

A comparative study of the corporate environmental
impacts of the six representative countries of six
continents

https://github.com/yw448/QiuWangXu_ENV872_EDA_FinalProject.git

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1 Rationale and Research Questions

As ESG performance became more and more important for investors to measure a corporation's competitiveness, evaluating the environmental impacts of companies becomes an essential topic. Therefore, Harvard Business School developed a methodology to monetize corporations' environmental impacts. With the monetized impacts, we can measure the overall environmental impacts of the corporations in a country.

Due to the different stages countries are in their industrial transition path, different countries' corporations have different environmental intensities. Therefore, by comparing the environmental intensity of the representative countries on six continents, we can see which country's corporations took the leading position in their way of industrial transition. Since each country is representative of its continent, we can have an overview of the industrial transition status of the world. The environmental intensity disparities of countries are also a reminder for the laggards to perform better in the future.

Key Questions: Is there any countries better off than others 2019? Which countries are better-off than others in 2019?

2 Dataset Information

1. Dataset Information

The dataset we choose is from Harvard Business School’s study of corporate environmental impact. They develop a methodology to estimate monetized environmental impact by “applying characterization pathways and monetization factors to organization level environmental outputs, including carbon emissions, water use, and other emission types”. Their monetization factors are from “the Environmental Priority Strategies (EPS) Database, Available Water REmaining (AWARE) Model, and Waterfund, along with organization-level data of environmental outputs, such as carbon emissions, nitrous oxide, sulfur oxide, VOC, PM 2.5, and water withdrawal and discharge, sourced from Bloomberg and Thomson Reuters”.

The monetized dataset includes Year, Company Name, Country, Industry, Environmental Intensity (Sales), Environmental Intensity (Op Inc), Total Environmental Cost, Capacity for each means of production, and the monetized impact on each selected SDG goal. A total of 14516 rows are in the dataset. The factor-environmental intensity (Sales) is the scaled calculations for total organizational environmental impact by sales as a proxy for organization size. The monetized damage to the environment is a minus, whereas the monetized benefits to the environment are a plus. The most recent year of data is 2019.

Table 1: Raw Data Structure

Year	Company Name	Country	Industry (Exiobase)	Environmental Intensity (Sales)
Min. :2010	Length:14515	Japan :2401	Length:14515	Min. :-1.99279
1st Qu.:2013	Class :character	United States :2397	Class :character	1st Qu.: -0.09345
Median :2015	Mode :character	United Kingdom:1691	Mode :character	Median :-0.02033
Mean :2015	NA	Taiwan :1024	NA	Mean :-0.11301
3rd Qu.:2017	NA	Australia : 584	NA	3rd Qu.: -0.00679
Max. :2019	NA	France : 565	NA	Max. : 1.90360
NA	NA	(Other) :5853	NA	NA

3 Exploratory Analysis

2. Data Wrangling Our key research goal is to compare the corporate environmental impacts of the six representative countries of six continents in 2019 since the data of 2019 is the most recent data we have. The six representative countries are chosen for the countries with the most environmental impacts data in their continents. Finally, the US, UK, Japan, Australia, Mexico, and South Africa, these six countries were selected.

The main effect variable we want to discuss is “Environmental Intensity (Sales)”, so we deleted all the irrelevant variables, and only left “Year”, “Company”, “Country”, and “Environmental Intensity (Sales)”-these four columns.

To make the graph easier to read, we multiplied “Environmental Intensity (Sales)” by “-1”, so that the larger the number is, the larger the negative impacts the environment are suffered.

