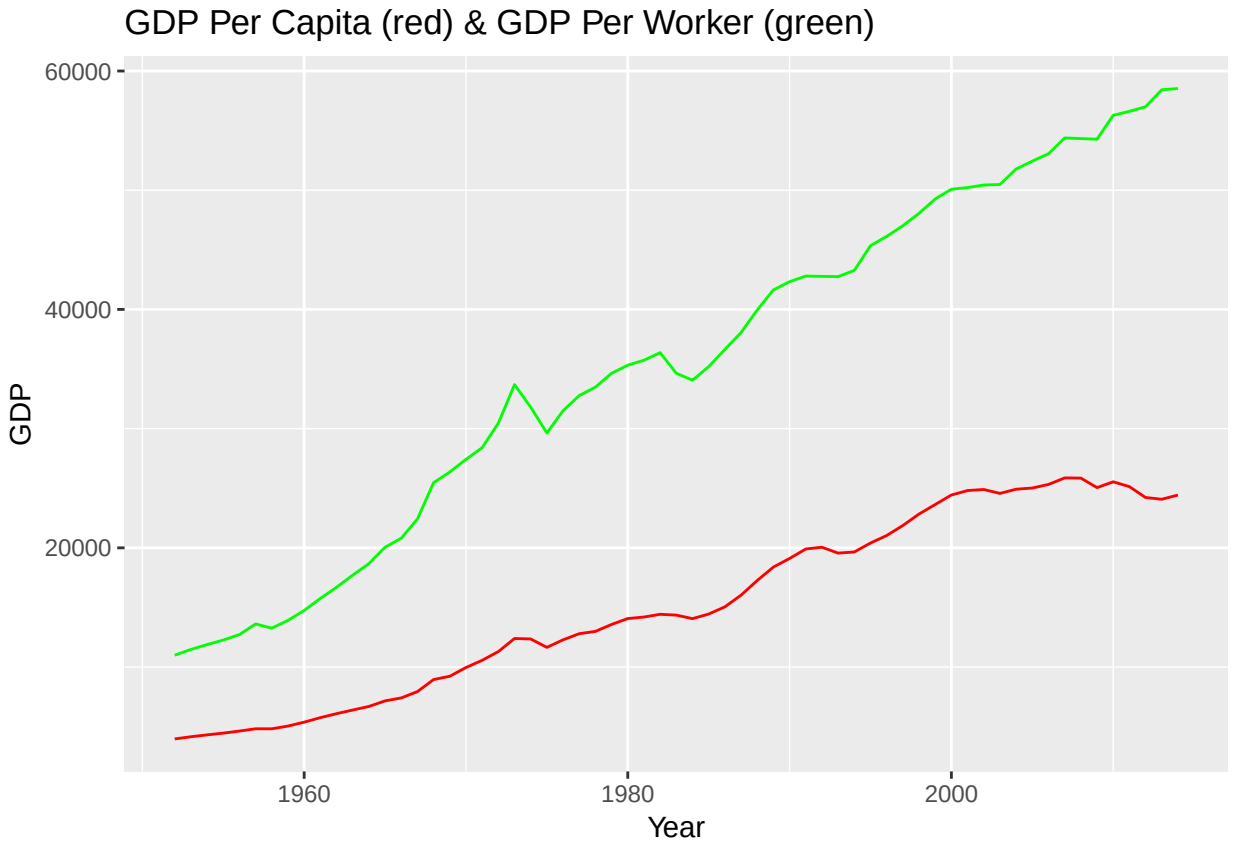
```
df <- pwt9.0 %>%
  mutate(Y = rgdpna, y = rgdpna/emp, k = rkna/emp, a = (1 - labsh)) %>%   #Question 4
  mutate(h = hc, d = delta, L = emp, s = (rdana - rconna)/rgdpna) %>%     #Question 4
  mutate(Y_pc = (rgdpna/pop), l_p = emp/pop, pop_hat = pop - lag(pop))

prt <- df %>%
  filter(isocode == "PRT") %>%
  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)
```

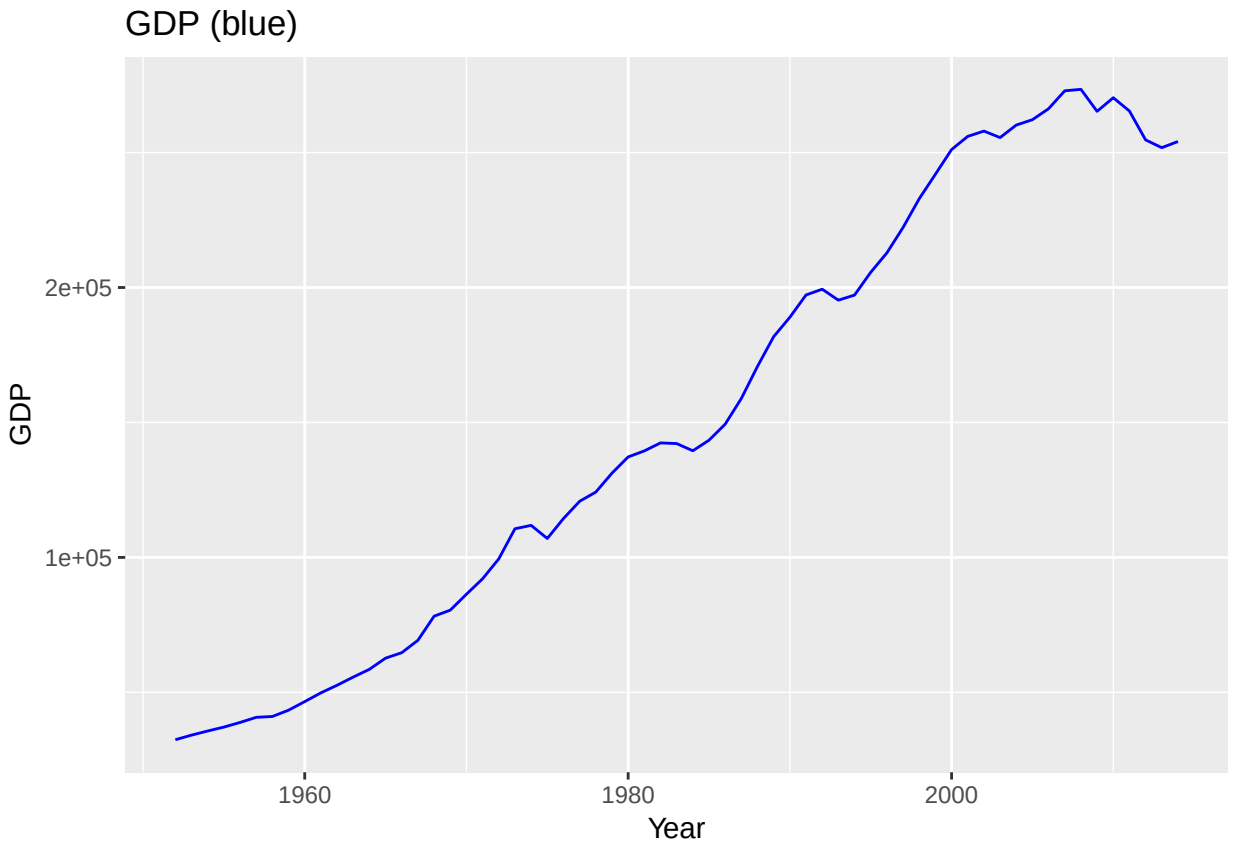
Graphing GDP Statistics:

