Coursework

Applied Statistics and Data Visualisation

(Principles of Data Science)

MSc Data Science

UNEMPLOYMENT SITUATION AMONG EUROPEAN COUNTRIES FROM THE REFORMATION AND DEVELOPMENT PERSPECTIVE

DAYO SAMUEL

@00644457

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Part One

An Interactive Dashboard Design for Analyzing the Unemployment Situation Among European Countries from the Reformation and Development Perspective

1. Introduction

During the 1970s, unemployment rates in European countries increased significantly. In response, the European Community (EC) implemented various initiatives in an effort to address this issue. However, these efforts were often fragmented and not coordinated in a cohesive manner. In the early 1990s, the EC developed a new strategy called the European Employment Strategy to address the persistent problem of unemployment, which had been exacerbated by the rise in unemployment rates in the 1970s. The strategy was designed to provide a more comprehensive and cohesive approach to tackling employment issues across the European Union (EU). In addition to promoting gender equality, the European Community (EC) also took several important social initiatives in the 1970s that were indirectly related to employment protection. These initiatives aimed to improve the lives of individuals and promote fairness within society. These included the introduction of directives on collective redundancies in 1975, on the transfer of enterprises in 1977, and on employee protection in case of employer insolvency in 1980 (Jamie Goetschy 1999). These initiatives were aimed at improving the stability and security of employment in the EC. Additionally, the EC introduced the concept of economic and monetary union, which was intended to foster convergence among member states and reduce unemployment and increase employment. The European Employment Strategy (EES), which emerged in the early 1990s, was also part of this broader effort to address employment issues in the EC.

During 1980s and 1990s, strong employment protection was alleged to be acting as a break on employment growth in the economics of continental Europe (Jason Heyes, Paul Levis 2014). In 2019, In a study reported by Laszio Konga (2019) on the employment rate convergence among the EU member states, He observed the unemployment rate differences whether it diminished from 1991 and

2014 among the Old EU Countries and the New EU countries. From his analysis he found some EU countries showed the strongest propensity to catch up OEU group.

This interactive dashboard design looks at and compares the unemployment rate from the Old EU to New EU countries. It further explores and visualize the differences diminished between 2012 and 2021, among the Low-Income EU to High Income EU countries which is often regarded as the developed and Underdeveloped EU countries. Few questions this dashboard intended to answer; the impact of the introduced employment strategy on the EU with regards to transformation from OEU to NEU and development from Low Income to high Income EU.

2. Background Research

The growing abundance of data has led to a phenomenon known as information overload, which refers to the difficulty of processing and making sense of large amounts of information (Asmaa and Andy, 2019). As the amount of data continues to increase, the challenge of managing and utilizing it effectively becomes more complex and overwhelming. This can impact individuals, organizations, and society as a whole, as it becomes increasingly difficult to effectively navigate the vast amounts of information that are available. Business Intelligence has attempted to address the issue of information overload by using tools such as dashboards, which allow for the integration of concepts like scorecards to provide valuable information that can help stakeholders and employees improve performance and make better decisions. (Yigitbasioglu and Velcu, 2012). As organizations grow, the need for effective communication becomes more pressing. This highlights the value of tools like dashboards for monitoring and improving performance, as well as for ensuring the accuracy and efficiency of the data that is available. (Koopman et al., 2011).

Generally, dashboards provide an intrinsic and accessible workspace for data analysis. Presenting data in a dashboard helps learners and empowers others to analyse data and develop strategic insights. Muhamad Nazir et al (2022) dashboard is a type of graphical user interface which often provides briefly views of key performance indicators (KPIs) relevant to a particular objectives or

business process in other usage. It is otherwise called ‘progress report or report and considered a form of data visualization. In providing this visual, it helps to save business owner’s and or institutions time and improve decision making by utilizing the dashboards.

Asmaa and Andy (2019) opine while referencing Janes, even though the value of dashboards has been recognized, a lot of software vendors have failed to pull the required level of awareness to the efficacy of dashboards, instead focusing on display features and maximising visualisation mechanisms for marketing purposes (Janes et al., 2013; Few, 2006). There is also little agreement regarding how dashboard should look like and what should do, with the majority of focusing on considerations like its features or customisation options instead (Yigitbasioglu and Velcu, 2012). In addition, a small number of papers has studied the use of dashboard in Higher Education (HE), with particularly limited investigation of the critical factors that make using them successful in this context or the metrics to determine this success.

2.1 Interactive Dashboard

Dashboards do not simply show data alone but are a created lens through which data are seen and can be engaged with: “a dashboard seeks to act as a translator, not simply a mirror, setting the forms and parameters for how data are communicated and thus what the user can see and engage with.” Kitchin (2015). Interactive dashboard is a data management tool that allows users to interact with data vis tracking, analysing, monitoring, and displaying key metrics, this could be in business or others.

This background research is focused on reviewing the current state of the art in the design of interactive dashboards. It aims to understand the benefits, alignment strategies, and goals of this work. Classifications and types of interactive dashboard there are and dashboard software available. And more importantly the soft that would use in this project.

