

## **Visualization 1: Distribution of 10-year Environmental, Social, and Governance (ESG) Performance By Markets**

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### **Statement of Purpose:**

Using box plots, this visualization aims to demonstrate the distribution of 10-year ESG scores data of 1100 individual companies that were evaluated by Thomson Reuters **by market**, in which the company's headquarter located.

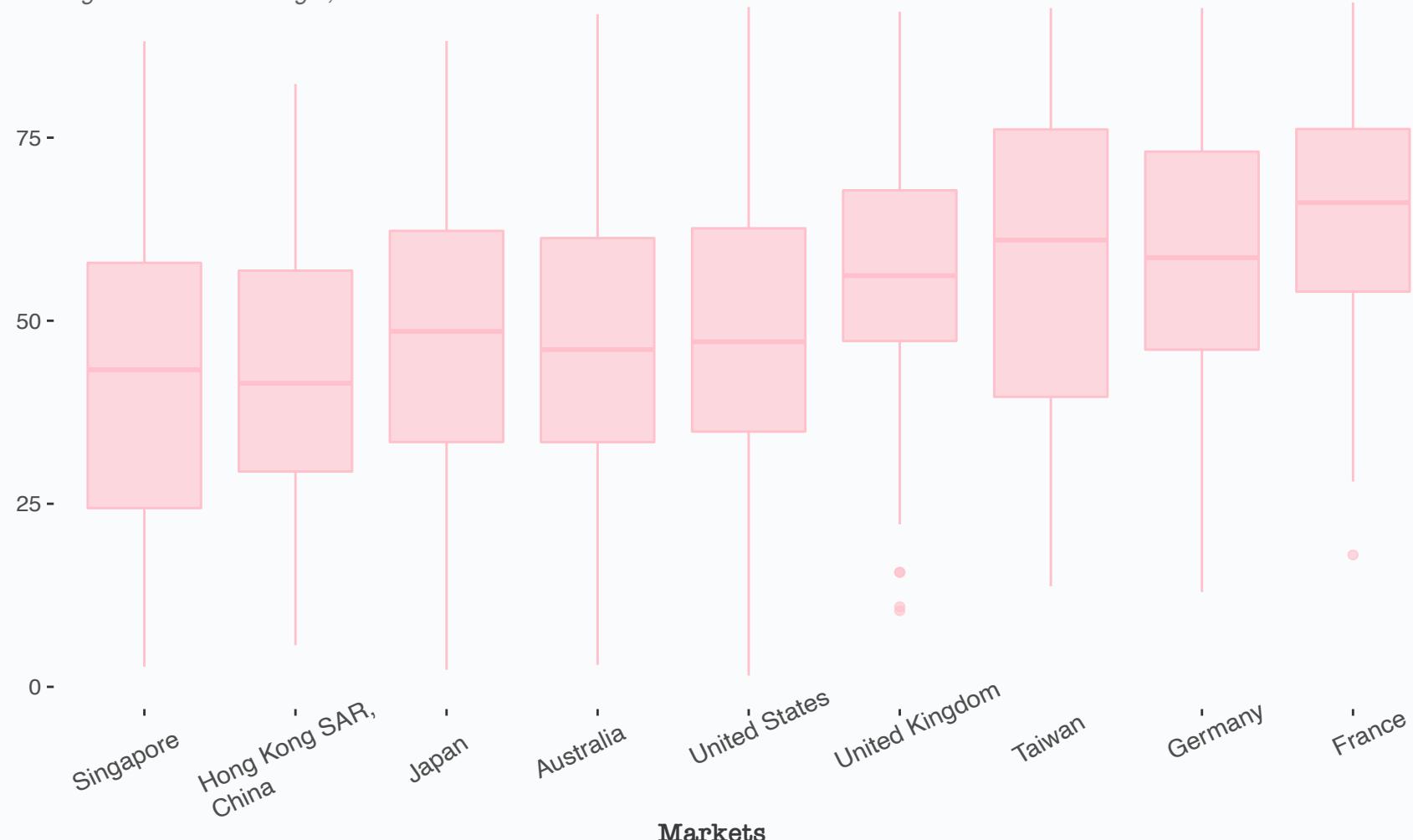
ESG score is a measure of sustainability performance of a company calculated based on 3 dimensions - Environmental (considers a company's resource use, emission, and innovation), Social (human right, workforce, community, and product responsibility), and Governance (corporate management, shareholders, and CSR Strategy).

# Distribution of 10-year Environmental, Social, and Governance (ESG) Performance By Markets

Based on ESG scores data of 1100 companies across 10 years (2010 to 2019), the box plots below show an overview of ESG performance of companies across different market (where the company's headquarter located). ESG score is a measure of the sustainability performance of a companies provided by Thomson Reuter, calculated based on 3 dimensions - Environmental (e.g. resource use, emission), Social (e.g. human right, workforce, community), and Governance (e.g. shareholders, corporate management). Higher ESG score represents better sustainability performance

## ESG Score (Percentage Points)

Ascending order from left to right, based on the mean ESG Score



## ***R Code for Visualization 1:***

```
# Load data
esg_universe <- read_excel("~/Desktop/Fall_2020/Data
Vis/Assignment/Data/ESG_Universe_long.xlsx")

# Data pre-processing
# Create two new variable that count number of observations each year for difference sectors
and markets
esg_universe <- esg_universe %>%
  group_by(Industry, Year) %>% mutate(Count_Sector = n()) %>%
  group_by(Market, Year) %>% mutate(Count_Market = n())

# Box Plots 1#
{
  ggplot (data = esg_universe %>% filter(Count_Market >= 25), # select market only have data
of at least 25 companies
    mapping = aes(x=reorder(Market, ESG_score, FUN = mean, desc = FALSE),
                  y=ESG_score)) +
  geom_boxplot(color = "pink", fill = "pink",
               alpha=0.6) +
  labs (
    title = "Distribution of 10-year Environmental, Social, and Governance (ESG) Performance
By Markets",
    x = "Markets",
    y = "ESG Score (Percentage Points)",
    caption = "Data Source: Thomson Reuters Datastream") +
  theme(
    plot.title = element_text(size = 16, face = "bold", vjust = 4, color = "steelblue"),
    plot.subtitle = element_text(size = 12.5, face = "italic", vjust = 3.5, color = "steelblue"),
    plot.caption = element_text(face = "italic", vjust = -3),
    axis.title.y = element_text(vjust = 1.5, size=12, face="bold", color = "steelblue"),
    axis.title.x = element_text(vjust = -2.5, size=12, face="bold", color = "steelblue"),
    plot.margin = unit(rep(1,4), "lines"),
    panel.grid.major = element_blank(),
    panel.grid.minor = element_blank(),
    panel.background = element_blank()
  )
}
```