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

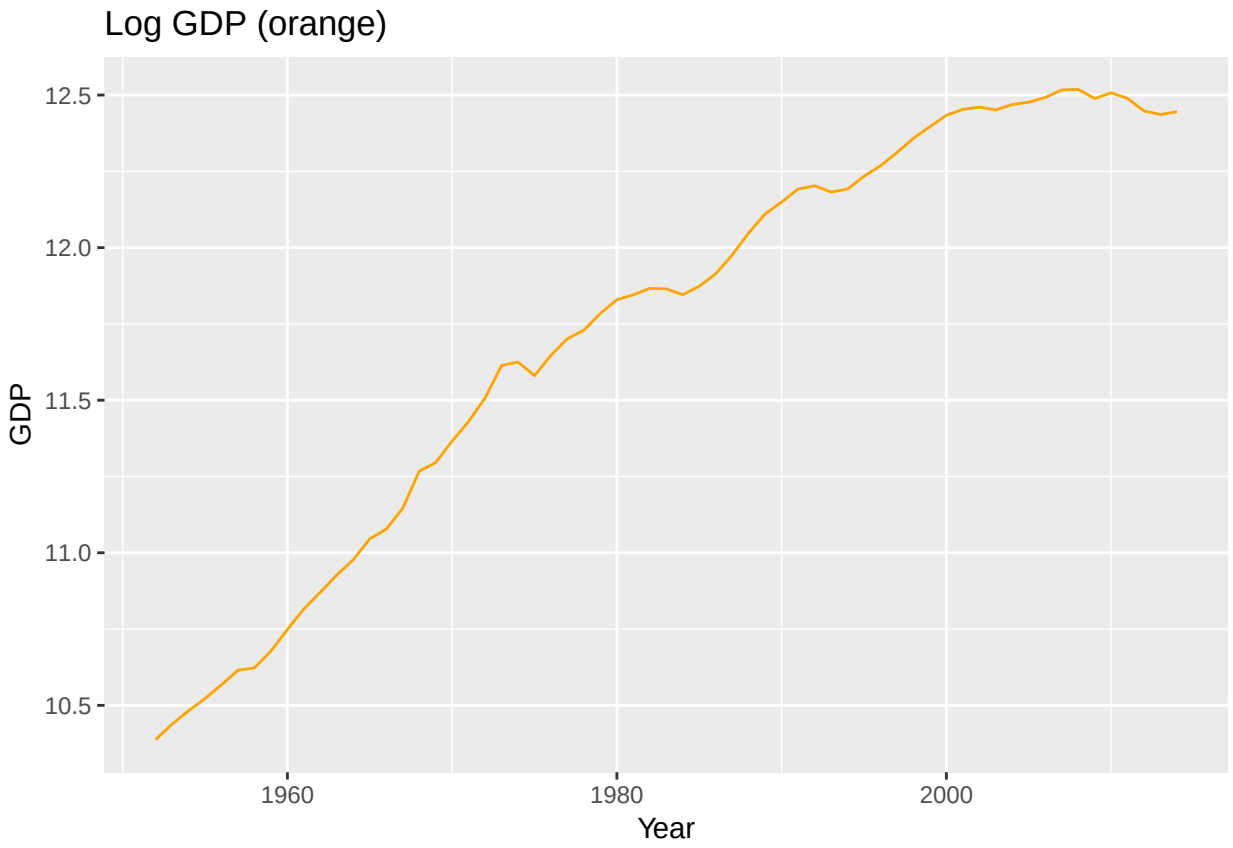
```
ggplot(prt) +
  geom_line(aes(x = year, y = Y_pc), color = "red") +
  geom_line(aes(x = year, y = y), color = "green") +
  xlab("Year") +
  ylab("GDP") +
  ggtitle("GDP Per Capita (red) & GDP Per Worker (green)")
```




