GNG5300K

DATA ANALYSIS AND VISUALIZATION DELIVERABLE 4 - THE STORY

Faculty of Engineering
University of Ottawa

National Data Analysis



Submitted to
Prof. Andrew Sowinski

Team Members - Group 4

Sakshi (300240266) Sahil Kapoor (300170453) Ramesh S (300230090) Harsh Patel (300249466)

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1. Introduction

As investment has become more prevalent in recent years, all our team members were highly interested in studying the stock market data. So when we were given the opportunity to choose the datasets for this course, we wanted to take advantage of it.

In our project, we analyzed GDP and stock indices data for various countries, which is relevant to the field of *finance*, and decided to explore this domain, to learn more about it. Additionally, we wanted to investigate past recessions and draw insights based on the information we gathered. In order to gain these insights from the available dataset and to visualize the same using the PowerBI tool, we used a number of *aggregation* functions throughout the project such as *Mean*, *Max*, and *Sum*.

The dashboard we present in this project will help **new** and **long-term investors** who are interested in knowing the historical performance of the stock indices and reckoning the right time to invest. Through this dashboard, we can also help **economists** who want to study the patterns in the GDP of a country and want to analyze which recessions were most dreadful for the country or in general for the whole world.

The objective of this project is to study the country's performance, before and after a recession based on its GDP and stock index values. Our data analysis will reveal numerous observations across all countries and will also reflect on the global impact of recessions in general. Additionally, we added a section where the stakeholders can check the current stock price of the stock index.

Please note that this project does not provide any financial advice. The insights derived from the dashboard are our team's observations based on the data sources linked in the next section.

2. Dataset

As mentioned earlier that our project relates to the field of *finance*, so retrieving the dataset was quite challenging. As part of the analysis, we had to construct some bespoke tables, retrieve data from multiple sources, and perform various computations. Our project relied on four different sources, *Investing.com* and *WorldBank.org* were used to collect historical and real-time information on stock indices and GDP (current \$US) respectively. *Investopedia* was used to fetch all the information related to recessions. Finally, *PACIFIC Exchange Rate Service* was used to get the exchange rates of all the currencies to standardize our analysis in one currency i.e. in the US Dollars.

What makes our sources reliable?

<u>Investing.com</u> was founded in 2007 and is a financial markets platform providing historical and real-time data, quotes, charts, financial tools, breaking news, and analysis across 250 exchanges around the world in 44 language editions. <u>WorkBank.org</u> was founded in 1947

and is a part of five government-regulated organizations to provide a wide array of financial products and technical assistance. <u>Investopedia</u> was founded in 1999 with the mission of simplifying financial decisions and providing financial information to its users. <u>PACIFIC Exchange Rate Service</u> was founded in 1996 through resources provided by the Sauder School of Business and is operated and maintained by Professor Werner Antweiler (University of British Columbia).

In total, we had 23 tables fetched from the sources mentioned above. These were then merged based on their identical record structures and relationships, resulting in *eight tables* that were needed for the data analysis. The names (linked to the dataset) of the resulting tables are listed below, along with their necessary fields.

Table Name	Important Fields	
CountryInfo	Country, Index Name, Currency Code, USD	
*Currency Code	Code, fcu/USD	
* <u>CurrentStockIndexPrice</u>	Index, CurrentPriceInUSD	
StockIndexHistorical	Country, Index Name, Date, CloseInUSD	
GDP	Country, Year, GDP	
Recession	Name, Start, End, Duration, PeakUnemploymentRate	
Country (Top 10)	Country, Count	
Conclusions	Country, High, MajorDrops	

^{*}Real-time data

Table 1: Tables and their important fields used for the analysis

We used PowerBI's **Append Queries** to combine the tables with similar records. For example, tables named by the country name (please refer to <u>Data Model</u>), were combined together to form a single table <u>CurrentStockIndexPrice</u>. Also, <u>Currency Code</u>'s fcu/USD column was merged with certain tables using the <u>Merge Queries</u> feature in PowerBI resulting in a new column named <u>USD</u> which contains the exchange rate of that currency in the US Dollar. Now to further convert all the prices into USD a new column was created ending with the name *InUSD. An example **power query** of table <u>StockIndexHistorical</u> is shown below. Similar calculations were performed on all the tables containing column names ending with *InUSD.

CloseInUSD = DIVIDE(StockIndexHistorical[Close], StockIndexHistorical[USD])
Please note that GDP was already extracted from the source in US Dollars and we created
new columns instead of new measures because creating 'new measure' was not allowing us

to perform this calculation without any aggregation. And we wanted to perform the division on the actual values of the prices and not the aggregated ones.