## **Visualization 2: Distribution of 10-year Environmental, Social, and Governance (ESG) Performance By Sectors**

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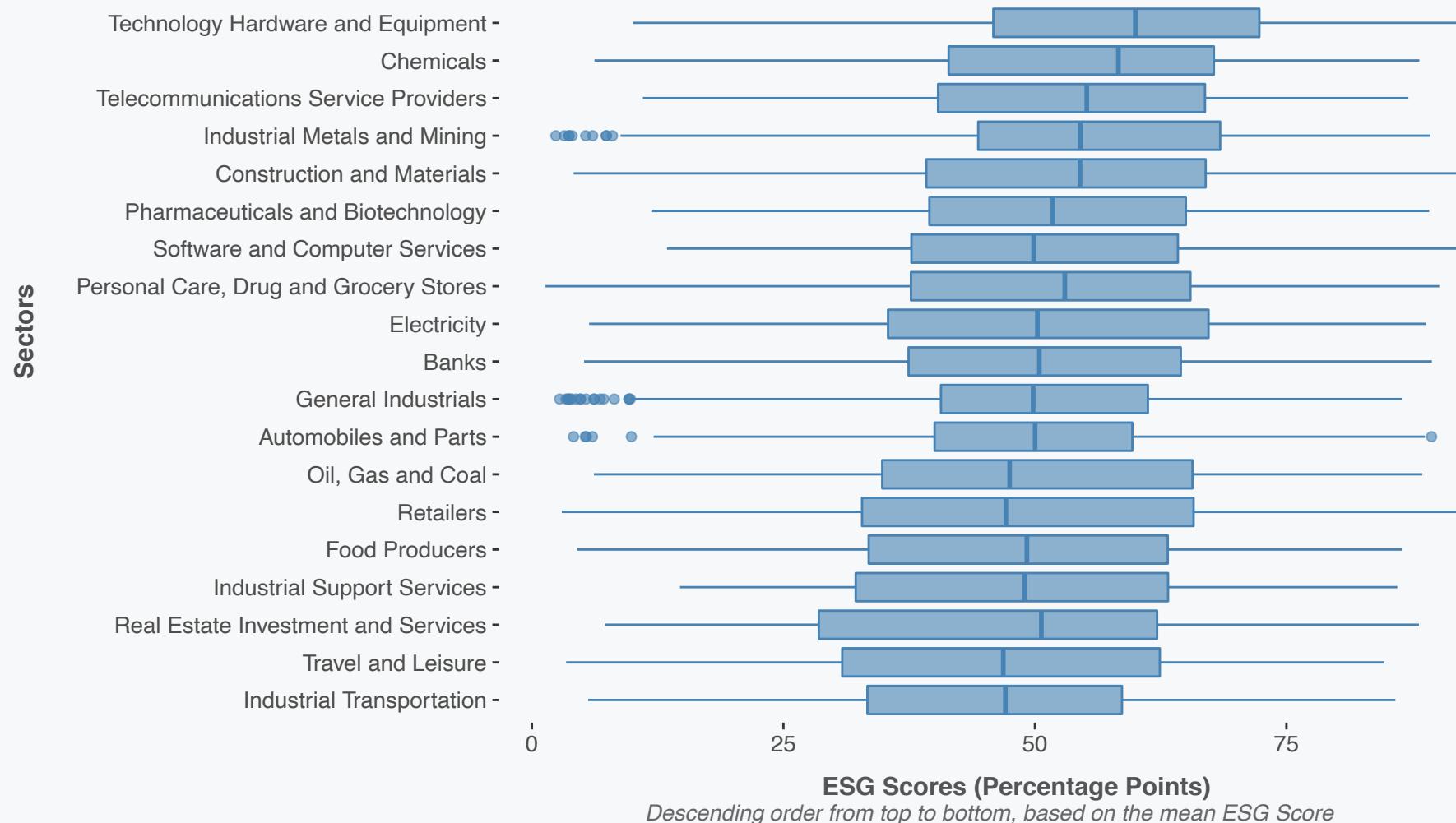
### **Statement of Purpose:**

Using another box plot, this visualization aims to demonstrate the distribution of 10-year ESG scores data of 1100 individual companies that were evaluated by Thomson Reuters, categorized **by sectors**.

ESG score is a measure of sustainability performance of a company calculated based on 3 dimensions - Environmental (considers a company's resource use, emission, and innovation), Social (human right, workforce, community, and product responsibility), and Governance (corporate management, shareholders, and CSR Strategy).

# Distribution of 10-year Environmental, Social, and Governance (ESG) Performance By Sectors

Based on ESG scores data of 1100 companies across 10 years (2010 to 2019), the box plots below show an overview of ESG performance of companies across different sectors. ESG score is a measure of the sustainability performance of each individual company calculated based on 3 dimensions - Environmental (e.g. resource use, emission), Social (e.g. human right, workforce, community), and Governance (e.g. shareholders, corporate management). Higher ESG score represents better sustainability performance.



## **R Code for Visualization 2:**

```
# Load data
esg_universe <- read_excel("~/Desktop/Fall_2020/Data
Vis/Assignment/Data/ESG_Universe_long.xlsx")

# Data pre-processing
# Create two new variable that count number of observations each year for difference sectors
# and markets
esg_universe <- esg_universe %>%
  group_by(Industry, Year) %>% mutate(Count_Sector = n()) %>%
  group_by(Market, Year) %>% mutate(Count_Market = n())

# Plot the sector box plot
ggplot (data = esg_universe %>% filter(Count_Sector >= 25),
        mapping = aes(x=ESG_score, y=reorder(Industry,ESG_score, FUN = mean, .desc =
FALSE))) +
  geom_boxplot(color = "steelblue", fill = "steelblue",
               alpha=0.6) +
  labs (
    title = "Distribution of 10-year Environmental, Social, and Governance (ESG) Performance
By Sectors,
    x = "ESG Scores (Percentage Points)",
    y = "Sectors",
    caption = "Data Source: Thomson Reuters Datastream") +
  theme(
    plot.title = element_text(size = 16, face = "bold", vjust = 4, color = "steelblue"),
    plot.subtitle = element_text(size = 12.5, face = "italic", vjust = 3.5, color = "steelblue"),
    plot.caption = element_text(face = "italic", vjust = -3),
    axis.title.y = element_text(vjust = 1.5, size=12, face="bold", color = "steelblue"),
    axis.title.x = element_text(vjust = -2.5, size=12, face="bold", color = "steelblue"),
    plot.margin = unit(rep(1,4), "lines"),
    panel.grid.major = element_blank(),
    panel.grid.minor = element_blank(),
    panel.background = element_blank()
  )
```

## **Visualization 3: The Average of Environmental, Social, and Governance (ESG) Performance by Sectors Across the Past Decade**