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




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

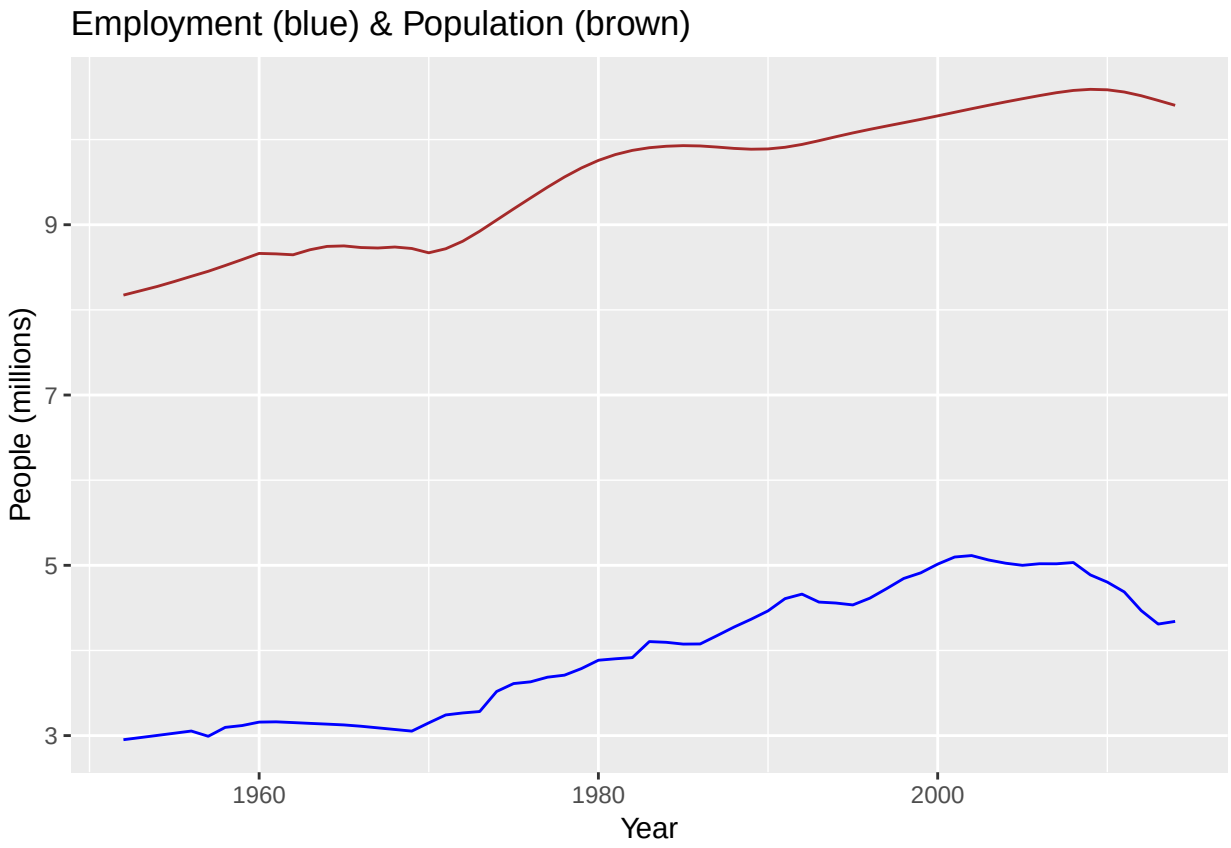


GDP in Portgual has seen relatively consistent growth post 1950s, with a recessionary period over the past decade. Log GDP shows that the growth rate in GDP has plateaued. As expected, GDP per worker will have a greater nomial value due to the employed population being smaller. In this case, GDP per worker is growing at a larger rate than GDP per capita. The interesting thing to note about this trend is post 2010; it appears that the GDP per worker remains relatively linear while the GDP per capita sees a decrease. This is showing that the non-working population is bearing a larger portion of the GDP flattening.

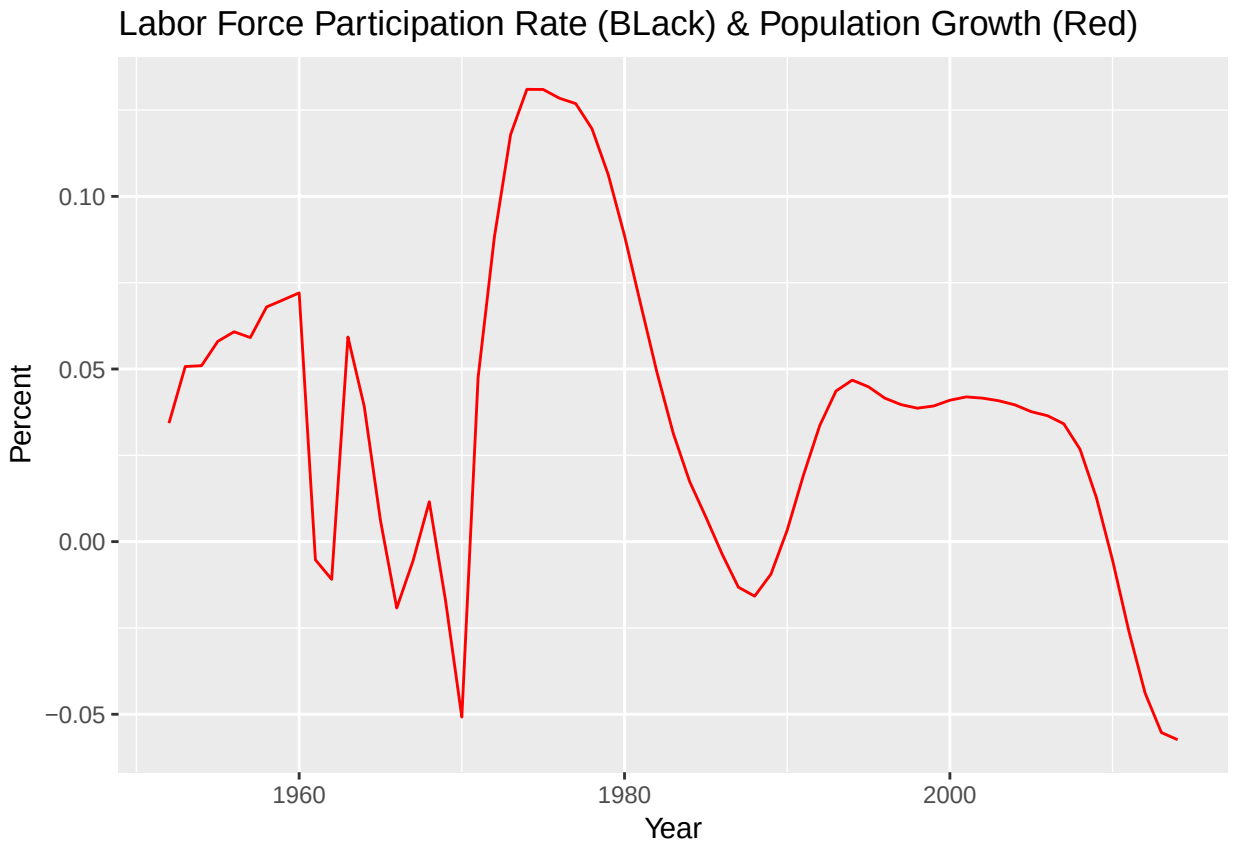
Graphing Employment and Population Statistics:

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

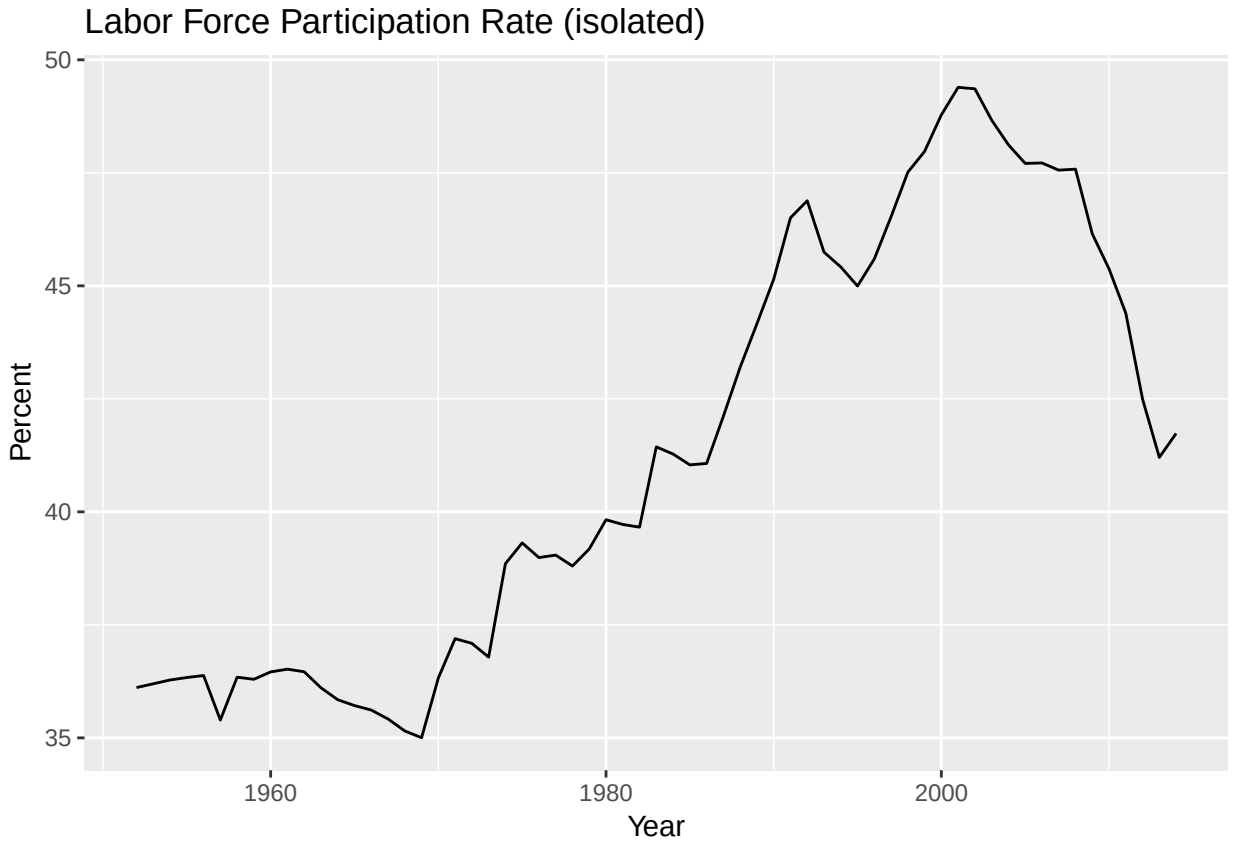
```
ggplot(prt) +
  geom_line(aes(x = year, y = emp), color = "blue") +
  geom_line(aes(x = year, y = pop), color = "brown") +
  xlab("Year") +
  ylab("People (millions)") +
  ggtitle("Employment (blue) & Population (brown)")
```




```
ggplot(prt) +
  #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)")
```