Furthermore, the number of rows in the eight derived tables ranges from *9 rows to 9K rows* and we are a group of four members. So, there was enough data for each of us to perform our own analysis, as we divided our efforts based on the extraction of data from different sources and on the number of tables.

3. Exploration and Analysis

Since we are dealing with financial data and our data sources are authorized and reliable, most of the tables did not require any data cleaning. But a few tables needed to be cleaned and transformed to fit our analysis. A brief description of all the data cleaning steps is mentioned below:

- a) Handling NaN/missing values: When we merged the table *CurrentStockIndexPrice* with table *CountryInfo* on the column *CurrencyCode* just one NaN value was observed because the source table i.e. *CurrentStockIndexPrice* did not contain the exchange rate for the currency code ARS. We resolved this issue in PowerBI, by replacing *null* with the actual value for ARS (167.88). Additionally, some of the data points in the GDP table were missing because of the unavailability of data from the source. But, these missing values did not hamper our analysis and we were able to ignore them because we wanted to analyze only a portion of this information, i.e. data for the top ten countries. So, after sorting (in descending order) the GDP values from the years 1960 to 2021, we came up with the names of 16 countries that were in the top ten at least once in this period, and none of them had any *null* data points.
- b) Normalization of values: The data we fetched from Investing.com was in the local currency of the countries. To eliminate any biases in the data we had to convert all the prices into one currency. So, we decided to normalize the prices of the required columns into US Dollars because of its <u>wide acceptance</u>. The normalization process was already explained in the previous section.
- c) Fixing structural errors: Our dataset also contains some text and date/time fields along with numerical data and due to the data being fetched from multiple sources there were some structural changes required. Initially, we capitalized the columns in all the tables which contained the names of the stock indices. We also simplified the names of the recessions so that we could display them in the visuals. When we fetched the real-time closing prices of the stock indices from Investing.com, PowerBI by default treated the time column as a date column because it consists of both date and time. So, we had to change the data type of this column to "Date/Time" and not to alone Date or Time because the source could return just the date or the time. Finally, there were some minor fixed, such as setting "Use First Row as Headers" for a few tables, updating the

- format of the columns *InUSD to "\$ English (United States)" format, and adjusting decimal places up to two places.
- d) **Data Outliers**: Our group decided to perform the analysis starting from the year 1960 to the year 2021. Due to the lack of information on past data for most of the countries, we had to narrow down the analysis period. Upon reviewing the data in depth, we decided that 1960 to 1969 were the outliers. So for this project, we analyzed the performance of the countries from the year 1970 to 2021.

Please note that the outliers were applied after extracting the names of the top-performing countries. Also, there were **NO** duplicate or irrelevant (such as emails, HTML tags, URLs) records in the dataset and encoding categorical data or feature scaling was **NOT** necessary according to our analysis.

4. Data Visualization

Our project is divided into three reports of PowerBI i.e. <u>Summary</u>, <u>Insights</u>, and <u>Details</u>. The tables below (*Table 2, Table 3,* and *Table 4*) contain a **detailed explanation** of each of the visuals along with their **connectivity with the dataset**, the **data source for PowerBI**, and the reasoning for **why the visual is important**.

Please note that clicking on each of the visuals will take you to a larger and clearer version of the representation. Also, these visuals are not displayed for any specific country (other than the Insights report which is a drill-through report) instead they contain compiled information for all the countries. Additionally, these tables will also explain the **aggregations** used for the visuals.

Summary

Title	Туре	Visual
Highly impactful recessions by count of countries	Donut chart	Highly impactful recessions by count of countries Great COVID-19 Dot-flomb Guiff War
		Fig. 1

- This visual represents the recessions that heavily affected most of the countries being studied.
- It is derived from the *Conclusions* table (using columns *Country* and *High*) which was imported into PowerBI using *Excel Workbook*.
- No filtering is applied to this visual as it was created manually to summarise the observations.
- The Count of the Country is used as the Values for the donut chart and the recessions

- in column High are used as the Legend.
- According to us, a recession is highly impactful if its stock price drops to at least half
 of its value before or during a recession. On the other hand, a recession will have a
 mild effect on a country if its stock prices did not drop significantly, and a low effect
 refers to no or a very slight decrease in the values of the stock prices.
- It can be observed from the visual that *The Great Recession* heavily impacted 12 out of the 16 countries being studied.
- It can also be noted that the recession that heavily impacted the 12 countries did not have the same impact on the other 4 countries.
- The COVID-19 recession was more dreadful for countries Argentina and Brazil.
 Whereas, the Dot Bomb and the Gulf War recessions were disastrous for France and Japan respectively.
- Due to the fact that the visual helped us determine the impact of recessions on the countries, it was an important one to use.