Benefits of using dashboard in this project:

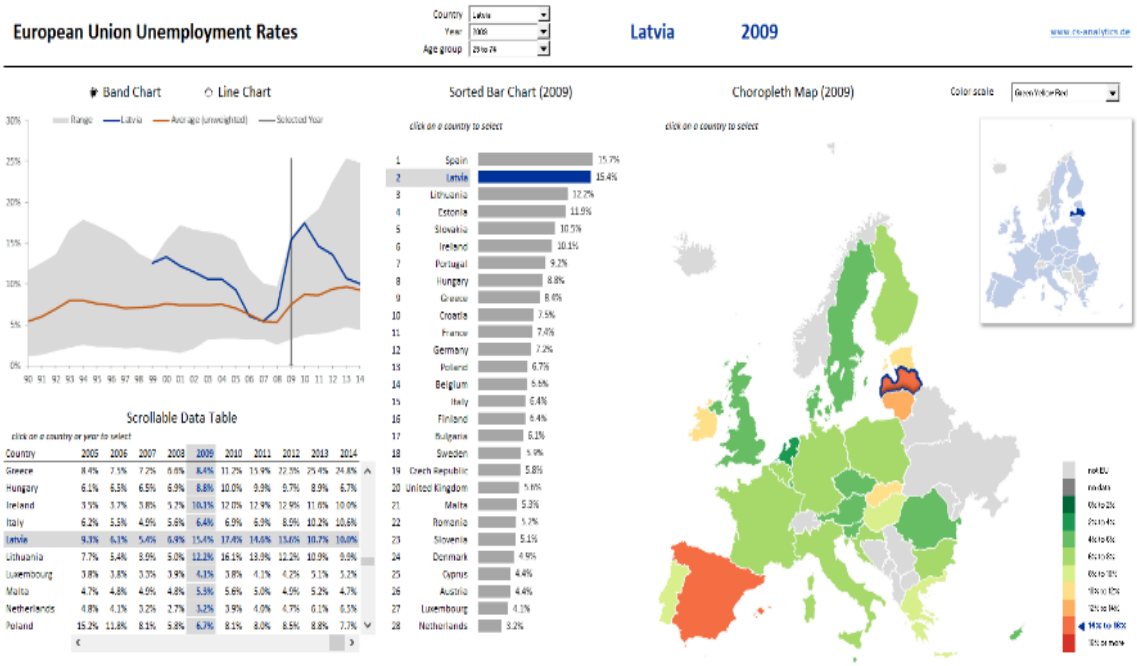
1. To communicate visual presentation of unemployment situation among EU countries
2. Prediction of reformation and development on unemployment in EU countries.

There are different types of dashboards, they are either strategic, analytical, and operational or informational according to Stephen Few (O'Reilly, 2006). Shewan (2016) defines data and information visualization as an interdisplinary field that deals with the graphic representation of data and information. It is an efficient way of communicating when data or information is numerous as for example the unemployment statistics and data for the EU countries. Furthermore, I would be getting more value from my data, to engage the right persons and promote a data driven culture.

2.2 Composition

The composition of a dashboard refers to how its various content components are arranged and presented. Dashboards typically display multiple pieces of information, and the way they are structured and laid out on a page is an important aspect of their design. Other researcher identified five key aspects of dashboard composition: page layout, screen fitting, content structure, interactivity, and colour scheme. Figure 1.0 provides an example of a dashboard that incorporates all of these elements.

Figure. 1.0. Example of an interactive dashboard (source: EuroStat)



3. Exploration of Data Set

The dataset used specifically for this project is gotten from the world bank, this data set is classified as public under its Access to Information Classification Policy, it states Users inside and outside the bank can access this dataset. The World Development Indicator (WDI) is the primary World Bank Collection of development indicators, this is compiled from officially recognized international sources. It presents the most current and accurate global development data available according to World Bank.

3.1 Overview of the data.

This project aims to investigate through visualization the impact of reformation and development of EU union on unemployment rate in a sample of 30 EU countries using yearly data from 2010 to 2021. The sample period was chosen based on the availability of data and to allow for the visualization of employment rates after the implementation of economic reforms. The EU countries were then divided into four categories: Old-EU (countries that joined the EU before 2000), New-EU (countries that joined the EU after 2000), Developed EU (countries considered to be high-income), and Underdeveloped EU (countries considered to be low-income) during the sample period. These categories were

chosen to facilitate analysis and comparison of employment rates in different groups of EU countries. This sample countries and classifications are displayed in Table 3.1. These classifications will help me to further clarify the impact of reformation and development on unemployment rate in the EU.

The measured variables used is as follows; Unemployment Total (UT) is the percentage of the total labour force that is without work but available for work. To robust investigation, I also considered some other measures of world development, such as Self-employed Total (ST) is the percentage of the total employment working on their own, and Part-time employment (PT) is the percentage of the total employment working less than normal.

Incomplete and missing data were identified to be universal between 2020 and 2021 for all the selected countries. These missing values were replaced and assumed to be Zero since no data was collected for these periods, hence removed from the dataset. Groups were intended to be created for the classified EU Countries as seen in Table 3.1. on BI.

