MSDS 6306 401 Case Study 1: Exploration of Countries' GDPs Vs Income Groups

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Contents

Introduction:

The following is a data exploration of GDPs and income groups for countries around the world. GDP data of countries is taken from http://data.worldbank.org/data-catalog/GDP-ranking-table, which was last updated on 01-Feb-2017. Income group of countries is taken from http://data.worldbank.org/data-catalog/ed-stats, which was last updated on 22-Feb-2017.

This case study is an exercise of gathering, cleaning, and analyzing data using R markdown to source .R files from various directories, and thus creating the paper file.

- Both data sets are stored in .csv format where headers are imported directly from the original data set, where the columns that are not used to answer the questions in the analysis are then eliminated.

- Column name description:
1. CountryCode – The 3 letter country shortcode
2. Ranking – Country ranking by GDP with 1 being the highest
3. Economy – Country name
4. US Dollars (millions) – Gross Domestic Product of a certain country, in U.S. Dollars
5. Income.Group – The income group of a country

- Problems with the data:
1. The countries that have missing values for those columns listed above are not included in the analysis
2. The download file is updated regularly and may create different results later on

Folder Description:

Directions to run the code:

```
source("main_helper.R")
```

```
## Loading required package: downloader
```

```
## Loading required package: ggplot2
```

```
## Loading required package: reshape2
```

==Analysis to answer questions==

0) Include code to count the number of missing values for each variable used in the analysis:

Extract the number of rows from origianl merged raw data, Track the number of cumulative matched rows, number of N/A values in Rankings, Economies, GDP, Income groups, and cumulative unmatched rows

```
print(paste0("Total Number of Rows in Merged Data: ", nrow(MergeData1)))
```

```
## [1] "Total Number of Rows in Merged Data: 235"
```

```
NARanking<-sum(is.na(MergeData1$Ranking) == TRUE)
print(paste0("Number of N/A Rankings: ", NARanking))
```

```
## [1] "Number of N/A Rankings: 45"
```

```
NAEconomy<-sum(is.na(MergeData1$Economy) == TRUE)
print(paste0("Number of N/A Economies: ", NAEconomy))
```

```
## [1] "Number of N/A Economies: 45"
```

```
NAGDP<-sum(is.na(MergeData1$`US Dollars (millions)`) == TRUE)
print(paste0("Number of N/A GDPs: ", NAGDP))
```

```
## [1] "Number of N/A GDPs: 45"
```

```
NAIncomeGroup<-sum(is.na(MergeData1$Income.Group) == TRUE)
print(paste0("Number of N/A Income Groups: ", NAIncomeGroup))
```

```
## [1] "Number of N/A Income Groups: 1"
```

```
NATotal<-sum(is.na(MergeData1$Ranking) == TRUE| is.na(MergeData1$Economy) == TRUE |
               MergeData1$`US Dollars (millions)` == TRUE |
               is.na(MergeData1$Income.Group) == TRUE)
print(paste0("Total Number of Unmatched Rows: ", NATotal))
```

```
## [1] "Total Number of Unmatched Rows: 46"
```

For each of the variables utilized in the analysis, there are 45 N/A values for rankings, economies, and GDP. There is one country with a N/A value for income groups and is also eliminated, which results in a total of 46 unmatched rows

1) Merge the data based on the country shortcode. How many of the IDs match?

```
print(paste0("Number of Rows in Merged Data without N/A values: ", nrow(MergeData2)))
```

```
## [1] "Number of Rows in Merged Data without N/A values: 189"
```

After merging the data by country shortcode and eliminating pertinent rows with N/A values, 189 countries has GDP, educational, and ranking values matching with income group.

2) Sort the data frame in ascending order by GDP (so United States is last). What is the 13th country in the resulting data frame?