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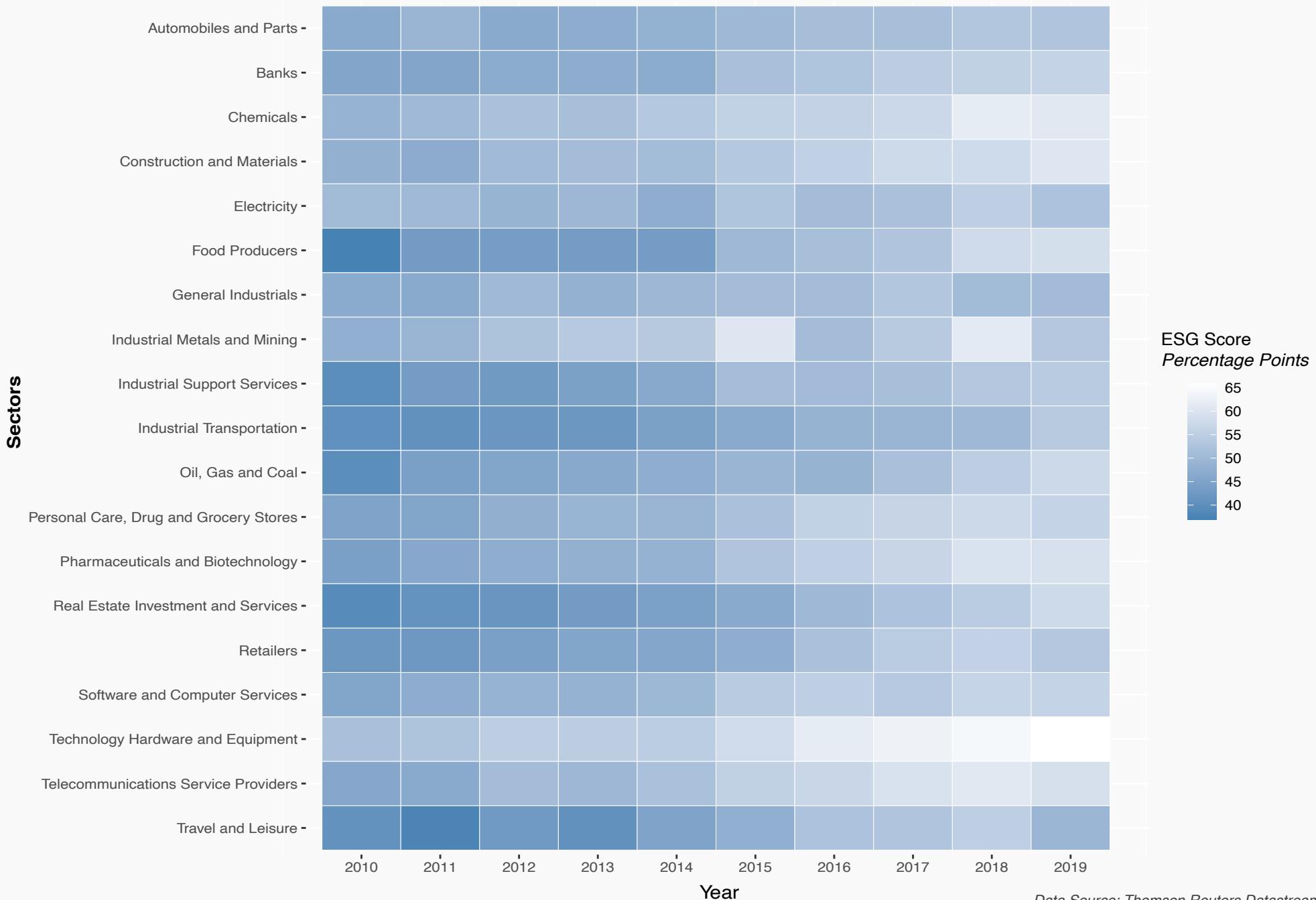
### **Statement of Purpose:**

This visualization uses a heat map to show the comparison of 10-year (2010-2019) trends of average ESG performance by sectors. ESG performance is measured by ESG scores.

ESG score is a measure of ESG/sustainability performance of a company calculated based on 3 dimensions - Environmental (considers a company's resource use, emission, and innovation), Social (human right, workforce, community, and product responsibility), and Governance (corporate management, shareholders, and CSR Strategy).

# Average Environmental, Social, and Governance (ESG) Performance by Sectors Across the Past Decade

Using 10 year data (2010-2019) of 784 individual companies from 19 sectors, this heat map shows the trend of the average ESG score by sectors across past 10 years. ESG score is a measure of ESG performance for individual companies calculated based on 3 dimensions—Environment (e.g. resource use, emission), Social (e.g. workforce, community), and Governance (e.g. corporate management, shareholders).



### **R Code for Visualization 3:**

```
library(ggplot2, dplyr, tidyr, readxl,forcats, ggpubr)

# Load data
esg_universe <- read_excel("~/Desktop/Fall_2020/Data
Vis/Assignment/Data/ESG_Universe_long.xlsx")

# Data Wrangling
# Create two new variable that count number of observations each year for difference sectors
and markets
esg_universe <- esg_universe %>%
  group_by(Industry, Year) %>% mutate(Count_Sector = n()) %>%
  group_by(Market, Year) %>% mutate(Count_Market = n())
## Convert industry to factor
esg_universe$Industry = factor(esg_universe$Industry)
##### Reverse the industry factor to display a ascending order in y-axis
esg_universe$Industry = fct_rev(esg_universe$Industry)
## Converse year to numeric
esg_universe$Year = as.numeric(esg_universe$Year)
## Summarize corporate average performance based on industry & year
esg_sector_avg <- esg_universe %>% filter(Count_Sector >= 25) %>% ## Keep sectors that
have at least 25 annual observations
  group_by(Industry, Year) %>%
    summarise_at(vars(ESG_score, ROA, Volatility, Total_Asset, Count_Market), funs(mean(.,
na.rm=TRUE)))
## Plot the heat map
ggplot(data = esg_sector_avg,
       mapping = aes(x=Year, y = Industry)) +
  geom_tile(aes(fill = ESG_score), color = "white") +
  scale_x_continuous(breaks = seq(2010, 2019)) +
  scale_fill_gradient(low = "steelblue", high = "white") +
  labs(
    title = "The Average of Environmental, Social, and Governance (ESG) Performance by
Sectors Across the Past Decade",
    legend = "ESG Score (Percentage Points)") +
  theme(
    plot.title = element_text(size = 14, face = "bold", vjust=1, hjust = 0.5),
    panel.background = element_blank())
```

## **Visualization 4: The Trend of Global Corporate Volatility Across the Past Decade (2010 to 2019)**

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### **Statement of Purpose:**