Table 3.1 Classification of the EU countries

EU Countries	Old-EU	New-EU	Undeveloped EU	Developed EU
Albania	Austria	Bulgaria	Bulgaria	Austria
Austria	Belgium	Cyprus	Czechia	Belgium
Belarus	Denmark	Czechia	Estonia	Cyprus
Belgium	Finland	Estonia	Hungary	Denmark
Bulgaria	France	Hungary	Latvia	Finland
Cyprus	Germany	Latvia	Lithuania	France
Czechia	Greece	Lithuania	Poland	Germany
Denmark	Ireland	Poland	Romania	Greece
Estonia	Italy	Romania	Ukraine	Ireland
Finland	Luxembourg	Slovak Republic	Albania	Italy
France	Netherlands	Slovenia	Belarus	Luxembourg
Germany	Portugal	Albania		Netherlands
Greece	Spain	Ukraine		Portugal
Hungary	Sweden			Slovenia

Ireland	United Kingdom	Spain
Italy	Belarus	Sweden
Latvia	Switzerland	United Kingdom
Lithuania		Slovak Republic
Luxembourg		Switzerland
Netherlands		
Poland		
Portugal		
Romania		
Slovak Republic		
Slovenia		
Spain		
Sweden		
Switzerland		
Ukraine		
United Kingdom		

4. Investigation of Data Workflows & Proposal for Design of Dashboard

Our brains have the ability to process visual information and images in different ways. Some of this processing happens quickly and automatically, without us even being aware of it. These processes, known as "pre-attentive attributes," are immediately noticeable and stand out to us. Examples of pre-attentive attributes include differences in color hue and intensity, and certain features of shape and form, such as size, length, width, enclosure, and orientation. (Few, 2012, pp. 67-71). Prior to the dataset selected and the objective to investigate unemployment among EU countries, The columns break down the population, employment rate and the unemployment rate each country and year in Percentage, in the following categories: Employment in agriculture, female

Employment in agriculture, male, Employment in industry, male, Employment in industry, female, Employment in services, female, Employment in services, male, Part time employment, female, Part time employment, male, Population ages 65 and above, female, male (two separate column), Population ages 15-64,female, male (two

separate column), Population ages 0-14, female, male (two separate column), GDP growth (annual %), GDP (current US$), Population, male, Population, female, Unemployment with advanced education, male, Unemployment with advanced education, female, Unemployment with basic education, female, Unemployment with basic education, male, Unemployment with intermediate education, female, Unemployment with intermediate education, male, Unemployment, female, Unemployment, male, Wage and salaried workers, male, Wage and salaried workers, female

The proposed dashboard would show the employment rate in the two groups or classes created, it would further show the unemployment rate and the population.

4.1 Power BI

Power BI is the interactive data visualisation software product that would be used in this design. Using the features in Power BI, I created two four groups, however classified under two categories as mentioned before. The design would answer which year has the most unemployment rate, which country class experienced the highest rate of employment and unemployment. And this would answer which class the EU would focus on taking strong employment strategy.

According to Susan Gardner et al. (2015), good data visualizations can help us understand the quantitative relationships presented by data. These relationships involve associations between quantitative values or multiple sets of values and categories. Different methods of data display are better at expressing these types of relationships than others. In this dashboard design, we would be using most of the common types of charts (both table and graphs). Table would be used to display and compare the individual employment and unemployment rates of the two EU classes created. I would also be using specific graphs such as bar chart and pie chart for my visualisation. In a graph, the shape of the data values reveals the meaning of the data. Graphs are useful for showing relationships among many values, and they are particularly helpful when there is a large amount of data (Lown, 2012)

After importing my data into power Bi, I transformed my data and created the two class as groups from the 30 EU countries under the country name column, In the

data view, I created new columns and new measures as needed for the visuals. The following columns were created using DAX expression:

- % Total Unemployment – The sum of male unemployment and female unemployment.
- Total Population – The Sum of all the population from age 0 to 65 and above.
- Unemployment with Advance education - The sum of male unemployment and female unemployment with advance education.
- Unemployment with intermediate education - The sum of male unemployment and female unemployment with intermediate education.
- Unemployment with basic education - The sum of male unemployment and female unemployment with basic education.
- Employment in agriculture - The sum of male employment and female employment in agriculture.
- Employment in industry - The sum of male employment and female employment in industry.
- Employment in service - The sum of male employment and female employment in service.

Likewise, the following measures were created using the DAX expression:

- % Unemployment with advance education – The sum of Unemployment with advance education divided by the sum of total unemployment.
- % Unemployment with intermediate education – The sum of Unemployment with intermediate education divided by the sum of total unemployment.
- % Unemployment with basic education – The sum of Unemployment with basic education divided by the sum of total unemployment.

4.2 Building Dashboard Components

In the search for getting meaningful information from the dashboard, I would focus on the data that would show activities going on within the reformed and the developed EU Countries. Using a pie chart, with reformation class as the legend and percentage of total unemployment as the value for the reformation class, the Old EU tends to have a higher unemployment rate compared to New EU with a 1% difference. However, the difference looks insignificant as showed in the Fig. 4.2.0. Likewise using a pie chart, with development class as the legend and percentage of total unemployment as the value for the Development Class, the developed countries show a higher unemployment rate compared to the underdeveloped EU countries as showed in figure. 4.2.1.