Rank the merged data by ascending GDP ranking, examine attributes and export dataset

```
NegGDP <- MergeData2[order(MergeData2$`US Dollars (millions)`),]
head(NegGDP)
```

```
##     CountryCode Ranking               Economy US Dollars (millions)
## 173         TUV     190                Tuvalu                    40
## 92          KIR     189              Kiribati                   175
## 113         MHL     188      Marshall Islands                   182
## 137         PLW     187                 Palau                   228
## 155         STP     186 São Tomé and Principe                   263
## 59          FSM     185 Micronesia, Fed. Sts.                   326
##             Income.Group
## 173 Lower middle income
## 92  Lower middle income
## 113 Lower middle income
## 137 Upper middle income
## 155 Lower middle income
## 59  Lower middle income
```

```
str(NegGDP)
```

```
## 'data.frame':    189 obs. of  5 variables:
##  $ CountryCode          : chr  "TUV" "KIR" "MHL" "PLW" ...
##  $ Ranking              : int  190 189 188 187 186 185 184 183 182 181 ...
##  $ Economy              : chr  "Tuvalu" "Kiribati" "Marshall Islands" "Palau" ...
##  $ US Dollars (millions): num  40 175 182 228 263 326 472 480 596 684 ...
##  $ Income.Group         : chr  "Lower middle income" "Lower middle income" "Lower middle income" "Up
```

```
write.csv(NegGDP, "NegGDP.csv")
```

Code to find 13th country with the ascending GDP. More code to show that there is a tie between St. Kitts and Grenada at 12th place, which results the alphabetical order to dictate St. Kitts at 13th place in ranking.

```
country13NegGDP<-NegGDP[13,3]
print(paste0("The 13th country in ascending order by GDP is: ", country13NegGDP))
```

```
## [1] "The 13th country in ascending order by GDP is: St. Kitts and Nevis"
```

```
NegGDP[12:13,]
```

```
##    CountryCode Ranking             Economy US Dollars (millions)
## 69         GRD     178             Grenada                   767
## 93         KNA     178 St. Kitts and Nevis                   767
##           Income.Group
## 69 Upper middle income
## 93 Upper middle income
```

From ascending GDP, country #13 is St. Kitts and Nevis in the resulting data frame NegGDP. Technically, St. Kitts and Grenada are tied at 12th in ascending GDP and further ascending alphabetical sorting makes St. Kitts appear at 13th and Grenada at 12th place.

3) What are the average GDP rankings for the "High income: OECD" and "High income: nonOECD" groups?

Assign a subset of High Income OECD countries from income group and find the mean of their GDP rank

```
HIOECD <- MergeData2[ which(MergeData2$Income.Group=='High income: OECD'), ]
head(HIOECD)
```

```
##    CountryCode Ranking        Economy US Dollars (millions)
## 9          AUS      12      Australia               1532408
## 10         AUT      27        Austria                394708
## 13         BEL      25        Belgium                483262
## 31         CAN      11         Canada               1821424
## 32         CHE      20    Switzerland                631173
## 44         CZE      51 Czech Republic                196446
##          Income.Group
## 9  High income: OECD
## 10 High income: OECD
## 13 High income: OECD
## 31 High income: OECD
## 32 High income: OECD
## 44 High income: OECD
```

```
write.csv(HIOECD, "HIOECD.csv")
HAvgGDPRank<- mean(HIOECD$Ranking)
print(paste0("The average GDP ranking of high income, OECD countries is: ",
             round(HAvgGDPRank, digits = 2)))
```

```
## [1] "The average GDP ranking of high income, OECD countries is: 32.97"
```