3. Data Exploration

[1] 7793 4

Table 2: Data Exploration of Six Countries

Year	Company	Country	Index
2017 : 895	3M COMPANY : 10	Japan :2401	Min. :-1.390194
2016 : 888	ABSA GROUP LTD : 10	United States :2397	1st Qu.: 0.006238
2018 : 830	ADELAIDE BRIGHTON LIMITED: 10	United Kingdom:1691	Median : 0.017521
2019 : 815	ADVANTEST CORPORATION : 10	Australia : 584	Mean : 0.107617
2015 : 804	AEON MALL COMPANY LIMITED: 10	South Africa : 527	3rd Qu.: 0.074098
2014 : 795	AGC INC : 10	Mexico : 193	Max. : 1.992787
(Other):2766	(Other) :7733	(Other) : 0	NA

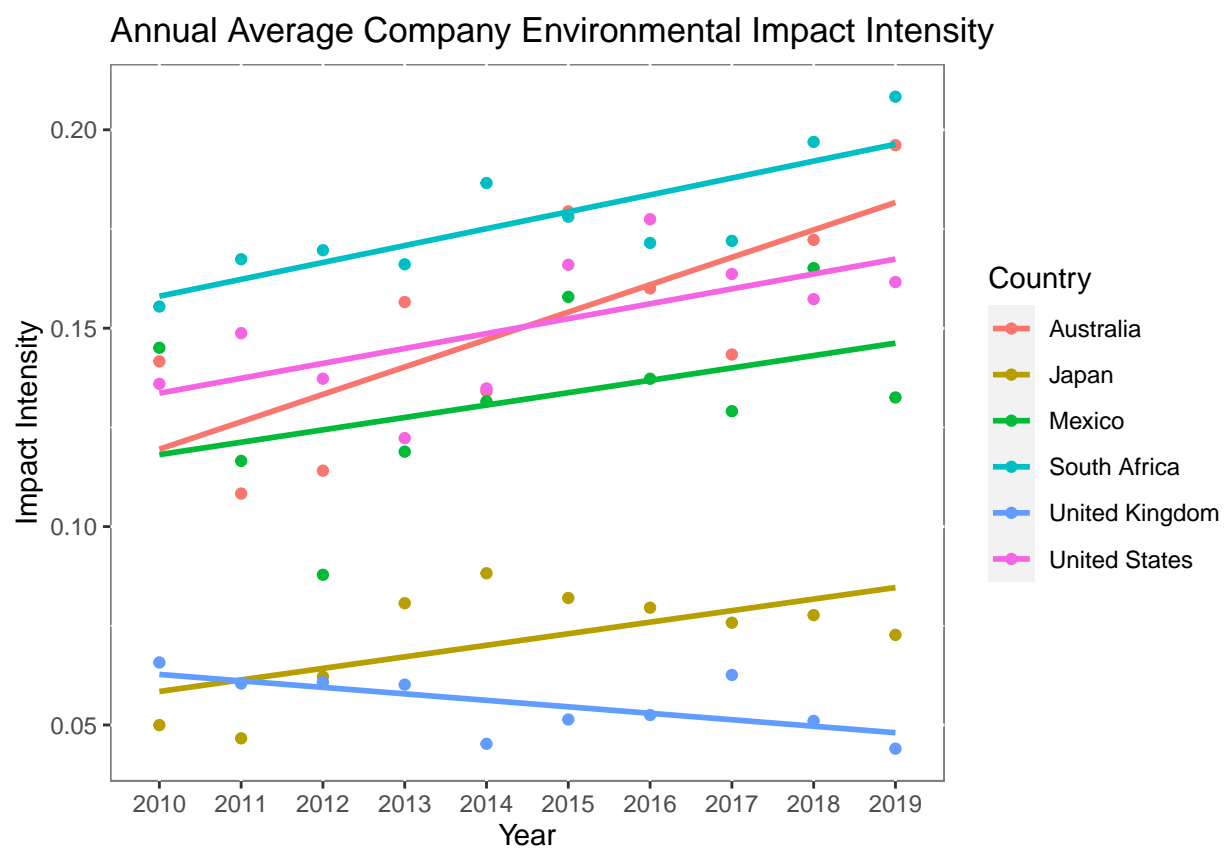


Figure 1: Company Environmental Impact Intensity Comparison