Fig 4.2.0 Percentage of Total Unemployment by Reformation Class

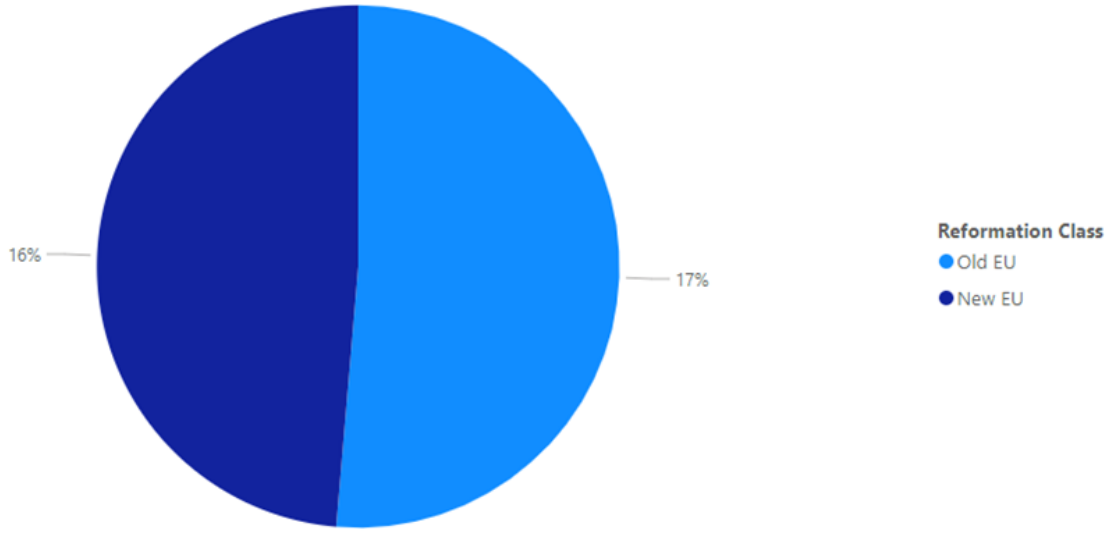
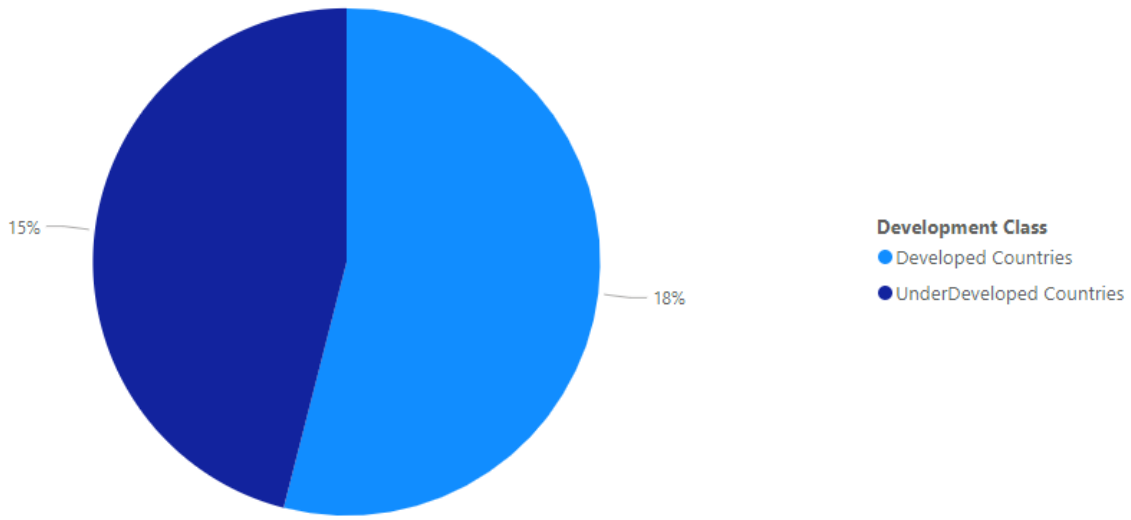


Fig 4.2.1 Percentage of Total Unemployment by Development Class



The question would be which amongst the countries then contributed to this high unemployment in these two classes over the space of 10 years as taken for this study, This I look forward to present in the proposed dashboard to take the right step on the right countries whilst implementing and promoting any employment strategy. Using a stacked column chart with the country name as the X-axis and Total population on the Y-axis, Germany showing the highest total number population despite do not tends to be the cause of high unemployment rate in both classes investigated. Figure 4.2.2 shows the total population over the space of the years studied in this assessment. However, using a stacked column chart with the country name as the X-axis and Percentage of total unemployment on the Y-axis revealed Greece has the highest unemployment rate while it's population account for 108.07million compared to 821.04million of Germany's total population. Figure 4.2.3