Assign a subset of High Income nonOECD countries from income group and find the mean of their GDP rank

```
HINonOECD <- MergeData2[ which(MergeData2$Income.Group=='High income: nonOECD'), ]
head(HINonOECD)
```

```
##    CountryCode Ranking              Economy US Dollars (millions)
## 1          ABW     161                Aruba                   2584
## 5          ARE      32 United Arab Emirates                 348595
## 18         BHR      93              Bahrain                  29044
## 19         BHS     138         Bahamas, The                   8149
## 23         BMU     149              Bermuda                   5474
## 26         BRB     153             Barbados                   4225
##            Income.Group
```

```
## 1  High income: nonOECD
## 5  High income: nonOECD
## 18 High income: nonOECD
## 19 High income: nonOECD
## 23 High income: nonOECD
## 26 High income: nonOECD
```

```
write.csv(HINonOECD, "HINonOECD.csv")
NAvgGDPRank<- mean(HINonOECD$Ranking)
print(paste0("The average GDP ranking of high income, nonOECD countries is: ",
             round(NAvgGDPRank, digits = 2)))
```

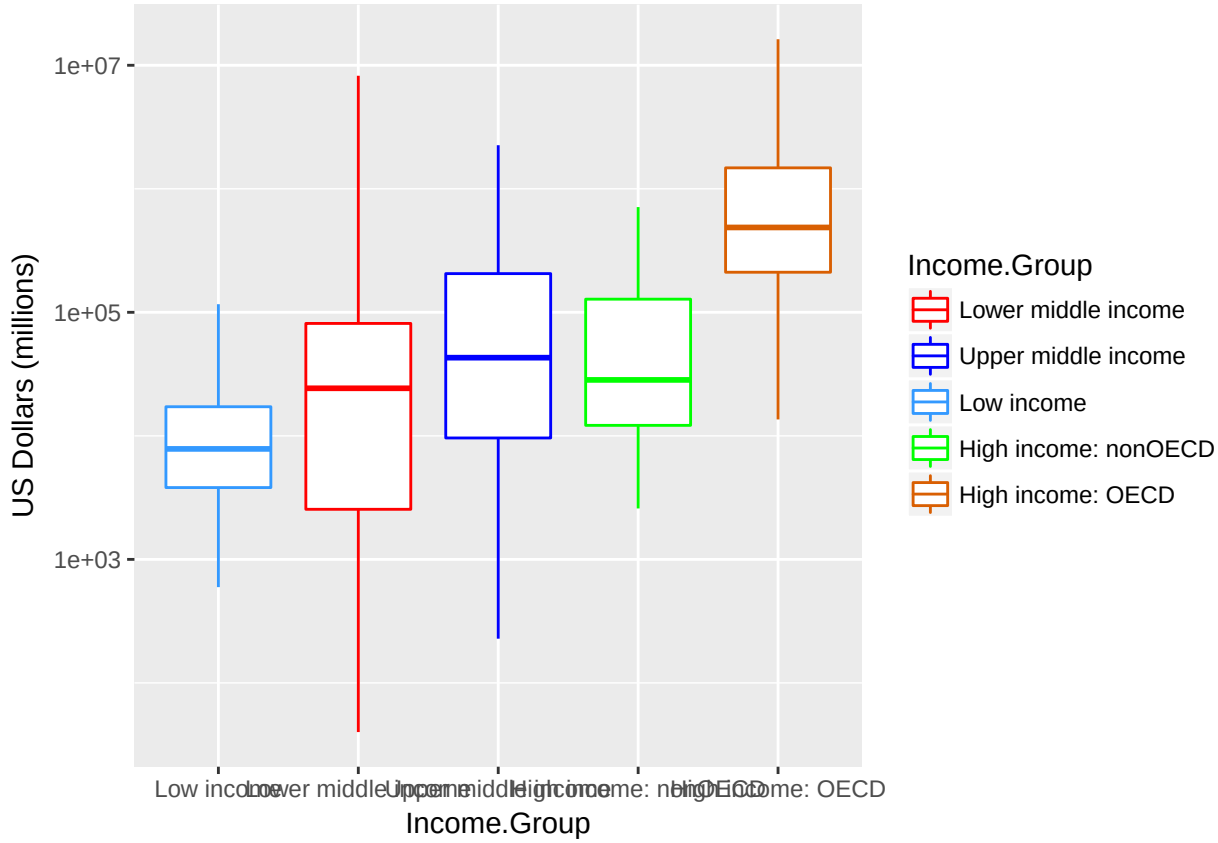
```
## [1] "The average GDP ranking of high income, nonOECD countries is: 91.91"
```

By income group, the average GDP rankings for High income: OECD countries is 32.97 and for High income: nonOECD countries is 91.91. High income OECD countries have higher GDP than that of High income nonOECD countries. Higher GDP ranking suggests that high income countries that are open to free world trade and development are more prosperous.