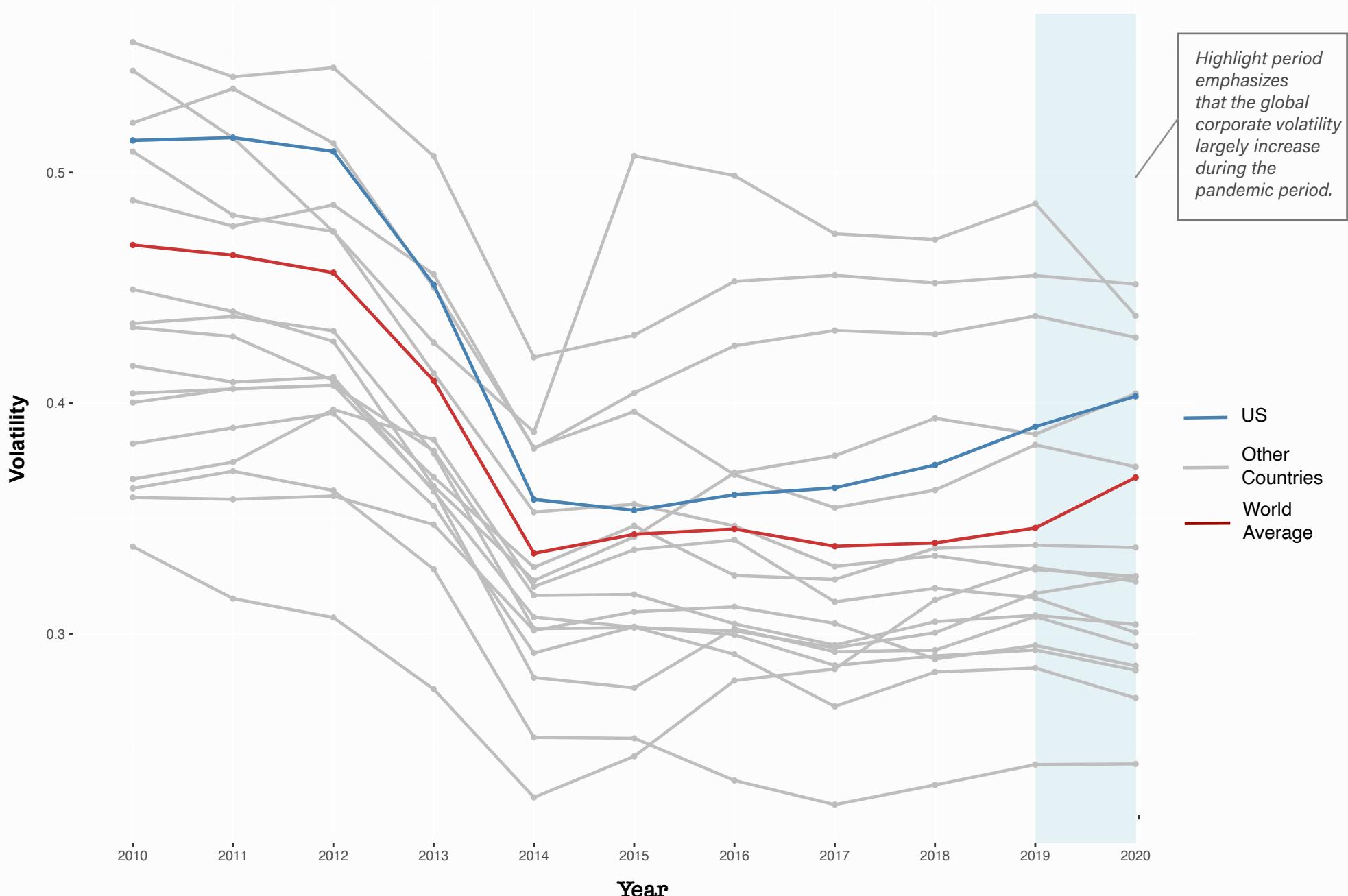
Using a time series line chart, this visualization aims to:

- demonstrate the trend of global corporate volatility compared to that of the rest of the world's (selected markets based on the data availability), especially to that of the US. Since US is the largest economy and is one of the countries mostly impacted by the 2020 COVID pandemic;
- highlight the volatility in the pandemic period (2019-2020).

Volatility is a measure of market risk for each individual company. It is calculated based on the percentage change of the stock price of an individual security (company).

# The Trend of Global Corporate Volatility Across the Past Decade (2010 to 2019)

Based on the volatility data of 1100 firms across 10 years (2010 to 2019), the time series below shows the average global volatility across past 10 years. Volatility is a measure of security risk, calculated as the percentage of change in stock price. Higher volatility indicates higher risk. The performance of the U.S. is highlighted, suggesting that the largest economy has a close association with the global trend, and that the average corporate risk apparently increases during the pandemic period (2019-20) for the world average and the U.S.



## **R Code for Visualization 4:**

```
library(readxl) library(dplyr) library(ggplot2) library(xlsx) library(tidyr) library(treemapify)

# Load data
esg_universe <- read_excel("ESG_Universe_long.xlsx")
volatility <- read_excel("~/Desktop/Fall_2020/Data Vis/Assignment/Data/ESG-Annual.xlsx",
sheet = "volatility")
volatility_longer <- pivot_longer(volatility, 5:15, names_to = "Year", values_to = "Volatility")
# Data wrangling
## Restructure the data set into average data
market_volatility <- volatility_longer %>% group_by(Market, Year) %>% mutate(Count=n())
%>% group_by(Market, Year, Count) %>% summarize_at(vars(Volatility), funs(mean(..,
na.rm=TRUE))) %>%
filter(Count>=100 | Market == "World Average") %>% drop_na()
## Got the highlighted data
US_market_volatility <- market_volatility %>% filter(Market == "UNITED STATES")
world_market_volatility <- market_volatility %>% filter(Market == "World Average")
# Plot
ggplot()+
geom_rect(aes(xmin = "2019", xmax = "2020", ymin = -Inf, ymax = Inf),
alpha = 0.3,
fill = "lightblue") +
geom_line(data = market_volatility, mapping = aes(x = Year, y = Volatility, group = Market),
color = "gray", size=0.8) +
geom_point(data = market_volatility, mapping = aes(x = Year, y = Volatility, group = Market),
color = "gray", size=1.2) +
geom_line(data = US_market_volatility, mapping = aes(x = Year, y = Volatility,group =
Market),
color = "steelblue", size = 0.8) +
geom_point(data = US_market_volatility, mapping = aes(x = Year, y = Volatility,group =
Market),
color = "steelblue", size = 1.2) +
geom_line(data = world_market_volatility, mapping = aes(x = Year, y = Volatility,group =
Market),
color = "brown3", size = 0.8) +
geom_point(data = world_market_volatility, mapping = aes(x = Year, y = Volatility,group =
Market),
color = "brown3", size = 1.2) +
labs(title = "The Trend of Global Corporate Volatility Across the Past Decade (2010 to 2019)",
caption = "Data Source: Thomson Reuters Datastream")+
theme(panel.background = element_blank())
```

## **Visualization 5: Relationship between ESG Performance and Profitability Across 13 Markets**

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### **Statement of Purpose:**