Fig 4.2.2 Total Population by Country name

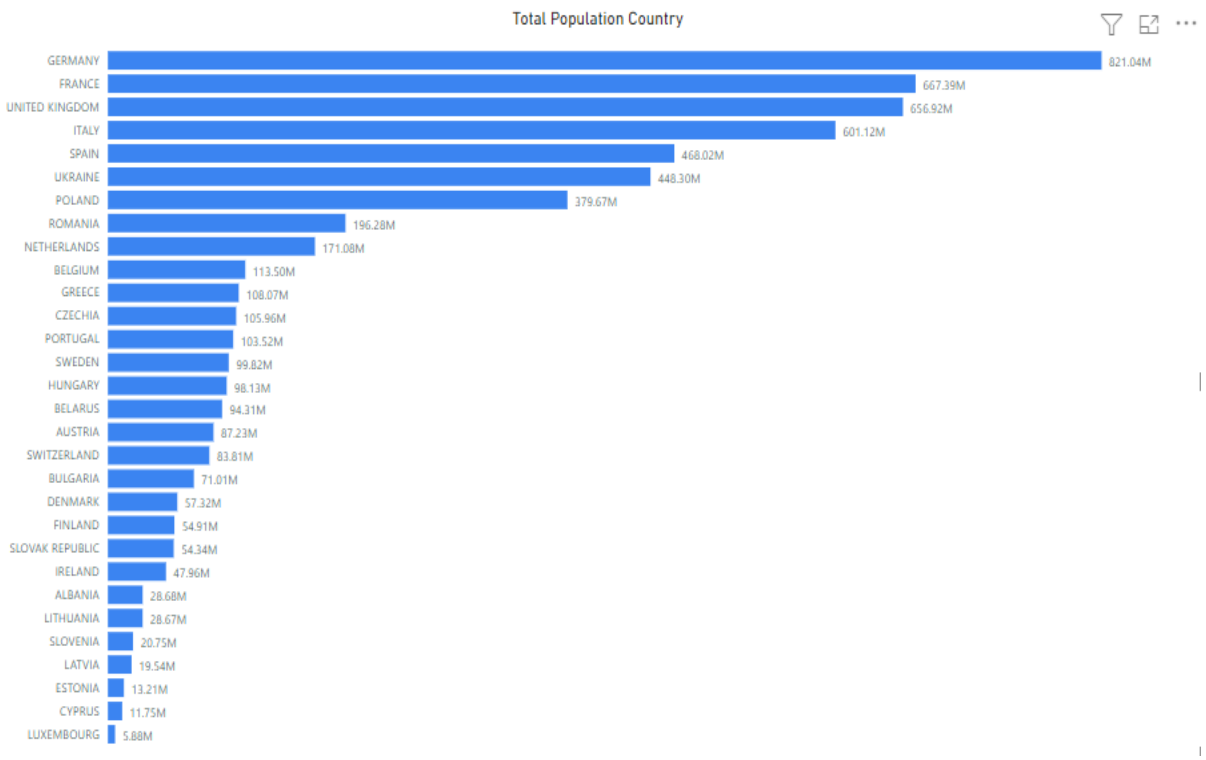
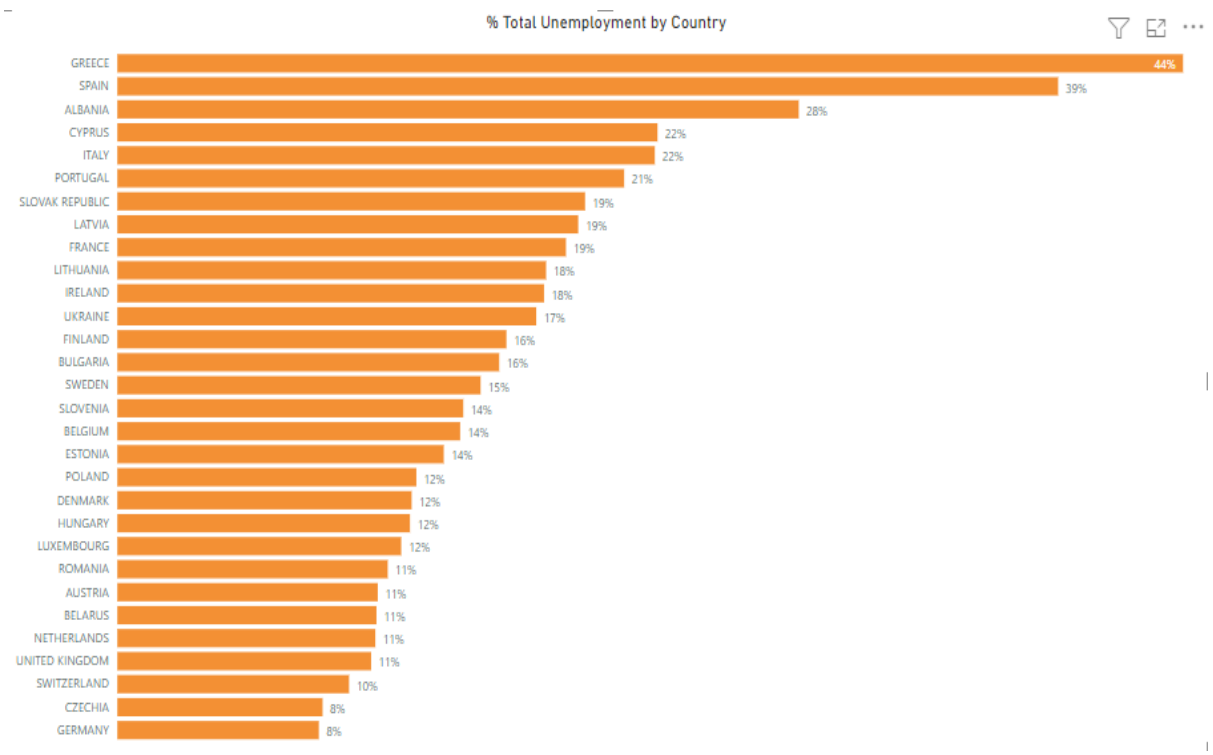


Fig 4.2.3 Percentage of Total Unemployment by Country name



Diving further and investigating, using a stacked column chart with the country name as the X-axis and Percentage of total unemployment on the Y-axis, and filtering Old EU and Developed countries shows a divergence little lower in unemployment rate compared to the New EU who happened to fall under the Developed countries. And on the other hand, using a stacked column chart with the country name as the X-axis and Percentage of total unemployment on the Y-axis, filtering Old EU and Underdeveloped countries shows Belarus appears to be the only Old EU country that hasn't developed with 11% unemployment rate accounted for unlike others.