4) Show the distribution of GDP value for all the countries and color plots by income group. Use ggplot2 to create your plot.

Using ggplot2, individual countries with matching rows in GDP are logarithmically plotted by separately colored income group box plots to show quantile distribution.

```
NegGDP$Income.Group <- factor(NegGDP$Income.Group, levels=c("Low income",
        "Lower middle income", "Upper middle income", "High income: nonOECD",
        "High income: OECD"))
color.codes<-as.character(c("#3399FF", "#FF0000","#0000FF", "#00FF00", "#D95F02"))
ggplot(data = NegGDP, aes(y = `US Dollars (millions)`, x = Income.Group,
                          colour = Income.Group))+ geom_boxplot() + scale_y_log10() +
                          scale_colour_manual(breaks = NegGDP$Income.Group,values =
                          unique(as.character(color.codes)))
```



Graphically by boxplot log distribution, it was expected that the median GDP of countries grouped by income group rose from low income to lower middle income to upper middle income. For high income countries, there is a discrepancy between OECD and nonOECD countries. If the country is high income but does not allow free global trade and development, they have an median GDP lower than that of upper middle income countries and about equivalent to that of lower middle income countries. Otherwise, if the high income country is an OECD member, they countinue the trend of GDP prosperity. In addition, the giant range of counties that fall into the lower middle income category suggests that the distinction of countries by income groups is not solely based on GDP qualities alone.

5) Provide summary statistics of GDP by income groups.

GDP summary statistics of countries based on income groups

```
tapply(NegGDP$`US Dollars (millions)`, NegGDP$Income.Group, summary)
```

```
## $`Low income`
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     596    3814    7843   14410   17200  116400
##
## $`Lower middle income`
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      40    2549   24270  256700   81450 8227000
##
## $`Upper middle income`
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     228    9613   42940  231800  205800 2253000
```

```
##
## $`High income: nonOECD`
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    2584   12840   28370  104300  131200  711000
##
## $`High income: OECD`
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
##    13580   211100   486500  1484000  1480000 16240000
```

From the boxplot log distribution of countries' GDP separated by income groups, the quantile distributions were plotted by range, interquantile range, and medians. The summary statistics show that the mean GDP per income group is very different than that of the median, with the mean being 0.8x, 9.5x, 4.3x, 2.6x, and 2x greater than that of the median for their respective income groups by ascending classification.

The range overlap in country GDP further suggests that countries separated by income group was not solely based on GDP. The order of mean GDP by income group is low income, high income: nonOECD, upper middle income, lower middle income, and high income: OECD, which means that there are more factors that dictate how a country is classifed into income groups than GDP alone.

6) Cut the GDP ranking into 5 separate quantile groups. Make a table versus Income.Group. How many countries are Lower middle income but among the 38 nations with highest GDP?

Breaks the GDP rankings into 5 separate quantile groups, with increment of 20%, and writes the quantiles into csv. Negdata is used because factors and levels are defined previously

```
Quantiles<-cut(NegGDP$Ranking, breaks=quantile(NegGDP$Ranking,seq(0, 1, 0.2)))
head(Quantiles)
```

```
## [1] (152,190] (152,190] (152,190] (152,190] (152,190] (152,190]
## Levels: (1,38.6] (38.6,76.2] (76.2,114] (114,152] (152,190]
```

```
write.csv(Quantiles, "Quantiles.csv")
```