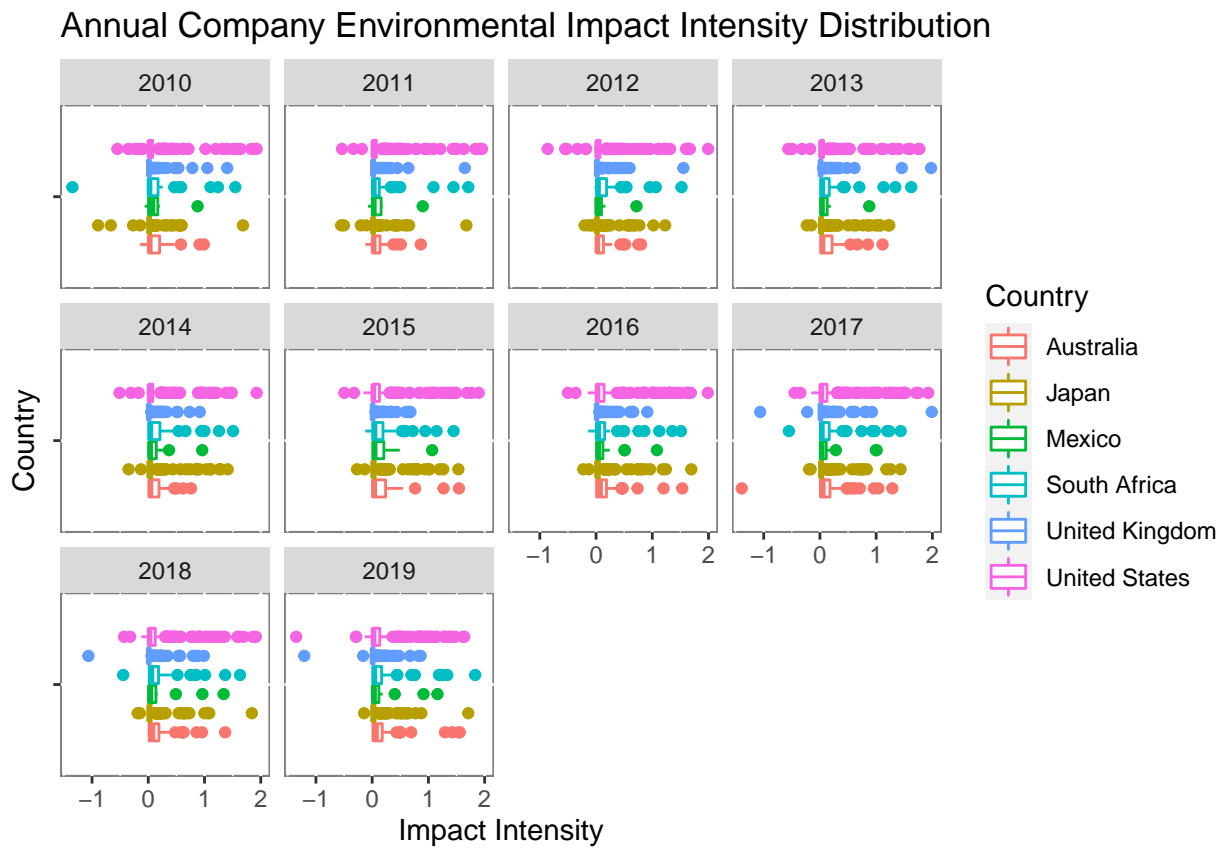


Figure 2: Company Environmental Impact Intensity Comparison

4 Analysis

We conducted two main parts of the analysis. The first part is a time-series analysis, where we looked at the trends in the environmental impact index for six countries from 2010 to 2019. From Figure 1 we can see that there is a clear distinction between the four countries in the upper part and the two countries in the lower part. The UK has a decreasing trend in the environmental impact index over the years, and Japan is also slowly decreasing since 2014, indicating that these two countries are performing better than others in the field of environmental governance.