Fanati and Manfredi, (2003), In many studies conducted to find the reason for unemployment rate, it was assumed from different investigation that there was no positive relationship between economic development and the rate of unemployment as stated by Muhammad Et al, this is commonly believed that the relationship between the unemployment rate and economic growth is governed by Okun's Law (Malley and Molana, 2007). According to the original research of Okun, an above normal rise in GDP rate (more than 3%) will result in the reduction of unemployment by 1% (Walterskirchen, 1999; Altig, Fitzgerald, and Rupert, 1997). Many empirical studies have been conducted to prove the law in different regions. These studies inspired the visualization of both GDP effect on unemployment and rate on the two classes in my study. As shown in my figure 4.2.2 and figure 4.2.3, Population growth doesn't necessarily have much impact on the unemployment rate in Germany and some other EU countries like United Kingdom. However, there seem to be a significant impact on countries like France and Ukraine.

Figure 4.2.4 GDP by Development Class

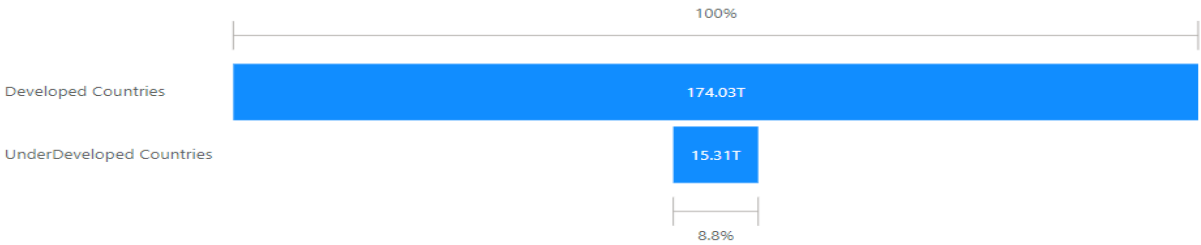
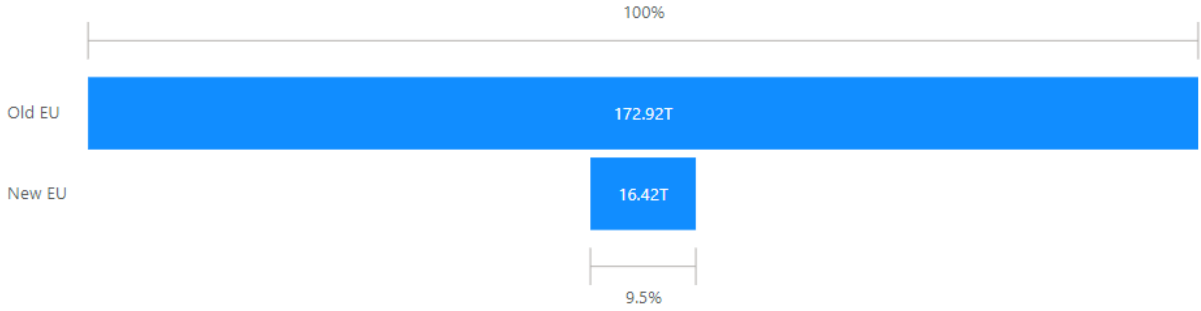


Figure 4.2.5 GDP by Reformation Class



Using GDP measure in both Figures 4.2.4 and 4.2.5, it looks like most of the OLD EU converge to be the Developed EU, and the New EU are converged towards the underdeveloped EU, this may be well defined, hence an interactive dashboard would be used to see which of these countries fall within this convergence. Interestingly, the unemployment rate of the Old EU and Developed EU is 2% higher than New EU and Underdeveloped EU. A more critical evaluation would be seen through the interactive dashboard.

5. Discussion

This section contains the critical evaluation and the approaches taken to properly tell the unemployment situation and trend in the EU countries. Building the dashboard, A considerate numbers of visualization is needed. Using Power BI, The percentage of total unemployment by countries, and the GDP per capita for these countries with other important variables. Here three to four navigations were used for telling the stories in a simplified way. However, major component was selected to form the dashboard needed to communicate key factors.

General statistics

From the build visualization pane, two stacked charts were selected, one of the charts was used to visualise the Total population by each country as shown in figure 5.1. This has been shown before in the previous section, however GDP per capita was also visualise by the stack chart as shown in figure 5.2. This shows the total GDP per capita for a selected country or choice to explore. Four cards were dragged to the pane to check unemployment at different level on each class. Percentage of unemployment with advanced education, percentage of unemployment with intermediate education, and percentage of unemployment with basic education. Slicer was introduced to filter the class and groups formed over time. Interesting insight that should be noted, Filtering the class to explore New EU, Ukraine has the highest total population of 448.30M within the time studied with GDP per capita close to 1.44T in dollars, unlike Poland whose population is almost twice Romania with the highest GDP per capita of 5.49T. In term of unemployment, the countries with the lowest population amongst the New EUs tends to have significant contribution to the total unemployment amongst the New EUs. Countries like Latvia, Cyprus, and Albania. This trend is also like the underdeveloped countries since most all New EU converged towards the underdeveloped EUs except Belarus. The Old EU on the other hand also tends to have similar stats with the developed EUs. This therefore tells that most New EUs and Underdeveloped EUs converged as well.

