Understanding Corporate Tax Rate and Foreign Direct Investment

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A. Introduction

I am seeking to estimate the relationship between Foreign Direct Investment and the stated corporate tax rate imposed nationally. Foreign Direct Investment represents investments from abroad in long term projects. The IMF Defines FDI as a purchase of 10% or more of a domestic business from a foreign investor. This could also be from a foreign business opening a subsidiary abroad. In my study, I want to understand if the corporate tax rate affects how much FDI is invested nationally. To get an unbiased estimate, I am holding constant correlated factors that are also determinants of FDI. In my model. I included measures of market innovation, financial freedom, and economic size as control variables. Finally, to estimate these relationships I will use a general linear model, and use normal assumptions for the dependent variable, FDI. In the checking the adequacy of the model section, I will verify the validity of these assumptions.

B. Data

RESPONSE VARIABLE:

- Foreign Direct Investment in Billions of USD, in Log base 10. I applied the log function to transform the data into a normal distribution. The base data had significant positive skew. Density plots before and after transformations are available in the appendix.

EXPLANATORY VARIABLES:

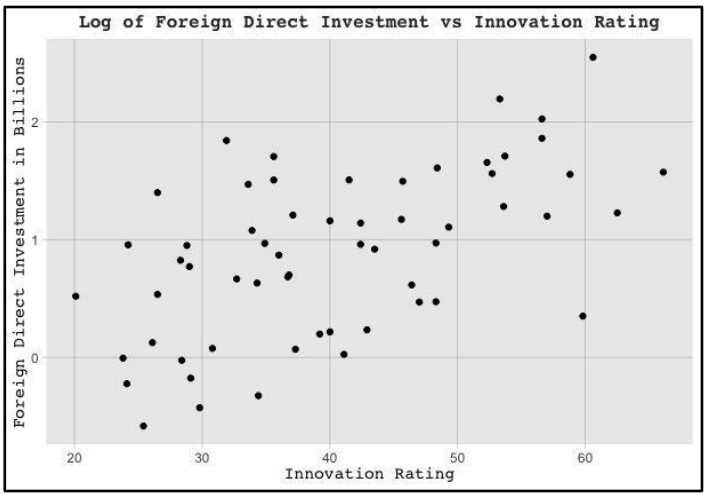
- Corporate Tax Rate in Percentage Terms. This is a standardized measure of how much businesses in each country pay on profits earned, based on officially posted data. A discussion on the validity of posted data is included in the Summary.
- Gross Domestic Product in USD, in Log base 10. Again here, I apply the log function to get rid of the skew of the data in base form. GDP is a measure of the size of a country's economy in terms of how large its total expenditures in a given year are.
- Financial Freedom as measured by Heritage. This is a measure of bank efficiency and a measure of independence from government control in the financial sector, A higher value of financial freedom indicates higher independence from the government within the financial sector.

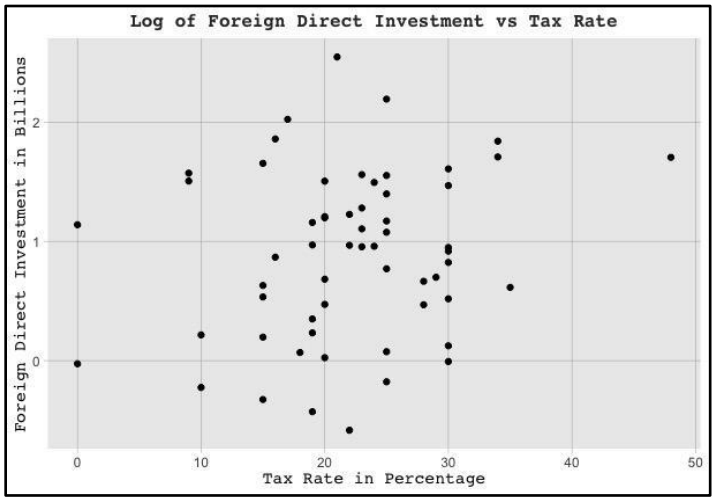
- Innovation measure by country income group. This is a measure of a country's overall advancement in innovation, it evaluates countries based on R&D, venture capital, and high-tech production.