Top performing stock indices as of <date></date>	Table		ing Stock Indices as of 2022 12:00:00 AM Last Closing Price (USD)
-auter		FTSE MIB TR EUR	\$58,756.38
		DOW JONES	\$33,476.46
		BOVESPA	\$20,510.08
		DAX	\$15,151.00
		S&P/TSX	\$14,634.68
		Total	\$28,505.72
			Fig. 2

- This visual represents the most recent top five stock indices.
- It is derived from the CurrentStockIndexPrice table (using columns CurrentPriceInUSD and Index) which was imported into PowerBI via Web.
- This visual is filtered to display only the Top 5 indices based on the Mean of CurrentPriceInUSD of the stock indices.
- This table visual consists of two data columns, namely Stock Index and Last Closing Price (USD).
- When the dataset of PowerBI is refreshed, the date and time in the header are automatically updated with the latest data available in the source.
- It can be observed from the visual that the stock index, **FTSE MIB TR EUR** with a closing price of \$58,756.38 is the current leading stock index as of date 07/12/2022 12:00:00 AM.
- It was important to include this visual since it shows the newest top-performing stock indexes, which would be a piece of useful information for investors.

Top performing stock indices historically	Table	Top Performing Stock Indices Historically		
		Stock Index	Country	Closing Price (USD)
		FTSE MIB TR EUR	Italy	\$39,328.50
		IBEX 35	Spain	\$8,872.09
		DOW JONES	United States	\$7,729.85
		DAX	Germany	\$6,416.68
		BOVESPA	Brazil	\$5,801.78
		Total		\$11,319.75
			Fig. 3	

This visual represents the top five stock indices in the analysis period.

- It is derived from the **StockIndexHistorical** table (using columns **CloseInUSD**, **Country**, and **Index Name**) which was imported into PowerBI using **Excel Workbook**.
- This table visual consists of three columns, namely *Stock Index*, Country, and *ClosingPrice(USD)*.
- The Closing Price (USD) column uses the aggregated Mean of the closing prices over the analysis period.
- This visual is filtered to display only the *Top 5* indices based on the *Maximum* value of the *Mean* of the *CurrentPriceInUSD*.
- It can be observed from the visual that *Italy's* stock index *FTSE MIB TR EUR* has an average closing price of \$39,328.50 and was the leading stock index in the past as well.
- It can also be observed that **Spain's IBEX 35** was leading in the past years but it did not appear in the previous visual which means that it is not performing well.
- Another observation was the huge difference between the prices of past and present stock indices.
- This visual was an important one because we were able to compare the past and the present performances of the stock indices through this visual.

Year 2014	Text Box	Year 2014
		High impact on thirteen countries but not a recession period Fig. 4

- This visual provides information about the year 2014 which was not a recession period but sharp declines in the values of the stock indices and GDP were observed in the 13 countries covered in the study.
- **Conclusions** table was used to form this visual based on the columns *Country, Major Drops, and Real Impact*.
- No filtering or aggregation was required for the analysis of this visual and the source table was imported in PowerBi using *Excel Workbook*.
- The visual highlighted the fact that sharp declines can occur even in the absence of a recession, which was important information to provide.

Max of current close (USD)	Card	Max of current Close (USD)
		\$58.76K
		Fig. 5

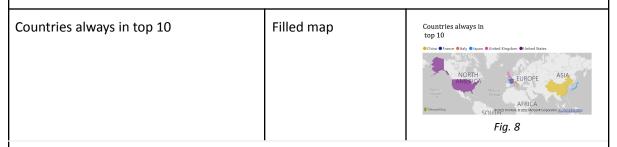
- This card representation in PowerBI shows the most recent *Maximum* closing price of the stock indices across all countries covered in the study.
- It is derived from the *CurrentStockIndexPrice* table (using column *CurrentPriceInUSD*) which was imported into PowerBI via *Web*.
- The visual was important because it gave a clear picture of the current maximum closing price.