Using reshape2, a table shows the number of contries per income group that falls inside their respective 20% quantile groups based on individual GDP ranking

```
table(MergeData2$Income.Group, Quantiles)
```

```
##                       Quantiles
##                        (1,38.6] (38.6,76.2] (76.2,114] (114,152] (152,190]
##   High income: nonOECD        1           6          4         5         7
##   High income: OECD           4           5          7         9         5
##   Low income                  8           8          6         8         6
##   Lower middle income        16           9         12         8         9
##   Upper middle income         8          10          8         8        11
```

It was expected that low income has more countries that fall inside the higher quantile GDP rankings while that of the higher income: OECD has more that fall inside the lower GDP quantile rankings. Lower middle income has a concentration of counties that fall inside ther higher GDP rankings with some of its countries in the lower quantile GDP rankings. Upper middle income countries has an even distribution of countries in each quantile category while that of high income: nonOECD countries have countries falling in the middle GDP quantile rankings. GDP ranking 1 to 38 is the top 20% quantile of all the nations. There are 5 lower middle income countries among the 38 nations with the highest GDP.

Document which countries from lower middle income group has the top 38 GDP rankings

```
LowerMiddleTop38 <- NegGDP[which(NegGDP$Ranking <= 38 &
                                 NegGDP$Income.Group == "Lower middle income"),]
LowerMiddleTop38
```

```
##     CountryCode Ranking          Economy US Dollars (millions)
## 51          EGY      38 Egypt, Arab Rep.                262832
## 165         THA      31         Thailand                365966
## 77          IDN      16        Indonesia                878043
## 78          IND      10            India               1841710
## 34          CHN       2            China               8227103
##            Income.Group
## 51  Lower middle income
## 165 Lower middle income
## 77  Lower middle income
## 78  Lower middle income
## 34  Lower middle income
```

```
write.csv(LowerMiddleTop38, "LowerMiddleTop38.csv")
```

Conclusion:

0 and 1) As the online data set updates to include more GDP and income groups, more of the world's countries would be included to do a full-world analysis. For now, the analysis is for 189 of the 235 available countries, with 46 countries with missing data.

2) If there is a tie in GDP rankings at #12 for Grenada and St. Kitts, further alphabetical sorting is used to distinguish St. Kitts as the 13th country in ascending GDP ranking.

3) The rankings gap between the average GDP ranking of high income, OECD countries (32.97) and that of high income, nonOECD countries (91.91) is quite significant, given that the range of GDP rankings is from 1 to 189. High income OECD countries that are open to free trade and development have a higher average GDP ranking than those nonOECD countries that do not.

4) When boxplot distributions are plotted for GDPs by income group, there is some upwards trend when comparing median GDPs for low income to lower middle income to upper middle income to high income OECD countries. As stated for number 3, high income nonOECD countries cripple their GDP by not having open trade to all countries for development and its median GDP fall close to that for lower middle income. There are non-GDP factors when categorizing certain countries by income group because of the wide GDP range that the lower middle income group constitutes.

5) The summary statistics show that the mean GDP per income group is very different than that of the median, with the mean being 0.8x, 9.5x, 4.3x, 2.6x, and 2x greater than that of the median for their respective income groups by ascending classification. As stated in number 4, there is quite a bit of GDP overlap when classifying certain countries to income groups and classification of income group is not solely based on GDP.

6) There are 5 lower middle income countries among the 38 nations with the highest GDP, which constitutes the top 20% quantile of all the nations analyzed. As stated in number 4) there are factors outside of GDP that qualify certain countries to certain income classifications.

- The world data sets are observational and no causal effect could be inferenced. The country data sampled are not randomized for population inference and does not reflect data from all the nations in the world.
- Writing functions in R makes the work reproducible for future analysis and R markdown is good for documenting all the steps.

Further Work:

Future work would be to analyze country GDP per capita or per land size to see if the GDP distributions per income group would change based on those incremental factors. It would also be good to know what constitutes a country to be categorized to a certain income group and see if any of the other columns imported from world data sets could indicate more trends based on column data from other factors.