Figure 5.1 EU Total population by country

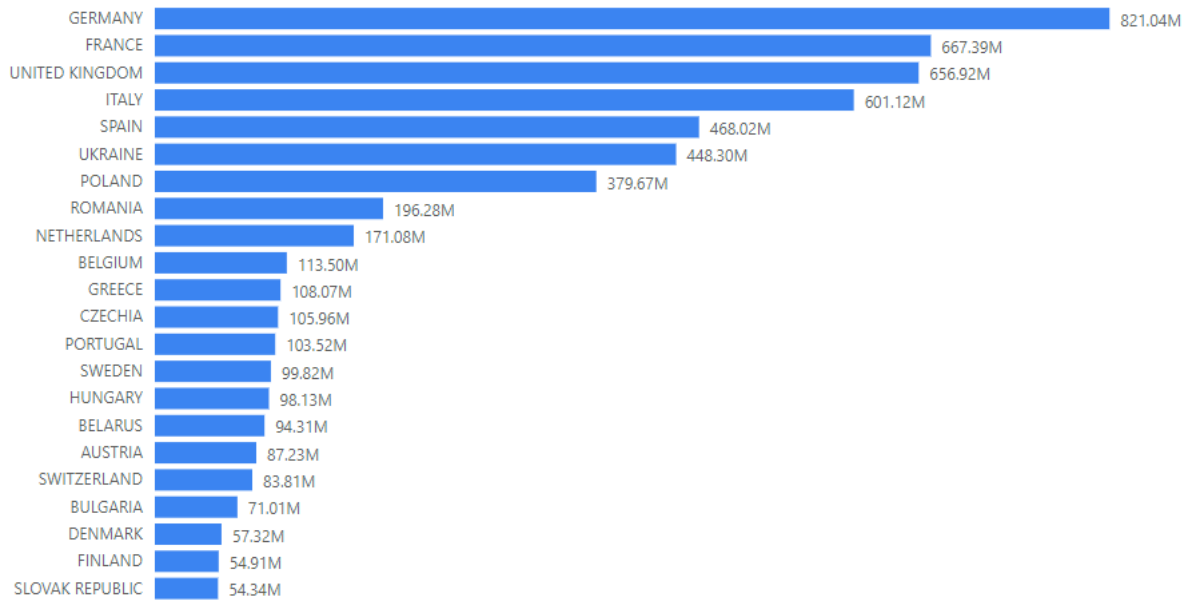
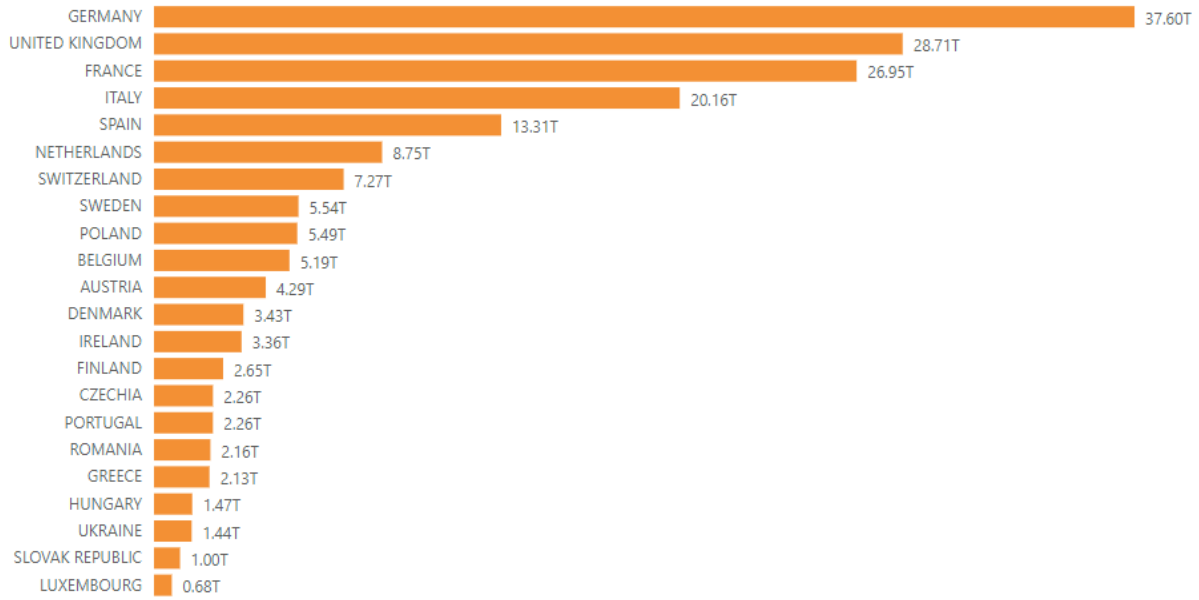
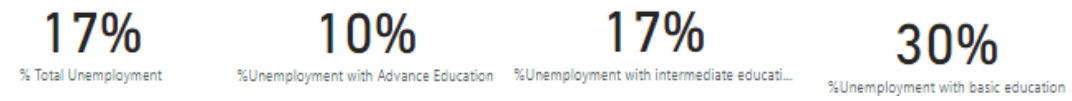