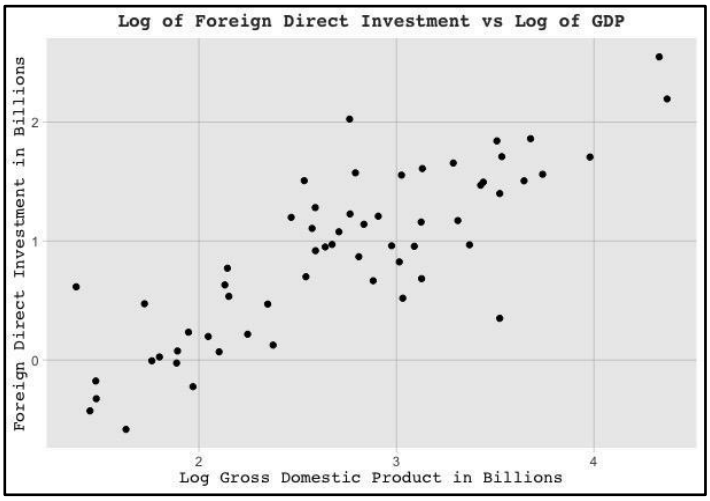
DATA SOURCES:

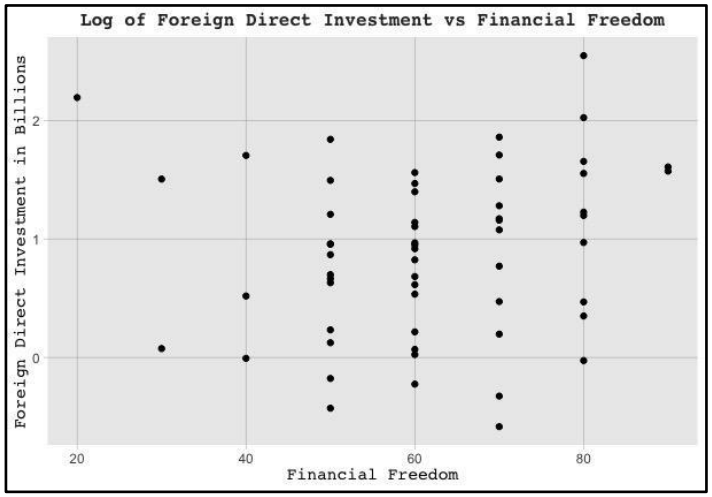
- Data Sources: Foreign direct investment, net inflow (https://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD),
- GDP, PPP (https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.CD),
- Effective Corporate Tax Rate by Country 2021 (https://worldpopulationreview.com/country-rankings/effective-corporate-tax-rate-by-country)
- Economic Freedom Index (https://www.heritage.org/index/ranking)
- The Most Innovative Countries, Ranked by Income Group (https://www.visualcapitalist.com/national-innovation-the-most-innovative-countries-by-income/)