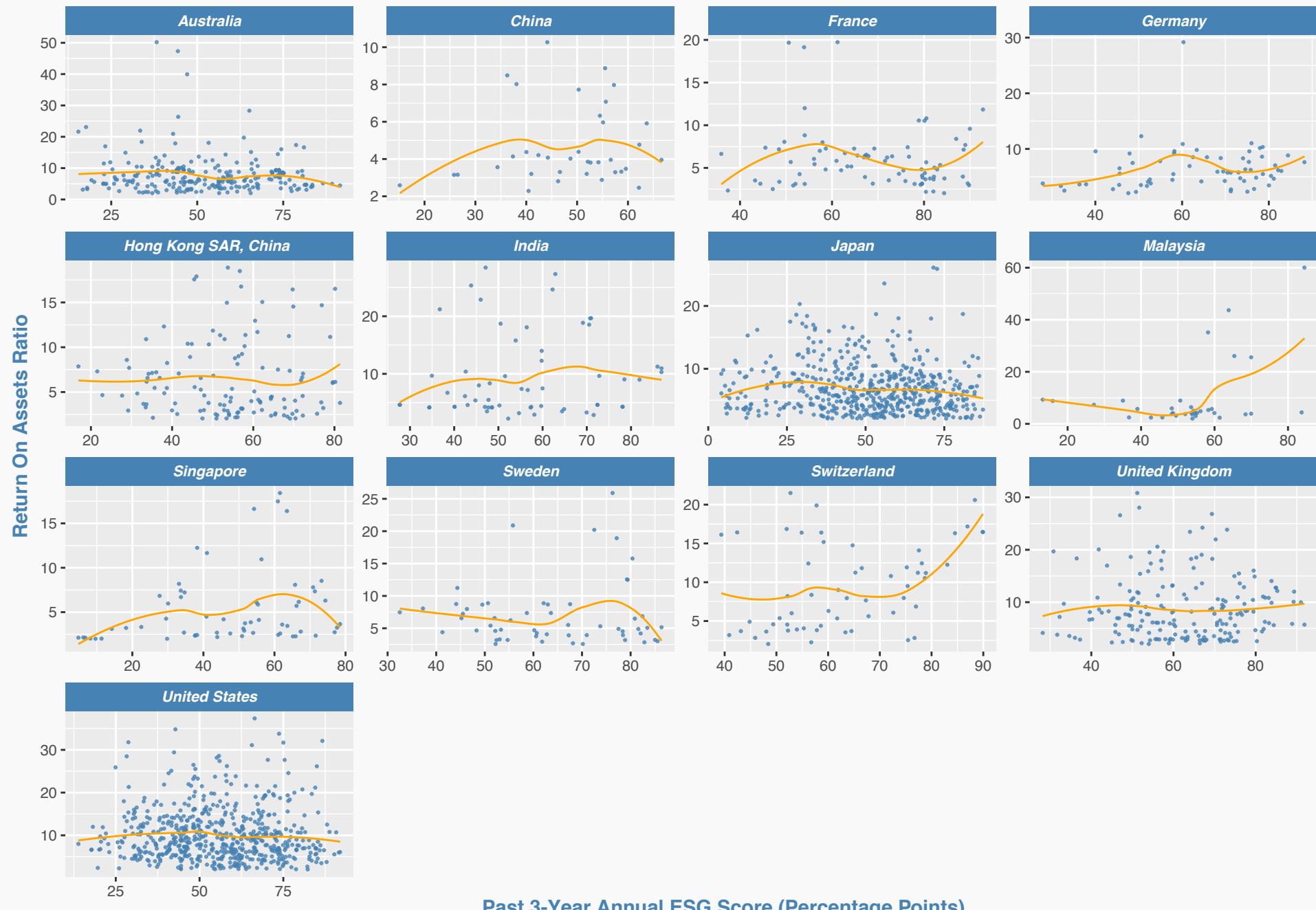
Using multi-face scatter plots, this visualization aims to demonstrate the relationship between ESG performance (measured by ESG score) and the profitability (measured by Return on Assets) of each individual company, categorized by 13 markets, trying to answer whether higher ESG score of a company is correlated with higher profitability.

ESG score is a measure of sustainability performance of a company calculated based on 3 dimensions - Environmental (considers a company's resource use, emission, and innovation), Social (human right, workforce, community, and product responsibility), and Governance (corporate management, shareholders, and CSR Strategy).

Return on Assets (ROA) is a measure of profitability for an individual company.

# Relationship between Firm ESG Performance and Profitability Across 13 Markets

Using 3 year data (2017-2019) of 756 individual companies from 13 markets , this visualization shows the relationship between a company's ESG score and return on assets (ROA) by different markets. ESG score is a measure of ESG performance for individual companies based on 3 dimensions—Environment (e.g. resource use, emission), Social (e.g. workforce, community), and Governance (corporate management, shareholders, and CSR Strategy). ROA ia a measure for corporate profitability.



Past 3-Year Annual ESG Score (Percentage Points)

Source: Thomson Reuters Datastream

## **R Code for Visualization 5:**

```
library(ggplot2, dplyr, tidyr, readxl,forcats, ggpubr)

# Data Wrangling
## Load Data
esg_universe <- read_excel("ESG_Universe_long.xlsx")
## Keep only last 3-years; Countries that have data of at least 20 companies; ROA > 2
esg_universe_mkt_20 <- esg_universe %>% filter(Count_Market >= 20) %>%
  filter(Year >= 2017) %>% filter(Market != "Taiwan") %>%
  filter(ROA > 2)
unique(esg_universe_mkt_20>Name)

# Plot
ggplot(data=esg_universe_mkt_15,
       mapping = aes(x=ESG_score, y=ROA)) +
  geom_point(alpha=0.7, color="steelblue", size=0.5) + # position = "jitter", size = 2
  facet_wrap(~Market, scales = "free") +
  scale_color_brewer(type='qual') +
  labs(
    title = "ESG Score vs. Return on Assets (ROA) of Companies Across 13 Countries, through Year 2017 to 2019",
    subtitle = "Does Environmental, Social, and Governance score have a relationship with Earning per Share of a company?",
    caption = "Source: Thomson Reuters Datastream",
    x="Annual ESG Score (Percentage Points)", y="Return on Assets (ROA) Ratio") +
  theme(
    plot.title = element_text(size = 15, face = "bold", vjust = 4, color = "steelblue"),
    plot.subtitle = element_text(size = 12.5, face = "italic", vjust = 3.5, color = "steelblue"),
    plot.caption = element_text(face = "italic", vjust = -3),
    axis.title.y = element_text(vjust = 1.5, size=12, face="bold", color = "steelblue"),
    axis.title.x = element_text(vjust = -2.5, size=12, face="bold", color = "steelblue"),
    # plot.margin = unit(rep(3,4), "lines"),
    strip.text = element_text(size = 9, color = "white", face = "bold.italic"),
    strip.background = element_rect(fill="steelblue")
  ) +
  geom_smooth(method = "loess", se = FALSE, size = 0.5, color = "orange")
```

## **Visualization 6: Average Environmental, Social and Governance (ESG) Performance & Return on Asset (ROA) of Markets with Different Economic Development Level Across Regions**

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### **Statement of Purpose:**