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

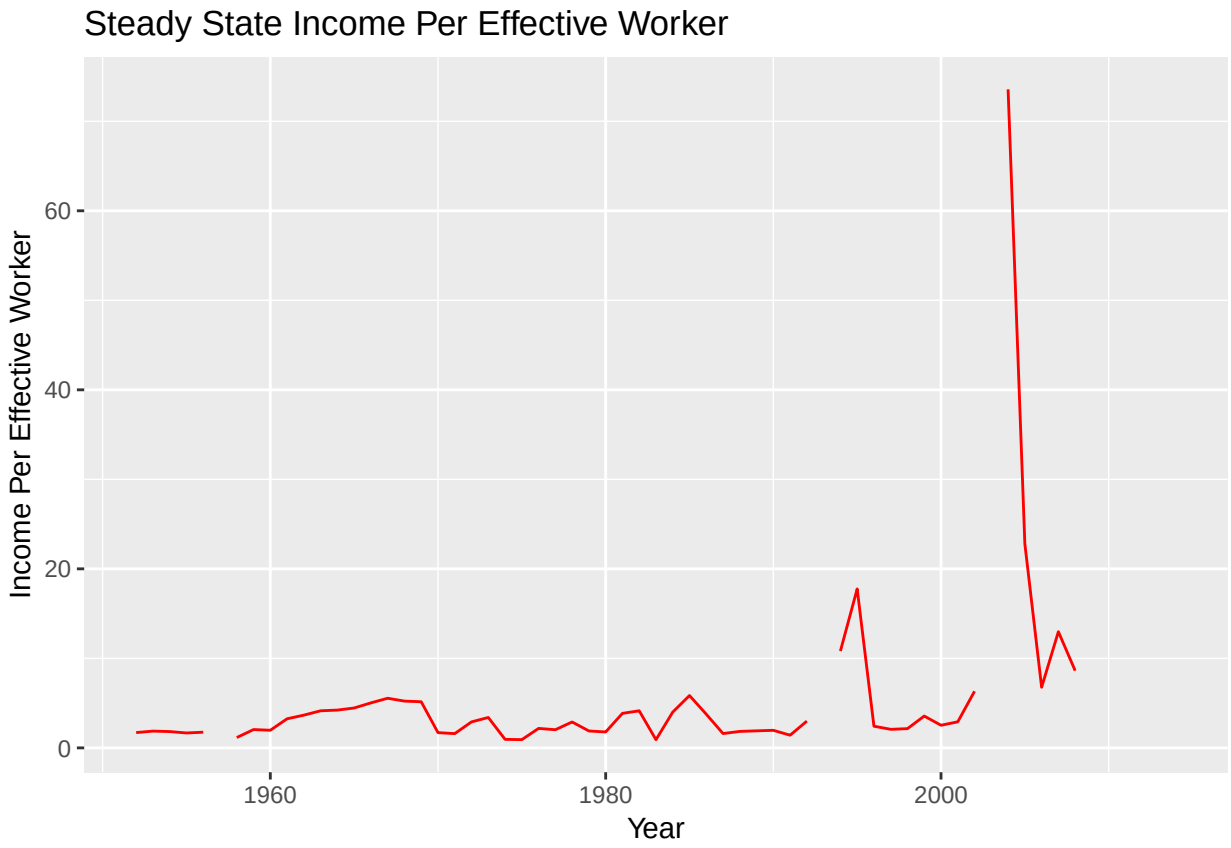


Labor force participation rate was exremely low in the 1960s and 1970s, eventually having a steep ascent. However, following the early 2000s, the labor force participation rate took an extremely steep decline, at approximately 7%. It appears that labor force participation rate might be correlated to population growth in some ways, as the trends are relatively similar. Looking at the population growth rate, the trend has reversed to a negative growth rate over the past five years.

Steady State Income Per Effective Worker

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

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

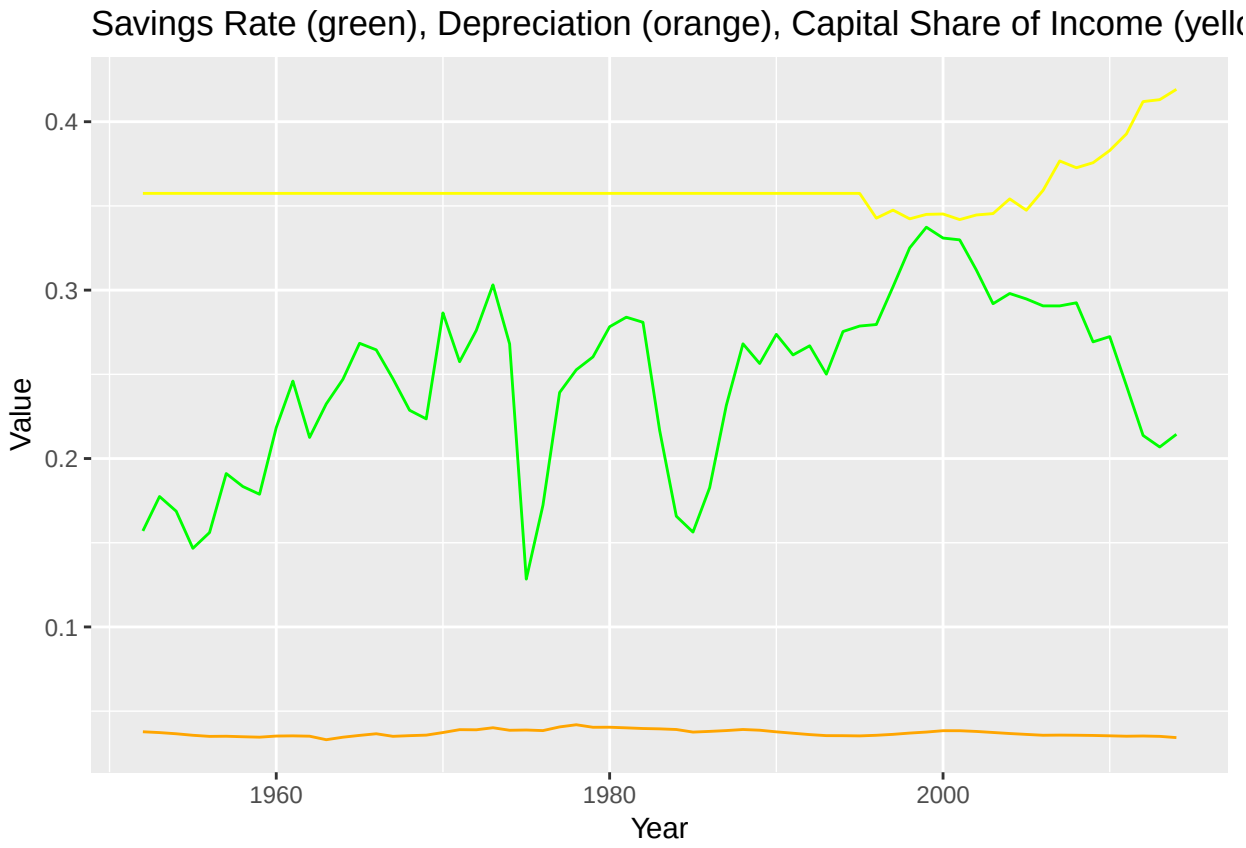


Due to missing data and other irregularities, it's difficult to draw a specific conclusion from the "SSIPEW" statistic.