Sum of GDP (USD)	Card	Sum of GDP (USD)
		2.91T
		Fig. 6

- This card representation in PowerBI shows the Sum of GDP of all the countries covered in the study.
- It is derived from the GDP table (using column GDP) which was imported into PowerBI via Excel Workbook.
- The visual was important because it gives a good idea of the contributions of the top-performing countries to the global economy.

Max of historical close (USD)	Card	Max of historical Close (USD)
		\$63.29K
		Fig. 7

- This card representation in PowerBI shows the historical *Maximum* closing price of the stock indices across all countries covered in the study.
- It is derived from the **StockIndexHistorical** table (using column **CloseInUSD**) which was imported into PowerBI via **Excel Workbook**.
- The visual is important because it gives a clear picture of the past maximum closing price of the stock index which can be compared with the most recent one.



- This map highlights those countries that have always appeared in the top 10 positions from the year 1960 to 2021.
- It can be seen from the visual that those countries are the United States, United Kingdom, Japan, Italy, France, and China.
- This visual was derived from the Country (Top 10) table (using column Country) which
 was imported into PowerBI using Excel Workbook.
- This visual is filtered to display those countries whose count is *Maximum* among all the countries covered in the analysis.
- The visual was useful in understanding that a country's performance isn't determined by its size.

Country	Slicer	Country V
		☐ Australia
		Brazil
		☐ Canada
		China
		☐ France
		Germany
		☐ India
		☐ Italy
		Japan
		Mexico
		Russia
		South Korea
		☐ Spain
		United Kingdom
		United States
		Fig. 9

- Finally, this is the most important visual of our summary report, as this slicer will help the user to view the previously mentioned statistics for a specific country.
- The stakeholders can make decisions based on the overall performance of the country.
- This visual was derived from the *CountryInfo* table (using column *Country*) which was imported into PowerBI using *Excel Workbook*.
- No filtering or aggregation was required in this visual. In fact this visual acts as a filter for the whole report.
- The user can click on the country's name and the report will be updated accordingly.
 The user can also select multiple countries by holding the CTRL key on the keyboard and other visuals will be updated as a *Sum* of the data of those selected countries.
- Finally, the user can right-click on any of the country names and use the **Drill-through** > **Insights** option to view the Insights report specifically for that country.

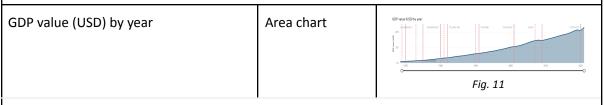
Table 2: Description of visuals in Summary report

Insights

Title	Туре	Visual
Average of close (USD) by year and index name	Line chart	Secret GB loss IGB by the seclades have

- This visual represents the trend of the closing prices of the stock indices from the year 1970 to 2021.
- It is derived from the StockIndexHistorical table (using columns CloseInUSD, Date, and Index Name) which was imported into PowerBI using Excel Workbook.
- The *Date* includes *Year*, *Month*, and *Day* and is plotted on the X-axis. The *Average CloseInUSD* is plotted on the Y-axis and the *Index Name* is used as the *Legend* for this visual.
- It is a *Drill through cross-report* on the field *Country*. This means that it will display the details of the country which is drilled through the summary report.
- The vertical lines represented in orange color are the periods of recession.
- A dashed (--) line is marked as the start of a recession and a solid (—) line represents its end. The area between a dashed line and its next solid line represents a recession's duration.

- Recessions are also labeled on the visual to make it easy to see the data.
- There is also a Zoom slider on the X-axis to provide a closer look at the trends for a specific recession or duration.
- The visual was very important since it provided an in-depth explanation of the closing prices of the stock indices.



- This visual represents the trend of the GDP values (in US Dollars) of the country from the year 1970 to 2021.
- It is derived from the *GDP* table (using columns *GDP*, and *Year*) which was imported into PowerBI using *Excel Workbook*.
- The Year is plotted on the X-axis and the **Average** GDP value is plotted on the Y-axis.
- It is also a **Drill through cross-report** on the field **Country**.
- Here again, the vertical lines represented in red color are the periods of recession.
 Where a dashed (--) line is marked as the start of a recession and a solid (—) line represents its end. The area between a dashed line and its next solid line represents a recession's duration. Recessions are also labeled on the visual to easily follow the data.
- It also contains a Zoom slider on the X-axis to provide a closer look at the trend for a specific recession or duration.
- The visual was an important one to include since it provided an in-depth explanation of the performance of the countries on the bases of their GDP.
- The country name in the title of this report is updated automatically when the user will drill the report for any other country from the summary report.