C. Plots of dependent variable and independent variables









D. Model specification and Regression Estimation Results

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.926942   0.299966  -6.424 3.54e-08 ***
Tax          0.004965   0.005978   0.831 0.409910
Log GDP      0.684656   0.071303   9.602 2.82e-13 ***
Fin Freedom  0.001992   0.003831   0.520 0.605268
Inv Rating   0.018030   0.005173   3.485 0.000985 ***
```

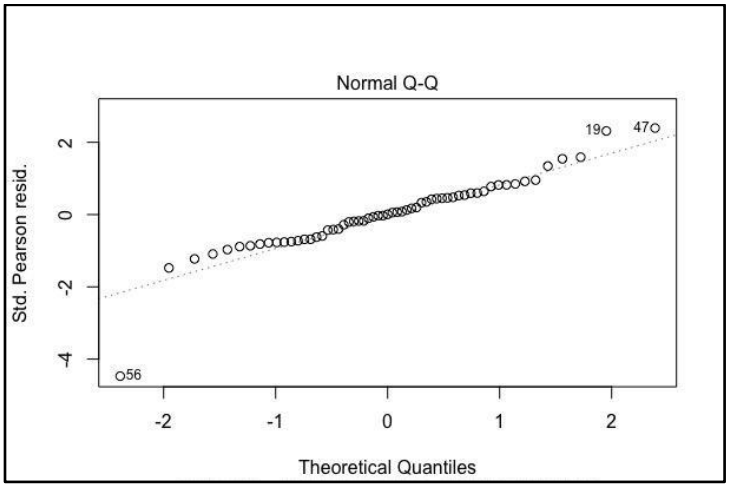
E. Checks of the adequacy of the model

To check my model, I compare it to a base specification, regressing FDI on only the Tax rate. To compare my full model to the base specification, I measure the Akaike Information Criterion. This is a measure of goodness of fit of the model, where lower values are better. The model with the lowest AIC is the model which explains the greatest amount of variation of the dependent variable, using the fewest independent variables. The base model has an AIC of 128.4, compared to my full model with an AIC of 47.5. There is significant improvement here in including my additional control variables.

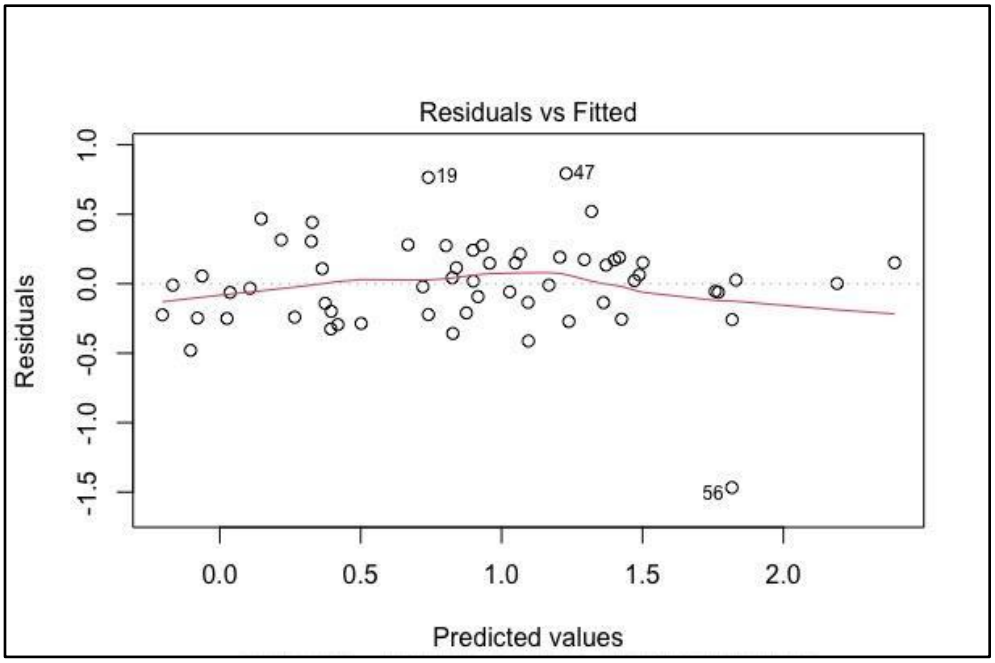
```
Base Model
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.54022    0.26166   2.065   0.0435 *
Tax.         0.01607    0.01116   1.440   0.1555