From the distribution analysis (Figure 2), we can find the distribution of the environmental impact index by industry in each country for each year. The data from the United States are more widely distributed, and the UK is mainly concentrated in low impact intensity, and this trend is evident year by year. South Africa is mainly concentrated in high impact intensity.

In the second part, we performed a statistical analysis that compares the corporate environmental impacts of the six representative countries of six continents in 2019, because the data of 2019 is the most recent data we have. We did the Shapiro test, bartlett test, and drew the q-q plot. Unfortunately, these three all rejected the null(no) hypothesis, which indicated that the data do not reflect good normal distributivity because of the presence of some extreme values. We still did the Anova test, dividing the six countries into two main groups in line with the previous conclusion in Figure 1.

```
##
##  Shapiro-Wilk normality test
##
## data:  Year2019$Index[Year2019$Country == "Australia"]
## W = 0.5764, p-value = 6.644e-13

##
##  Shapiro-Wilk normality test
##
## data:  Year2019$Index[Year2019$Country == "Japan"]
## W = 0.42944, p-value < 2.2e-16

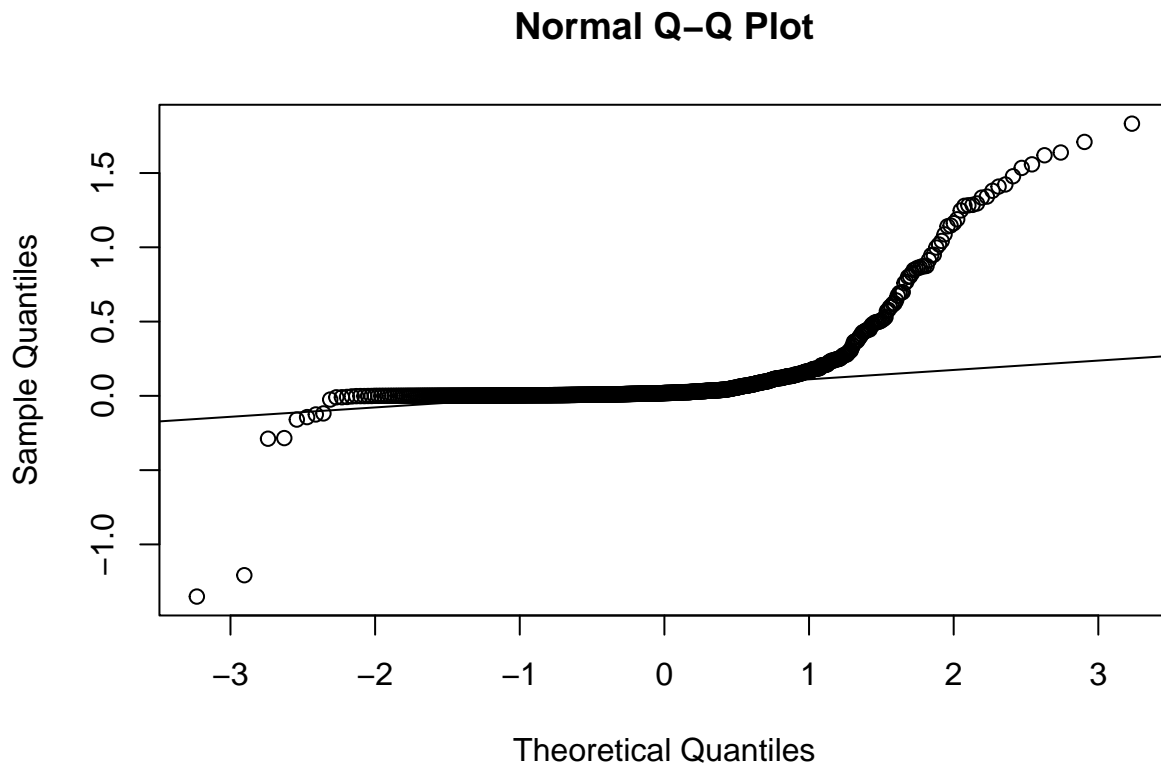
##
##  Shapiro-Wilk normality test
##
## data:  Year2019$Index[Year2019$Country == "South Africa"]
## W = 0.56954, p-value = 4.133e-11

##
##  Shapiro-Wilk normality test
##
## data:  Year2019$Index[Year2019$Country == "United Kingdom"]
## W = 0.45052, p-value < 2.2e-16

##
```

```
## Shapiro-Wilk normality test
##
## data: Year2019$Index[Year2019$Country == "United States"]
## W = 0.60069, p-value < 2.2e-16

##
## Shapiro-Wilk normality test
##
## data: Year2019$Index[Year2019$Country == "Mexico"]
## W = 0.52411, p-value = 2.986e-08
```