Using a scatter plot with linear prediction line, this visualization aims to

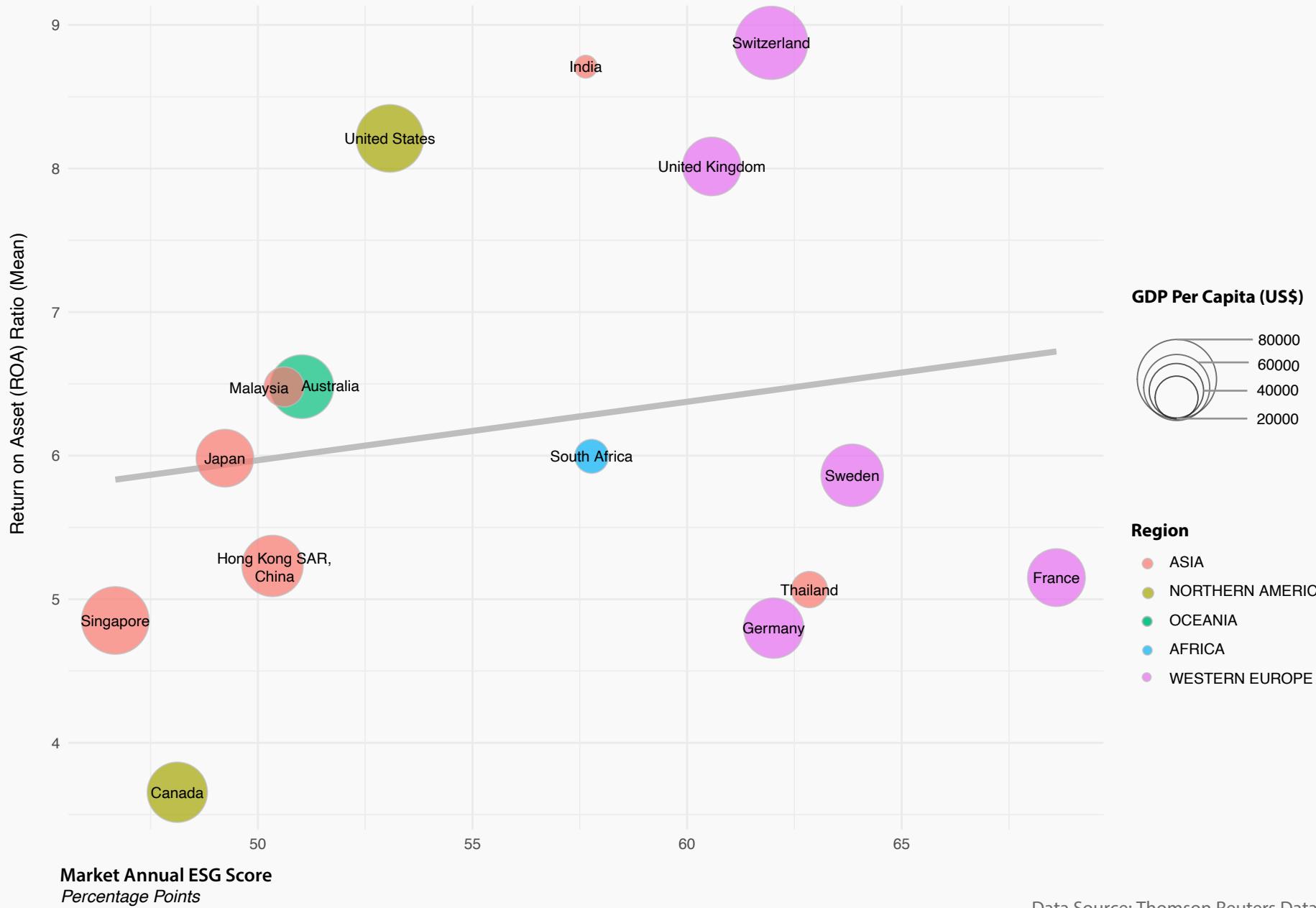
- demonstrate relationship between the average ESG performance and ROA of all companies grouped by different markets
- suggest any pattern between market economic development level (measured by GDP per capita) and average market ESG performance
- suggest the relationship between continent and ESG performance and answer whether European companies in overall have a better ESG performance

ESG score is a measure of sustainability performance of a company calculated based on 3 dimensions - Environmental (considers a company's resource use, emission, and innovation), Social (human right, workforce, community, and product responsibility), and Governance (corporate management, shareholders, and CSR Strategy).

Return on Assets (ROA) is a measure of profitability for an individual company.

# Average Environmental, Social and Governance (ESG) Performance & Return on Asset (ROA) of Markets with Different Economic Development Level Across Regions

Using 5-year average ESG score of 900 companies grouped by 15 countries, this chart reveals the possible relationship between ESG performance (as measured by ESG scores) and various factors – profitability of company's (measured by return on assets), market economic development (measured by GDP per Capita), and market region (continents). It shows that higher ESG level is likely to demonstrate higher ROA and companies from European countries are more likely to have better ESG performance.



## R Code for Visualization 6:

```
library(ggplot2, dplyr, tidyr, readxl,forcats, ggpubr)

# Data Wrangling
## Load Data
esg_universe <- read_excel("ESG_Universe_long.xlsx")
countries_gdp <- read_excel("~/Desktop/Fall_2020/Data Vis/Assignment/Data/countries_gdp.xls")
countries_gdp_2019 <- select(countries_gdp, "Country Name", "2019")
continents <- read_excel("~/Desktop/Fall_2020/Data Vis/Assignment/Data/continents_list.xls", skip = 3)
%>% select(Country, Region)
## Summarize corporate average performance based on market
esg_score_ctmarket <- esg_universe %>% group_by(Market, Year) %>% mutate(Count_Market=n())
%>% filter(Count_Market >= 15 | Market == "Canada") %>% filter(Year >= 2015) %>% group_by(Market)
%>% summarise_at(vars(ESG_score, ROA, Volatility, Total_Asset, Count_Market), funs(mean(., na.rm=TRUE)))
## Combine ESG data with GDP data
esg_by_gdp <- left_join(esg_score_ctmarket, countries_gdp_2019, by = c("Market" = "Country Name"))
%>% rename(gdppc2019 = "2019") %>% left_join(continents,by = c("Market" = "Country")) %>%
na.omit()
## Plot the scatter plot
ggplot(data=esg_by_gdp,
       mapping = aes(x=ESG_score, y=ROA, size=gdppc2019)) +
  geom_smooth(method = "lm", se = FALSE, col = "grey", size = 1.5, alpha = 0.3) +
  geom_point(aes(fill = Region), color = "grey",
             shape=21, alpha = 0.7) +
  scale_color_brewer(type='qual')+
  ggrepel::geom_text_repel(aes(label = Market), # use ggrepel to repel overlapping text labels
                          size = 3, segment.color = NA,
                          point.padding = NA) +
  scale_size_continuous(name="GDP Per Capita (US$)", range=c(6, 20)) +
  labs(
    title = "Average Environmental, Social and Governance (ESG) Performance & Return on Asset (ROA) of Markets with Different Economic Development Level Across Regions",
    caption = "Data Source: Thomson Reuters Datastream",
    x="3-Year Average ESG Score\nPercentage Points", y="Return on Asset (ROA) Ratio") +
  theme(
    plot.title = element_text(size = 15, face = "bold", vjust = 4, color = "steelblue"),
    plot.subtitle = element_text(size = 12.5, face = "italic", vjust = 3.5, color = "steelblue"),
    plot.caption = element_text(face = "italic", vjust = -3),
    axis.title.y = element_text(vjust = 1.5, size=12, face="bold", color = "steelblue"),
    axis.title.x = element_text(vjust = -2.5, size=12, face="bold", color = "steelblue"),
    plot.margin = unit(rep(3,4), "lines"),
    strip.text = element_text(size = 10.5, color = "white", face = "bold.italic"),
    strip.background = element_rect(fill="steelblue")
  ) + theme_minimal()
```

## **Visualization 7: Average Total Assets and Environmental, Social, and Governance (ESG) Score Across Sectors (Year 2019)**

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### **Statement of Purpose:**

The purpose of this chart is to show how different industries perform in Environmental, Social, and Governance (ESG). For this visualization, I used the 2019 annual data across all industries available in Thomson Reuters ASSET4 data.