Table 3: Description of visuals in Insights report

Details

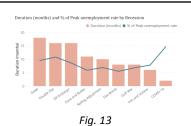
Title	Туре	Visual
Recurrence of top countries over the past six decades	Pie chart	Recurrence of top countries over the past six decades (GDP) Span Merica 1

- This pie chart displays the countries with their occurrences in the top 10 positions from the years 1960 2021 based on their GDP values in US Dollars.
- It is derived from the *Country (Top 10)* table (using columns *Count, and Country*) which was imported into PowerBI using *Excel Workbook*.
- No filter is applied to this visual.

- The **Sum** of the *Count* is used as the *Values* for the pie chart and the *Country* as the *Legend*.
- This visual is important as it provides an overview of the performance of the countries being studied.

Duration (months) and % of peak unemployment rate by Recession

Line and stacked column chart



- This visual shows all the recessions that occurred in the past six decades.
- It is derived from the *Recessions* table (using columns **Duration**, **Name**, and **Peak** unemployment rate) which was imported into PowerBI using **Excel Workbook**.
- The *Recessions* are plotted on the X-axis and the *Sum* of their *Duration* in months is plotted on the Y-axis.
- The line shown in the chart represents the trend of the *Peak unemployment rate*.
- No filter is applied to this visual.
- It is an important visual because through this we are able to see that the peak unemployment rate does not depend on the duration of the recession.

Current closing price (USD) by Index Name

Line chart

Fig. 14

- This line chart shows the most recent closing prices of the stock indices in US Dollars.
- It is derived from the *CurrentStockIndexPrice* table (using columns CurrentPriceInUSD, Index, and *Time*) which was imported into PowerBI using *Excel Workbook*.
- The *Stock Indices* are plotted on the X-axis and the *Sum* of their *Prices* in USD is plotted on the Y-axis.
- Additional fields were used in its *tooltips* which are, Country's name (derived from *CountryInfo* tables) and the *Last Updated* time of the closing price.
- This visual is sorted in descending order of the *Country* name.
- It is important to include this visual to analyze the current trend in the closing prices of the stock indices of all the countries covered in the analysis.

Table 4: Description of visuals on Details report

Please note that PowerBI offers a number of choices to connect data to its application such as Excel Workbook, Azure SQL Database, Azure SQL Data Warehouse, SQL Server Analysis Services, Web Based Services, and a lot more. But we have used only two 'Get data' options from this extensive list i.e. Excel Workbook and Web Based Services.

We also designed a **Data Model** which helped us in the development of the above-mentioned visuals. Our data modeling approach was based on **Star Schema** since it meets our visualization requirements well. An overview of all the tables and their relationships for this PowerBI project is shown in the figure below. It can be seen from the figure that the **CountryInfo** table acts as the **Fact** table for the model and the rest are its **Dimension** tables. Also, the tables shown on the right side of the figure are either reference tables or static tables through which these main tables were generated.

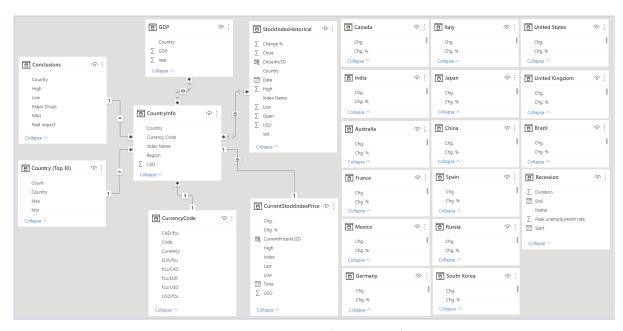


Fig. 15: Data Model (Star Schema)

5. Final Conclusions and Recommendations

After performing the data analysis and visualization we came up with the following conclusions.

a) **Objective**: The main objective of choosing this field was to explore the stock market data. We also wanted to study the performance of the stock indices before and after a recession in light of the current economic crisis, for which some believe we are already in a recession, while others argue that these are pre-recession effects. So, we wanted to study past trends and understand what happens to the stock market before, during, and after a recession. Through our data analysis and visualization, we were very well able to meet our objectives. We identified some expected trends as well as discovered some unexpected patterns. After in-depth analysis, we can now conclude that a recession is of course dreadful for most countries but not equally disastrous for all countries. We were also able to meet our other objective, which was to have a good understanding of the stock market data/terms and to learn how to use the tool *PowerBI*.