```
##
## Bartlett test of homogeneity of variances
##
## data: Year2019$Index by Year2019$Country
## Bartlett's K-squared = 213.26, df = 5, p-value < 2.2e-16

##          Df Sum Sq Mean Sq F value Pr(>F)
## Country    5   2.79   0.5578    7.373  9e-07 ***
## Residuals 809  61.21   0.0757
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```

## $statistics
##      MSerror Df      Mean      CV
##    0.07565801 809 0.1153906 238.373
##
## $parameters
##   test name.t ntr StudentizedRange alpha
##   Tukey Country   6           4.039786 0.05
##
## $means
##               Index      std   r           Min           Max           Q25
## Australia      0.19612327 0.3483305  70 -0.001497662 1.5583389 0.014773036
## Japan          0.07270127 0.1741734 234 -0.143046024 1.7091834 0.007539765
## Mexico         0.13254267 0.2769682  27 -0.024868665 1.1622471 0.004186873
## South Africa   0.20834417 0.3903786  52  0.001405651 1.8321458 0.016665110
## United Kingdom 0.04403163 0.1576510 178 -1.207315335 0.8622585 0.002090376
## United States  0.16162368 0.3534198 254 -1.350964518 1.6380528 0.007599951
##               Q50           Q75
## Australia      0.068164944 0.17916116
## Japan          0.016284642 0.04954285
## Mexico         0.033507035 0.11986662
## South Africa   0.038476424 0.16808371
## United Kingdom 0.007530084 0.02637540
## United States  0.024853952 0.13522728
##
## $comparison
## NULL
##
## $groups
##               Index groups
## South Africa   0.20834417    a
## Australia      0.19612327    a
## United States  0.16162368    a
## Mexico         0.13254267   ab
## Japan          0.07270127    b
## United Kingdom 0.04403163    b
##
## attr(,"class")
## [1] "group"