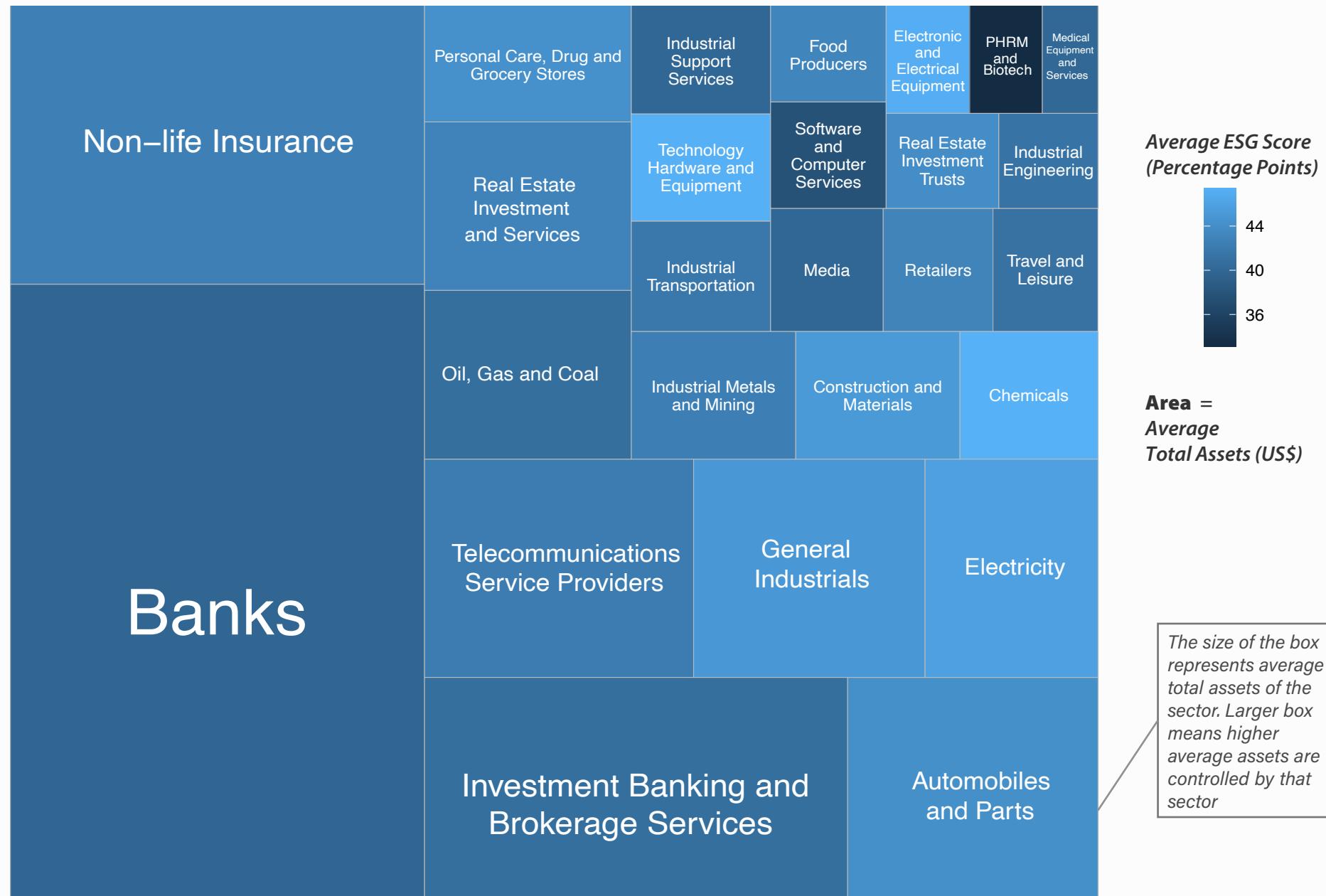
The area of each block represents the average total assets of all corporations in the data set within a particular industry. Total assets is a measure of the corporate size.

The sequential color palette represents ESG score. Dark blue represents low ESG score, namely poor ESG performance. Assets (ROA) is a measure of profitability for an individual company.

# Average Total Assets and Environmental, Social, and Governance (ESG) Score Across Sectors (Year 2019)

Based on 2019 reported total assets and ESG scores data from Thomson Reuters, the tree map shows average ESG (represents by color) and average total assets (represents by size of the area) of 26 industries. ESG score is a measure of ESG performance for individual companies calculated based on 3 dimensions—Environment (e.g. resource use, emission), Social (e.g. workforce, community), and Governance (e.g. Corporate management, shareholders).

It suggests that in average, most assets were control by the Bank sector; Pharmaceuticals and Biotechnology Industry has the worst ESG performance. No clear relationship between assets under control and ESG performance.



```

library(readxl) library(dplyr) library(ggplot2) library(xlsx) library(tidyr) library(treemapify)

# Data
## ESG Data
esg_score <- read_excel("~/Desktop/Fall_2020/Data Vis/Assignment/Data/ESG-Annual.xlsx",
                         sheet = "ESG Combined Score")
## Volatility Data
volatility <- read_excel("~/Desktop/Fall_2020/Data Vis/Assignment/Data/ESG-Annual.xlsx",
                         sheet = "volatility")
##### create world average observation for volatility
world_average <- data.frame("World", "-", "World Average", "all", mean(volatility$`2010`, na.rm=TRUE),
                             mean(volatility$`2011`, na.rm=TRUE), mean(volatility$`2012`, na.rm=TRUE),
                             mean(volatility$`2013`, na.rm=TRUE), mean(volatility$`2014`, na.rm=TRUE),
                             mean(volatility$`2015`, na.rm=TRUE), mean(volatility$`2016`, na.rm=TRUE),
                             mean(volatility$`2017`, na.rm=TRUE), mean(volatility$`2018`, na.rm=TRUE),
                             mean(volatility$`2019`, na.rm=TRUE), mean(volatility$`2020`, na.rm=TRUE))

names(world_average) <- c("Name", "Code", "Market", "Industry", "2010", "2011", "2012", "2013",
                           "2014", "2015", "2016", "2017", "2018", "2019", "2020")
volatility <- rbind(volatility,world_average )

## Total Asset Data
total_asset <- read_excel("~/Desktop/Fall_2020/Data Vis/Assignment/Data/ESG-Annual.xlsx",
                           sheet = "total-asset-us$WC07230")

## Re-constructure data from wide to long
esg_score_longer <- pivot_longer(esg_score, 2:11, names_to = "Year", values_to = "ESG_score")
volatility_longer <- pivot_longer(volatility, 5:15, names_to = "Year", values_to = "Volatility")
total_asset_longer <- pivot_longer(total_asset, 2:11, names_to = "Year", values_to = "Total_Asset")

## Combine the Data Set
esg_universe <- left_join(volatility_longer, total_asset_longer, by = c("Code" = "Code", "Year" = "Year"))
esg_universe <- left_join(esg_universe, esg_score_longer, by = c("Name" = "Name", "Year" = "Year"))
esg_universe_rmna <- na.omit(esg_universe)

## Group 2019 ESG data by industry and summarize at mean ESG score
industry_esg_2019 <- esg_universe_rmna %>% filter(Year=="2019") %>%
  group_by(Industry) %>% mutate(Count=n()) %>%
  group_by(Industry, Count) %>%
  summarize_at(vars(ESG_score, Total_Asset), funs(mean(.))) %>%
  filter(Count >= 100) # keeping only those have at least 80 observation

# Draw treemap to show the average asset and ESG performance across industry
ggplot(industry_esg_2019, aes(area = Total_Asset, fill= ESG_score, label=Industry),
       title="Average Total Assets and Environmental, Social, and Governance (ESG) Score Across Sectors (Year 2019)") +
  geom_treemap() +
  geom_treemap_text(size = 11, colour = "white", place = "centre", grow = F, reflow = T)