- b) Interesting discoveries: As a result of our data analysis and visualization, we uncovered three interesting discoveries. First, the year 2014, which is not marked as a recession period, had significant impacts on the majority of the countries being studied for this project. The GDP values as well as their stock index prices were seen to be declining heavily during this year. Our investigation of the events of 2014 led us to discover that the Russian-Ukrainian conflict is a common event (source: abcnews) for the years 2014 and present 2022. Secondly, despite the fact that the United States's, US Dollar is considered the world's reserve currency, it was still not seen as the number one performing stock index in the world. Finally, through our analysis, we also observed that the peak unemployment rate does not depend on the duration of a recession but we can say that the duration of a recession might be a factor in determining how impactful it will be for the majority of the countries.
- c) **Tool limitations:** The biggest limitations of PowerBI that made our visualizations difficult were, less control over the formatting of the text (e.g. padding, margin, etc.) and less customization available on some of the parts of the visual (e.g. tool-tip and legends). Also in some datasets, if any kind of aggregation is either not required or not applicable, PowerBI still demands the individual to aggregate it (for numeric data types). A few other limitations that we encountered are, we had to change the format of the dataset according to PowerBI, as it reads and stores the data on the bases of columns; there are fewer features available for the *X-Axis Constant Line* which we used to mark the start and end of a recession (e.g. no tool-tip option and no option to shade the area between two constant lines). *Please note* that the tool (PowerBI) is relatively new to everyone in our group. But we did our best to try and understand its available features to incorporate them well into our PowerBI reports and dashboard. So, some of the limitations mentioned might not be the actual limitations of the tool but these were the ones that we came across during our analysis.
- d) **Challenges with the dataset**: Almost 90% of our dataset was clean and well organized, but we had to do some modifications (mentioned thoroughly in <u>section 3</u>) to make it fit for the tool to process well. Additionally, to remove any biases in the data points we had to convert all the required price fields into one currency i.e. US Dollars. It was a challenging task but we were able to achieve it with the help of PowerBI features and thorough research.
- e) Other difficulties: Finding the right dataset for our analysis was the biggest challenge of this project. This is because it is financial data and it was really difficult to trust the authenticity of the source. Also, most of the sources were not able to provide us with all the fields that we were looking for. We also had some difficulty understanding when to use average, sum, or other aggregations initially, but with time and practice, we were

- able to achieve our goal. Further, If we had more time we would have also explored additional features that PowerBI offers and tried to include those in our report.
- f) Recommendations: To the users of our PowerBI report, we highly recommend using the option *Drill-through* from the *Summary* report to the *Insights* report and gaining a deeper understanding of the trends of the stock indices of different countries. As our PowerBI project contains a large number of tables fetched from multiple sources, the refresh time of the project can take up to *60 seconds*. We also recommend selecting multiple countries in the *Summary* report to view the analysis for a group of countries, for example, if you want to view the analysis for the Asia region, you can select all the countries of this region from the given list and explore the results. Finally, if you encounter any type of errors during the refresh of the dataset/report, please follow these steps: open the 'Transform data' from the toolbar, select 'Refresh All' from the 'Refresh Preview' option from the toolbar, then click 'Close & Apply' and hit 'Refresh' again. If you are still unable to refresh the data, then there might be an issue with the source from where we are fetching the real-time information, the tables/visual related to this will continue to show the last data present in the database and the ones that do not deal with the real-time data will still work fine.

6. Task Allocation, Dataset, and References

The links to the dataset and the references to all the sources were provided alongside. As a team of four, we assisted each other with all tasks. As for our task allocation, it is as follows:

Sakshi: Responsible for creating the tables *CountryInfo* and *StockIndexHistorical*; compiled the *Data Visualization* section of this report and worked on the *Summary* Report in PowerBI.

Sahil: Responsible for creating *CurrentStockIndexPrice* and *GDP* tables; compiled the *Introduction* and *Dataset* sections and also worked on the *Summary* Report in PowerBI.

Ramesh: Responsible for creating *CurrencyCode* and *Recession* tables; compiled the *Exploration and Analysis* section and worked on the *Insights* Report in PowerBI.

Harsh: Responsible for creating *Country(Top10)* and *Conclusions* tables; compiled the *Final Conclusions and Recommendations* section and worked on the *Details* Report in PowerBI.

*We have also attached the *.pbix* file in the submission. The PowerBI web version can be found <u>here</u>, and the Dashboard can be accessed <u>here</u>. We recommend that you <u>click here</u> for the report and <u>here</u> for the dashboard if you are having issues viewing them on the web.

— END OF REPORT —