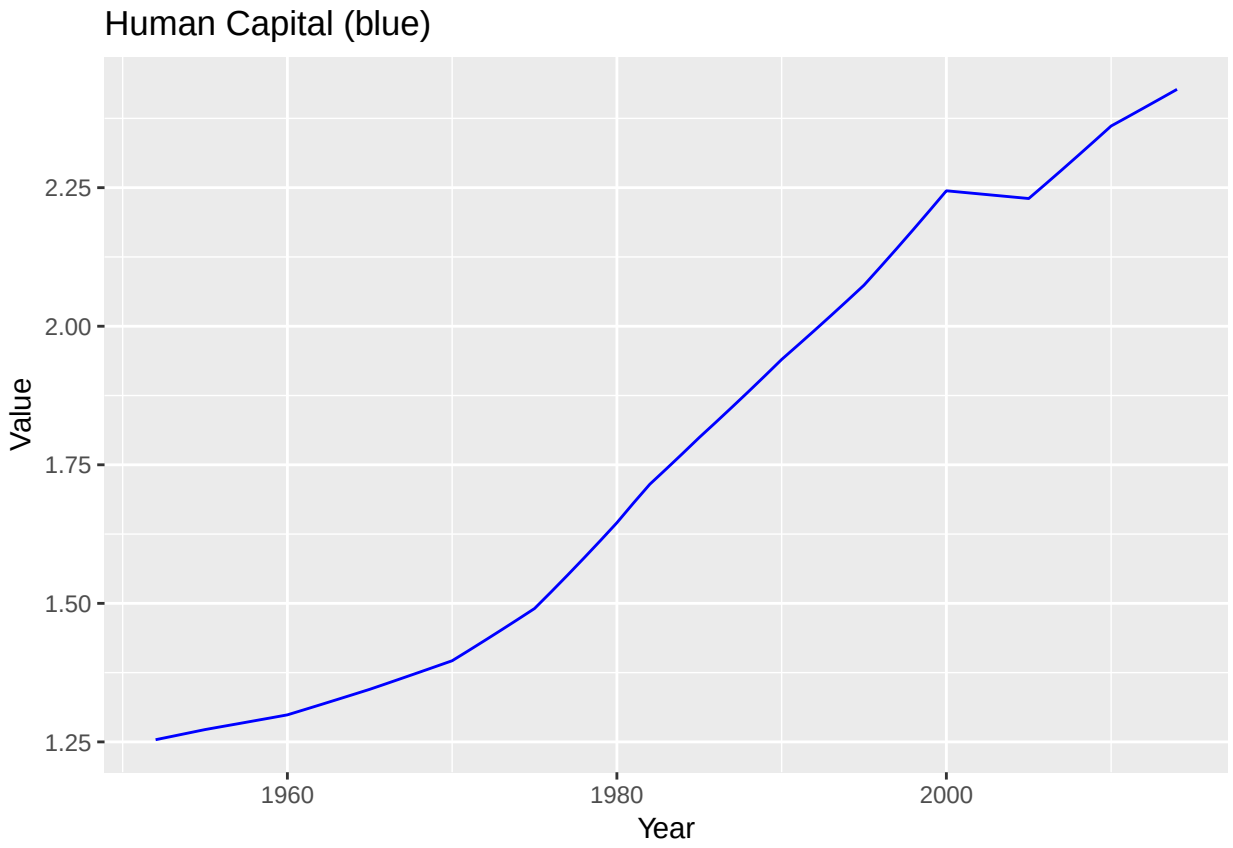
Capital Share of Income and Income Inequality Statistics:

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

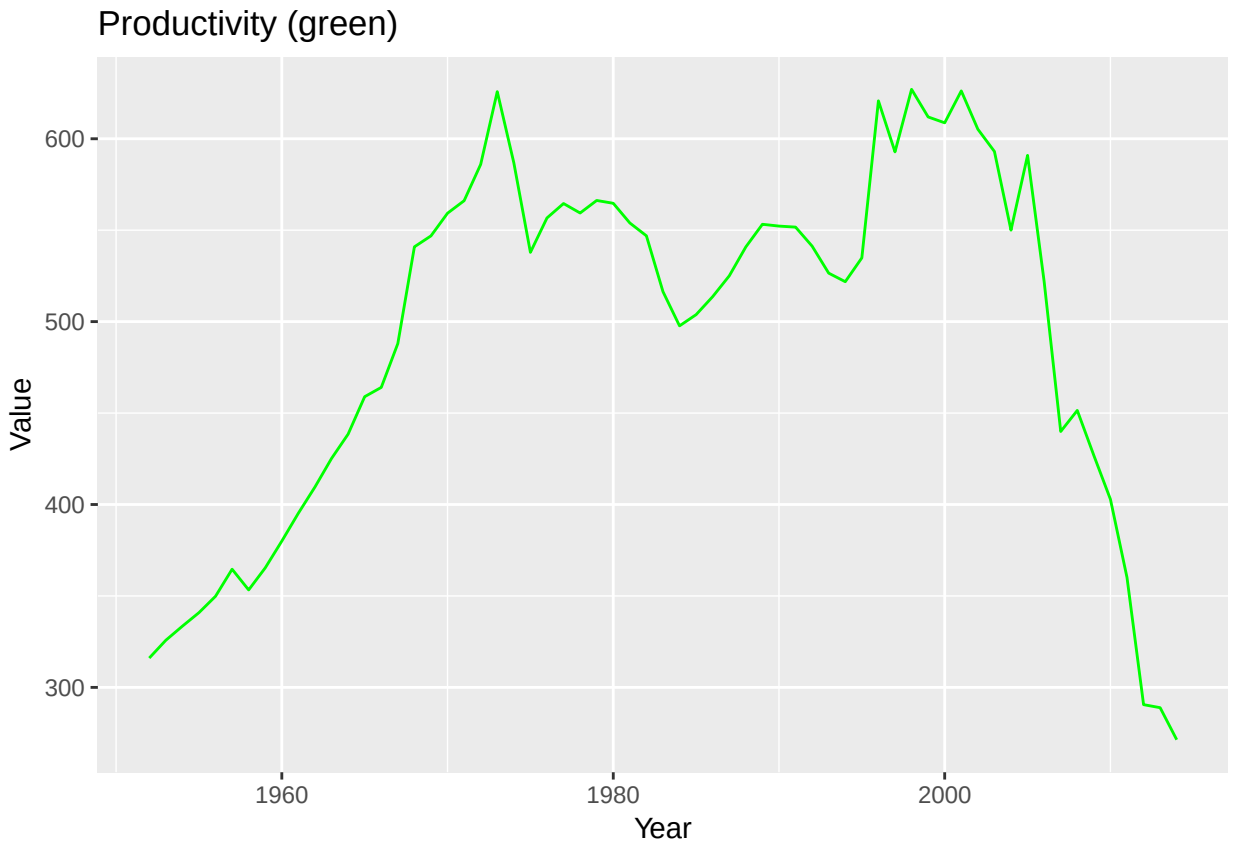
```
ggplot(prt) +
  geom_line(aes(x = year, y = s), color = "green") +
  geom_line(aes(x = year, y = d), color = "orange") +
  geom_line(aes(x = year, y = a), color = "yellow") +
  xlab("Year") +
  ylab("Value") +
  ggtitle("Savings Rate (green), Depreciation (orange), Capital Share of Income (yellow)")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



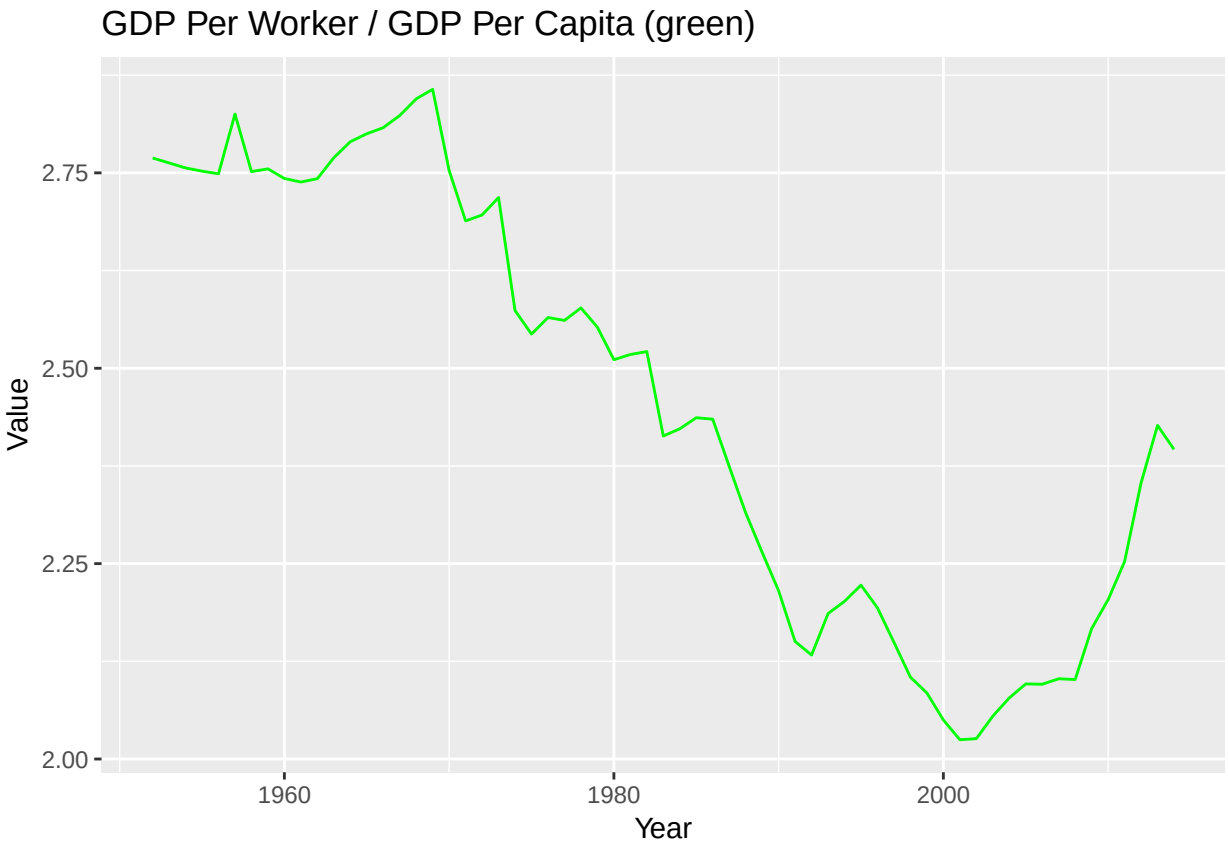