```

4.1 Question 1: <Is there any countries better off than others in 2019? >

Answer: Yes. The Anova test returns two distinct groups.

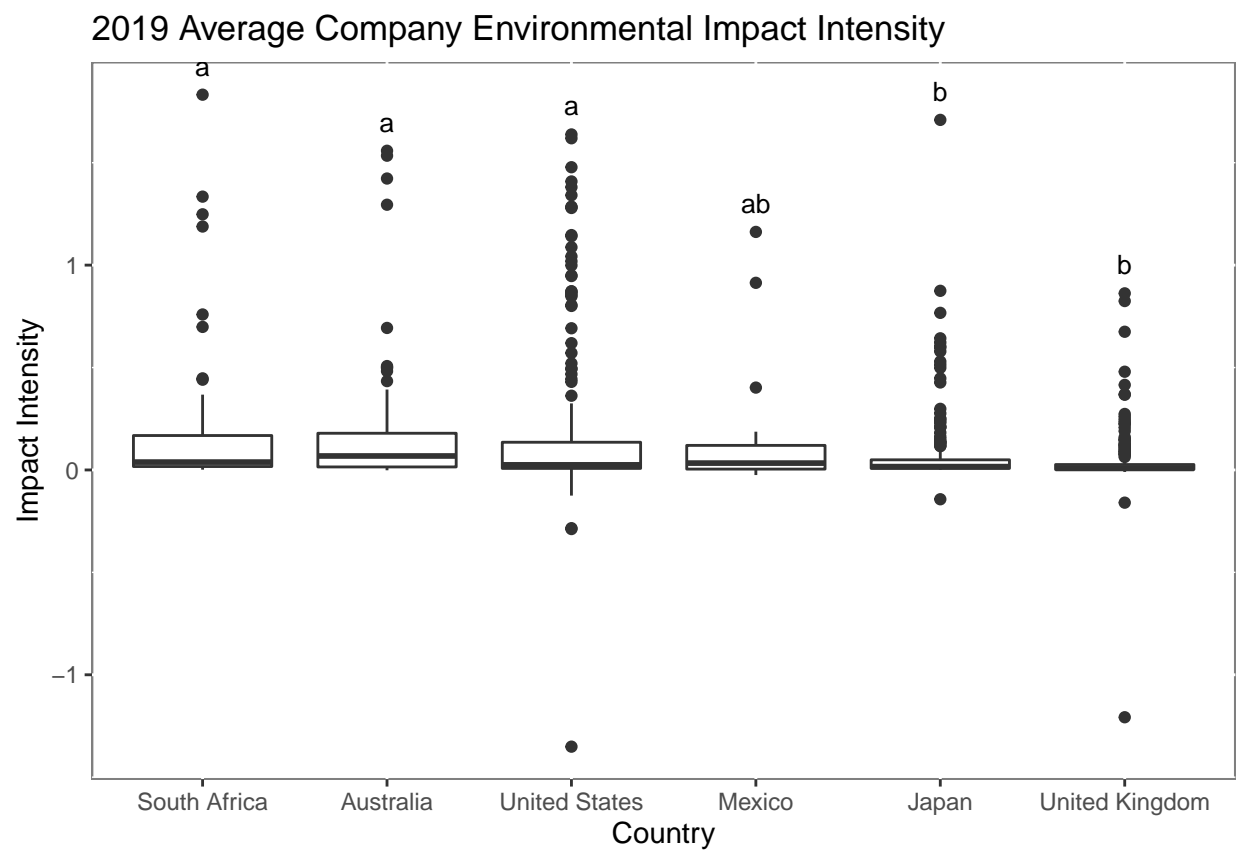


Figure 3: 2019 Average Company Environmental Impact Intensity

4.2 Question 2: <Which countries are better-off than others in 2019?>

Answer: United Kingdom and Japan are better-off than others.

5 Summary and Conclusions

We finally focused on industries and extracted the industries with the largest share of the overall environmental impact index for each country. From the table, we can see that the overall national environmental impact index is higher for countries that are still clustered in highly polluting and energy-intensive industries, such as mining, sand quarrying, and oil refining, and lower for those that have transitioned to cleaner industries.

Overall, we believe it's meaningful to compare and monitor the environmental intensity of different countries, since then we can see which country's corporations took the leading position in their way of industrial transition.

Country	Top Industry
Japan	Production of electricity by hydro
United Kingdom	Production of electricity by hydro
South Africa	Mining, Petroleum Refinery
Australia	Mining of coal and lignite
United States	Mining
Mexico	Quarrying of sand and clay

6 References

<Freiberg, et. al. 2020, Corporate Environmental Impact: Measurement, Data, and Information, Harvard Business School, Impact-Weighted Accounts Project Research Report. Retrieved from: <https://www.hbs.edu/impact-weighted-accounts/Documents/corporate-environmental-impact.pdf>>