AIC: 128.38
```

Next, I checked the model assumptions for regression. I need to determine if my residuals, or error terms, are normally distributed. To check this visually, I used a Q – Q Plot, which plots a line of the theoretical quartiles of a Normal Distribution, versus my actual data. Visually, my residuals are well approximated by a normal distribution. A final check of the mean of residual values yielded a result of 7.9x10^-16, which is insignificantly different from 0. This is important, as a non-zero mean residual value would imply that my model is biased, with it consistently over or underestimating my data. With that, my model checks my regression assumptions, with a normally distributed error term about a mean zero.



Lastly, I check my model's consistentcy. A mean residual value of 0 confirms that my model is unbiased, however, I want to visually confirm it is unbiased for all levels of my data. To do this, I plotted a residuals vs fitted values plot, below.



Ideally, my data will be centered about the zero line, with equal points above and below that line. My data checks this visually.

F. Inference and Interpretations of Significant Independent Variables

In my findings of the effect of Innovation, when innovation rank increases by one unit, FDI is expected to increase by 1.82%. This finding matched my initial expectation, that more innovative countries will attract more foreign investment. Among the relationships I measured, this one is one of the stronger, with a standard error of 0.005. Further, while I included this as a control variable for my primary question about corporate rate, innovation in and of itself can be targeted by policymakers, for example issuing grants for Research and Development targets.

GDP is a control variable I used. When GDP increases by 1%, FDI increases by 0.68%. Again, this relationship is expected as larger economics scale necessarily will attract more investment. The

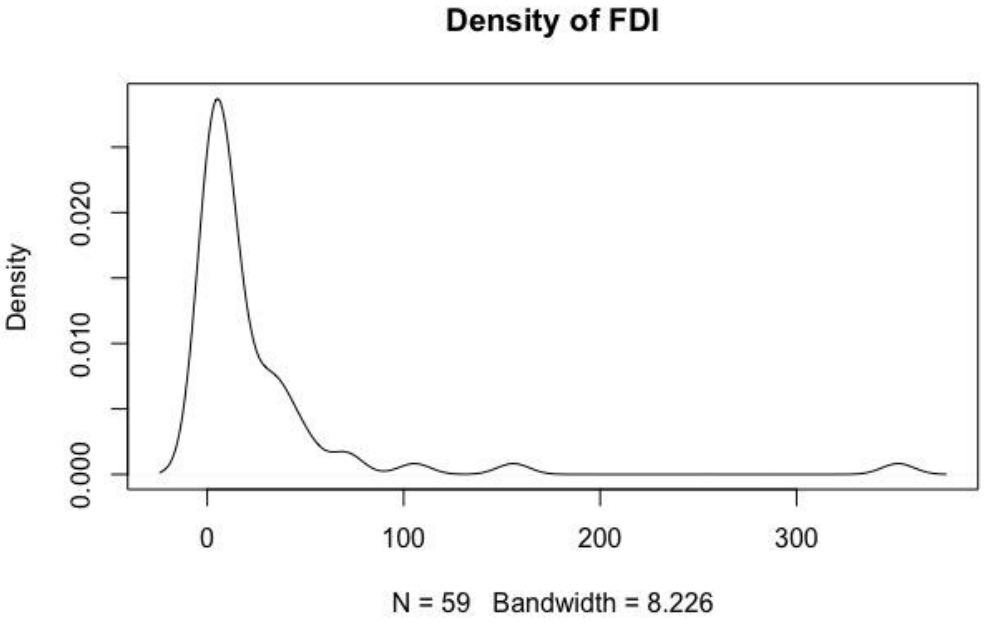
relationship here is very strong, with a standard error of 0.07. An interesting point, however, is that before log transforming the data, there were some significant outliers, specifically the United States and China, drawing disproportionately large FDI relative to their respective economies.

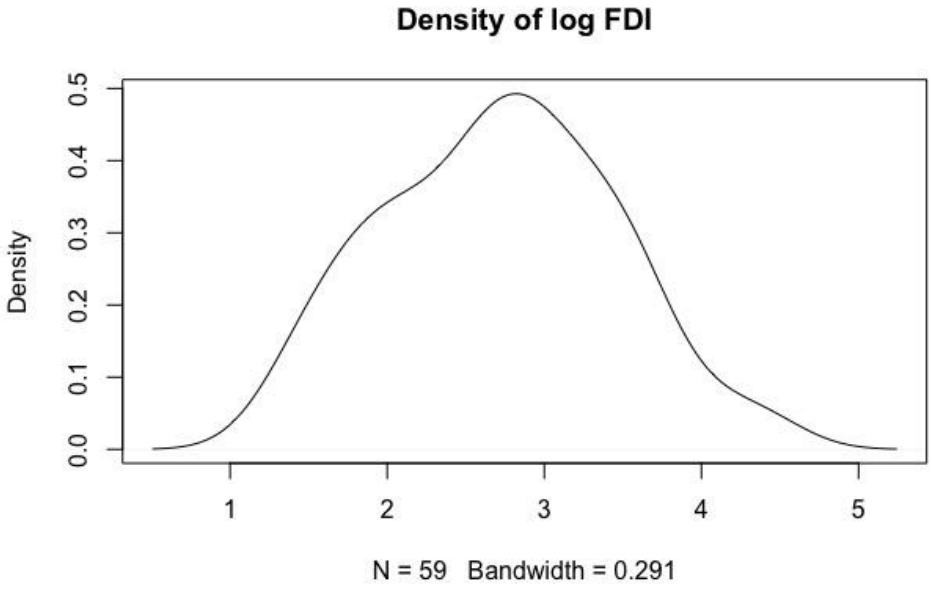
G. Summary

My Research sought to investigate the relationship between corporate tax rate and Foreign Direct Investment. In my findings, there is no significant relationship to be found. Investors are apparently agnostic to tax policy in foreign investments and there are more important determinants. This is useful information for policymakers, as the impact of corporate tax rate changes will likely not impact foreign investment. However, there may be more than meets the eye. Further research into the effective tax rate is needed. While some nationals have high official tax rates, the rate paid in practice may differ greatly. In looking for control variables, I made equally informative discoveries. Relative innovativeness is a significant determinant of FDI. Economically this might be expected and in an ideal system, this is desired: more capital flowing to the most innovative locations. Another surprising finding is that Financial Freedom is not a significant determinant of FDI. This is contrary to expectation, that more free markets lead to greater investment. An economical explanation of this might be that outliers such as China, with massive FDI and relatively less free markets, skew the data. Ultimately, innovativeness might be the most important factor here.

All said, the punch line to my findings is that policymakers can ignore meddling with tax policy and bank regulation, instead focusing on driving innovation in its domestic industries, and investment will follow, at least based on the official information.

H. Appendix


Density of FDI
Density
0.000
0.010
0.020
0
100
200
300
N = 59 Bandwidth = 8.226


Density of log FDI
Density
0.0
0.1
0.2
0.3
0.4
0.5
1
2
3
4
5
N = 59 Bandwidth = 0.291

Code:

```
# Made using R Studio
# Final Project Code

library(dplyr)
library(ggplot2)
library(ggthemes)
library(e1071)

# Importing Data
new_data = read.csv('csvfinalfinal.csv')
df2 = data.frame(new_data)

# Density plots
plot(density(df2$fdi.billion))
plot(density(df2$gdp.billion))
plot(density(df2$tax))
plot(density(df2$ff))
plot(density(df2$rating))

# Transformed data
loggdp = log10(df2$gdp.billion)
logfdi = log10(df2$fdi.billion)

# Testing for Skewness of logged Data
skewness(df2$fdi.billion)
skewness(logfdi)

# Density of Transformed Data
plot(density(logfdi))
plot(density(loggdp))

# Estimating Regressions
model1 = glm(logfdi ~ df2$tax, family = gaussian(link = 'identity'))
model2 = glm(logfdi ~ df2$tax + df2$gdp.billion, family =
gaussian(link = 'identity'))
model3 = glm(logfdi ~ df2$tax + df2$gdp.billion + df2$ff, family =
gaussian(link = 'identity'))
model4 = glm(logfdi ~ df2$tax + loggdp + df2$ff, family =
gaussian(link = 'identity'))
model5 = glm(logfdi ~ df2$tax + loggdp + df2$ff + df2$rating, family =
gaussian(link = 'identity'))
```

```
model_final = glm(logfdi ~ loggdp + df2$ff + df2$rating, family =
gaussian(link = 'identity'))
# Plotting Relationships
plot(x = df2$tax, y = logfdi)
plot(x = loggdp, y = logfdi)
plot(x = df2$ff, y= logfdi)
plot(x = df2$rating, y = logfdi)
# Plotting Residuals
model5_resid = residuals(model5)
plot(model5_resid, main = "Scatter Plot of Residuals")
hist(model5_resid, n = 10)
plot(model5)

# plots 2

library(ggplot2)
library(ggthemes)

# Plot 1
qplot(x = df2$tax, y = logfdi, geom = 'point',
      main = 'Log of Foreign Direct Investment vs Tax Rate', xlab =
'Tax Rate in Percentage',
      ylab = 'Foreign Direct Investment in Billions')+
  theme(
    plot.title = element_text(face = "bold", size = 12, family=
'mono', hjust = 0.5, colour = 'grey20'),
    axis.title = element_text(family = 'mono'),
    axis.ticks = element_line(colour = "grey70", size = 0.2),
    panel.grid.major = element_line(colour = "grey70", size = 0.2),
    panel.grid.minor = element_blank()
  )

# Plot 2

qplot(x = loggdp, y = logfdi, geom = 'point',
      main = 'Log of Foreign Direct Investment vs Log of GDP', xlab =
'Log Gross Domestic Product in Billions',
      ylab = 'Foreign Direct Investment in Billions')+
  theme(
    plot.title = element_text(face = "bold", size = 12, family=
'mono', hjust = 0.5, colour = 'grey20'),
    axis.title = element_text(family = 'mono'),
    axis.ticks = element_line(colour = "grey70", size = 0.2),
    panel.grid.major = element_line(colour = "grey70", size = 0.2),
    panel.grid.minor = element_blank()
```

```
  )

# Plot 3

qplot(x = df2$ff, y = logfdi, geom = 'point',
      main = 'Log of Foreign Direct Investment vs Financial Freedom',
xlab = 'Financial Freedom',
      ylab = 'Foreign Direct Investment in Billions')+
  theme(
    plot.title = element_text(face = "bold", size = 12, family=
'mono', hjust = 0.5, colour = 'grey20'),
    axis.title = element_text(family = 'mono'),
    axis.ticks = element_line(colour = "grey70", size = 0.2),
    panel.grid.major = element_line(colour = "grey70", size = 0.2),
    panel.grid.minor = element_blank()
  )

# Plot 4

qplot(x = df2$rating, y = logfdi, geom = 'point',
      main = 'Log of Foreign Direct Investment vs Innovation Rating',
xlab = 'Innovation Rating',
      ylab = 'Foreign Direct Investment in Billions')+
  theme(
    plot.title = element_text(face = "bold", size = 12, family=
'mono', hjust = 0.5, colour = 'grey20'),
    axis.title = element_text(family = 'mono'),
    axis.ticks = element_line(colour = "grey70", size = 0.2),
    panel.grid.major = element_line(colour = "grey70", size = 0.2),
    panel.grid.minor = element_blank()
  )
```