```
ggplot(prt) +
  geom_line(aes(x = year, y = h), color = "blue") +
  xlab("Year") +
  ylab("Value") +
  ggtitle("Human Capital (blue)")
```




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



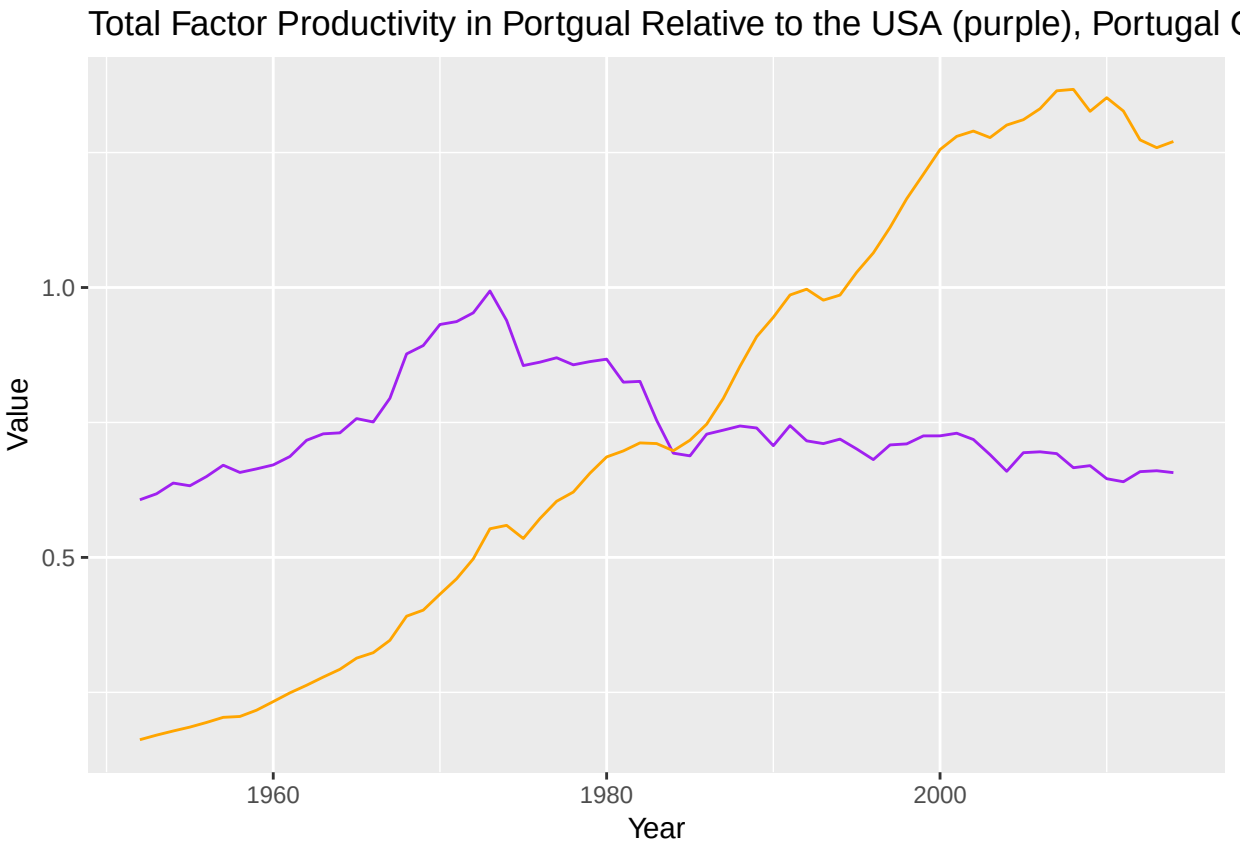