```

## **Visualization 8:Correlation between Environmental, Social, and Governance (ESG) and Other Factors**

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### **Statement of Purpose:**

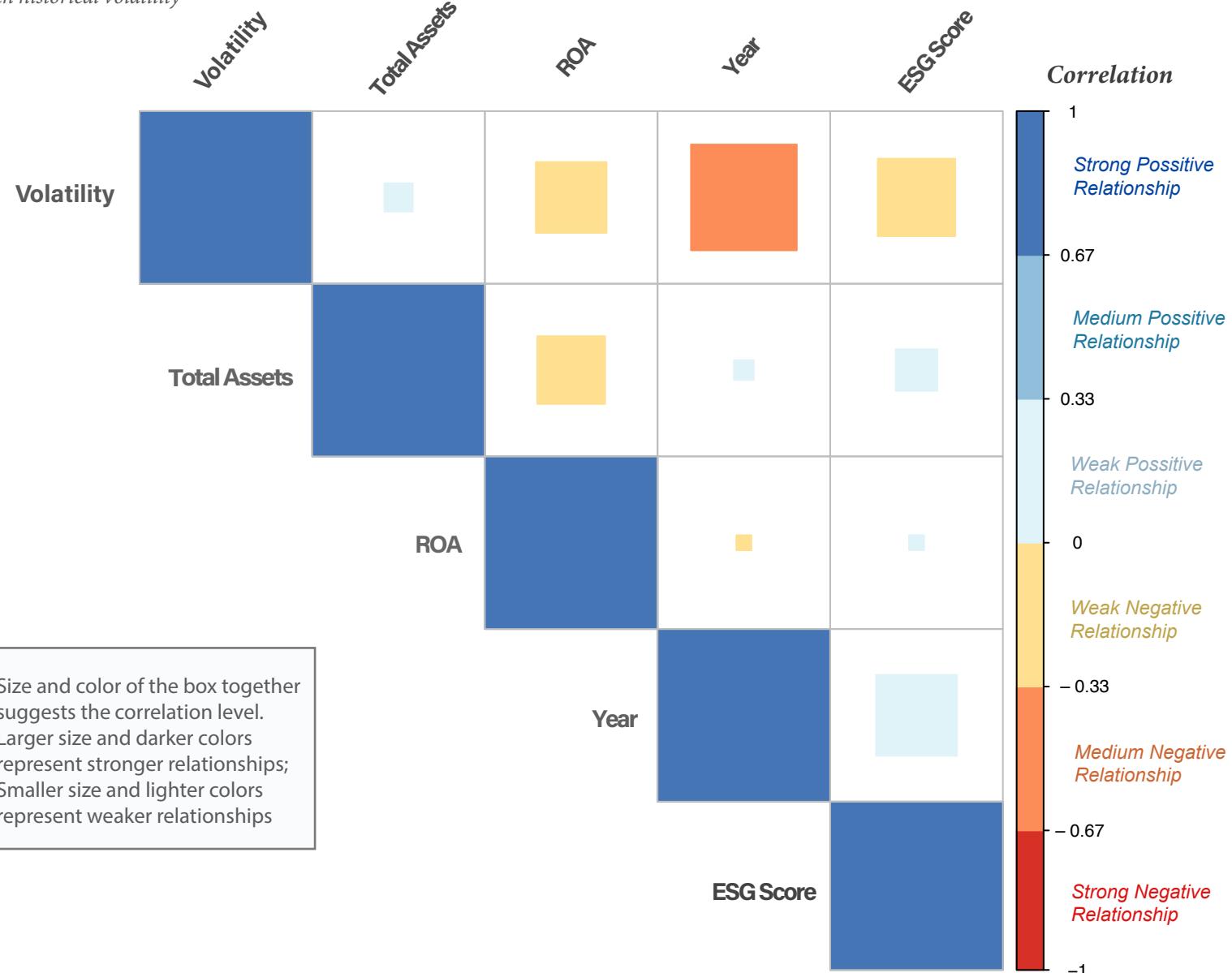
Using a correlation matrix, this visualization demonstrates the relationship between corporate ESG performance and other factors, including volatility, total assets, ROA, and year. The correlation matrix is based on 10-year (2010-2019) data of 1100 companies. Size and color of the box together suggests the correlation level — Larger size and darker color represents stronger relationships; Smaller size and lighter colors represent weaker relationships. Color type suggests the direction of relationship — Blue indicates positive correlation; red indicates negative correlation.

ESG score is a measure of ESG performance for individual companies calculated based on 3 dimensions— Environment (e.g. resource use, emission), Social (e.g. workforce, community), and Governance (e.g. Corporate management).

The matrix suggests that ESG score is positively correlated with corporate total assets, return on assets (ROA), and year; whereas negatively correlated with historical volatility

# Correlation between Environmental, Social, and Governance (ESG) and Other Factors

The correlation matrix is based on 10-year (2010-2019) data of 1100 companies. ESG score is a measure of ESG performance for individual companies calculated based on 3 dimensions— Environment (e.g. resource use, emission), Social (e.g. workforce, community), and Governance (e.g. Corporate management). It suggests that ESG score is positively correlated with corporate total assets, return on assets (ROA), and year; whereas negatively correlated with historical volatility



## **R Code for Visualization :**

```
library(ggplot2, dplyr, tidyr, readxl,forcats, ggpubr)

# Data Wrangling
## Load Data
esg_universe <- read_excel("ESG_Universe_long.xlsx")
## Total company average performance
total_company <- esg_universe %>% group_by(Year) %>% mutate(Count_year = n()) %>%
  group_by(Year, Count_year) %>%
  summarize_at(vars(Volatility, Total_Asset, ESG_score, ROA), funs(mean(., na.rm=TRUE)))
}

# Generate Correlation Matrix
esg_universe_cor <- esg_universe %>%
  select(-Name, -Code, -Market, -Industry)

esg_universe_cor$Year <- as.numeric(esg_universe_cor$Year)
correlation_matrix <- cor(esg_universe_cor)
corrplot(correlation_matrix, method = "square",
         type = "upper", tl.col = "black",
         order = "hclust", col = brewer.pal(n = 6, name = "RdYlBu"),
         title = "Correlation between Environmental, Social, and Governance (ESG) and Other Factors")
```