```
ggplot(prt) +
  geom_line(aes(x = year, y = y / Y_pc), color = "green") +
  xlab("Year") +
  ylab("Value") +
  ggtitle("GDP Per Worker / GDP Per Capita (green)")
```



Looking at the graphs, depreciation is predictably flat (and even slightly decreasing). Savings rate was extremely volatile up through the expansion period, and saw a relative flattening. Capital share of income has inaccurate data up through the mid 1990s, however in the period after it appears to rise. "Productivity" rises very quickly until flattening from the 1970s to the 2000s. Immediately following, there is a sharp decline back to 1950s levels. That said the statistic is not necessarily indicative of true productivity and may be flawed. Looking at the GDP per capita / GDP per worker graph, there is a widening in potential income disparity as laborers are forced out of the market (inverse trend of labor force participation rate).

Total Factor Productivity in France Relative to the USA:

```
ggplot(prt) +
  geom_line(aes(x = year, y = ctfp), color = "purple") +
  geom_line(aes(x = year, y = Y / 200000), color = "orange") +
  xlab("Year") +
  ylab("Value") +
  ggtitle("Total Factor Productivity in Portgual Relative to the USA (purple), Portugal GDP / 200000")
```



Portugal, compared to the U.S, saw its greatest output nearing the mid 1970s reaching a 1:1 ratio in total factor productivity. Although the overall economy conitnued to rise after that period, compared to the U.S the total factor productivity grew at a much slower rate. Eventually, that TFP trend plateaued at around 60% that of the U.S.

Technology Relative to Economic Efficiency:

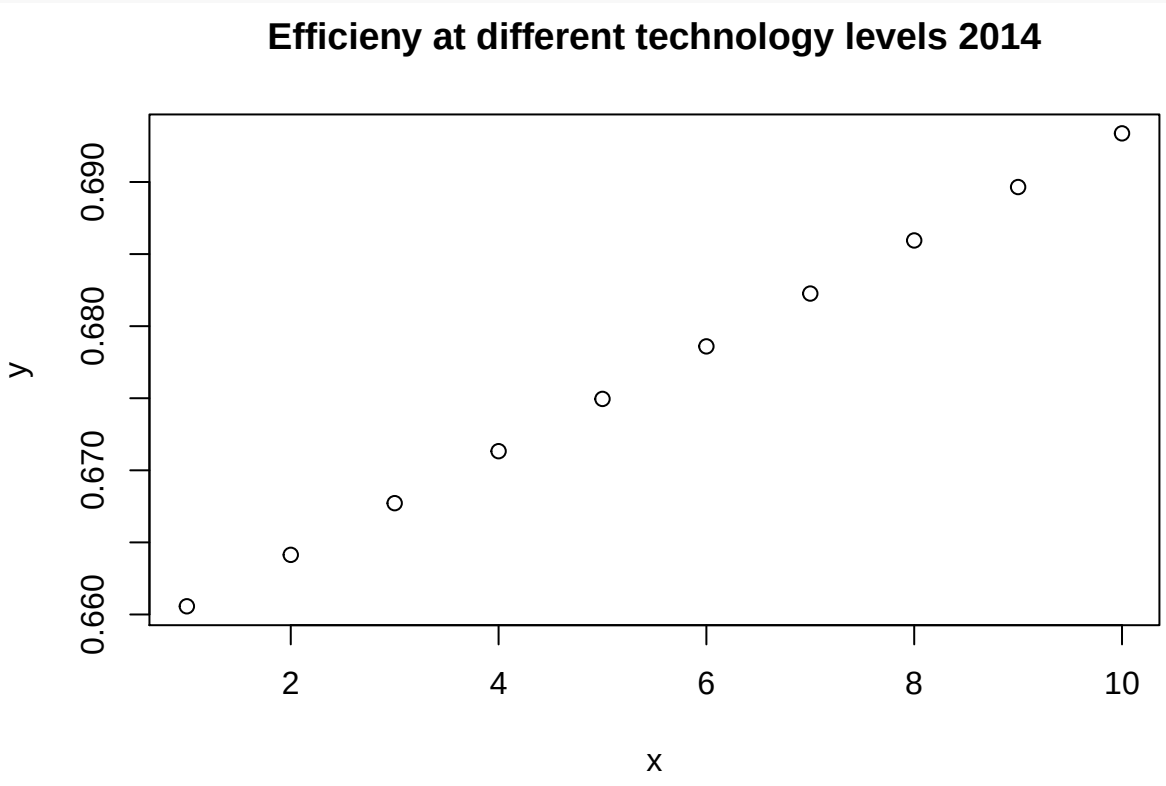
The Global Creativity Index is a study that looks to compare countries in terms of their technology and overall "creativity". They rank countries in a "Global Technology Index" based on said countries' R&D investments, researchers, and overall innovation. In this category, the USA ranks third in the world, while Portugal ranks twenty-third. With that in mind, I would assume that Portugal is likely at least a few years behind the United States in terms of actual technology. So, we will calculate Portgual's efficiency relative to the United States making the assumption that France is between two and five years behind the USA. To be safe, we will also look at that number should Portugal be closer to ten years behind in technology.

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)

```
prt2 <- df %>%
  filter(isocode == "PRT") %>%
  filter(year == 2014)

productivity <- prt2$ctfp              #Total Factor Productivity

tech_1yr <- (1.0054)^(-1)              #Technology where G = 1
tech_2yr <- (1.0054)^(-2)              #Technology where G = 2
tech_3yr <- (1.0054)^(-3)              #Technology where G = 3
```

```r
tech_4yr <- (1.0054)^(-4)               #Technology where G = 4
tech_5yr <- (1.0054)^(-5)               #Technology where G = 5
tech_6yr <- (1.0054)^(-6)               #Technology where G = 6
tech_7yr <- (1.0054)^(-7)               #Technology where G = 7
tech_8yr <- (1.0054)^(-8)               #Technology where G = 8
tech_9yr <- (1.0054)^(-9)               #Technology where G = 9
tech_10yr <- (1.0054)^(-10)             #Technology where G = 10

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

x <- c(1,2,3,4,5,6,7,8,9,10)
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 portgual is somewhere between 66% and 70% as efficient that the U.S dependent on their level of technology.