Figure 5.2 EU Total GDP per capita by country

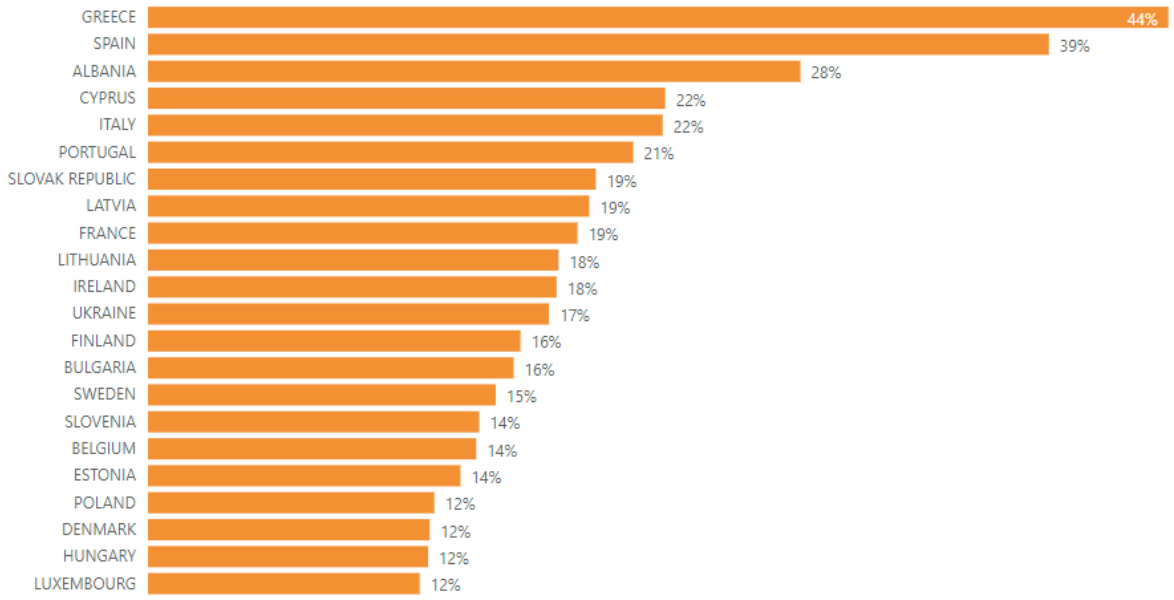




Unemployment Trends

From the build visualization pane, two area chart was dropped into the screen to visualise total unemployment by time and total population by time. While stacked bar chart to visualise the percentage of total unemployment by country used as shown in figure 5.3. Four cards were used for the following metric, total unemployment, total population, percentage of total unemployment and GDP per capita. Slicer was included to filter down the story and find insight. The Unemployment trend over the 10 years in New EUs group was like Underdeveloped EUs group. Belarus over the last ten years has decrease in population with a slight decrease in unemployment over the past ten years. This could mean the increase population for Belarus doesn't really affect the unemployment rate compared to Albania whose unemployment rate decreases as their population decreases. Unlike some countries who converges under the developed and Old EU group, their unemployment rate was observed to decrease with an increase in total population. Sweden stood out different as the increase in the total population shows an increase in their unemployment, this difference started in 2018 till 2021. More insight would be seen in the dashboard designed.

Figure 5.3 Percentage of Total Unemployment by country



Unemployment Vs Employment Distribution

From the visualization pane, two donut charts were used to visualise the unemployment rate distribution and employment rate distribution amongst the four classes as shown in figure 5.4 and 5.6. In addition, Total Unemployment by year and total population by year was also added to the screen. For New EU, there was a high unemployment rate with basic education and high employment rate industry. For Old EU, this rate of unemployment with basic education is like that of the New EU. This is also the same with developed and underdeveloped EU. There was more employment in the industry compared to service and Agriculture. The population trends for the developed EU were found to be in opposition to the underdeveloped.

Figure 5.4 Unemployment Education Distribution

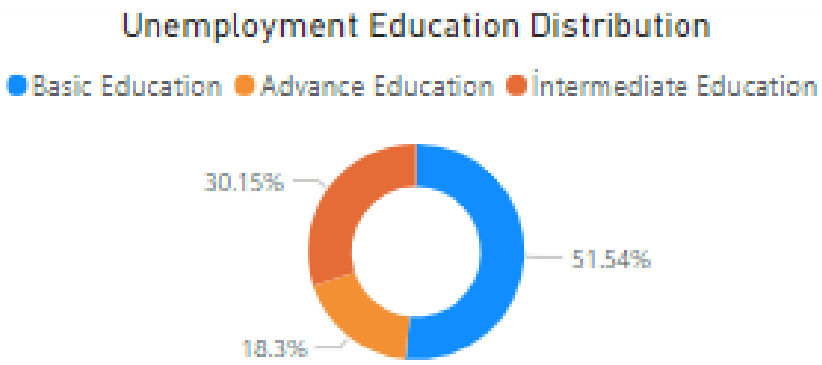
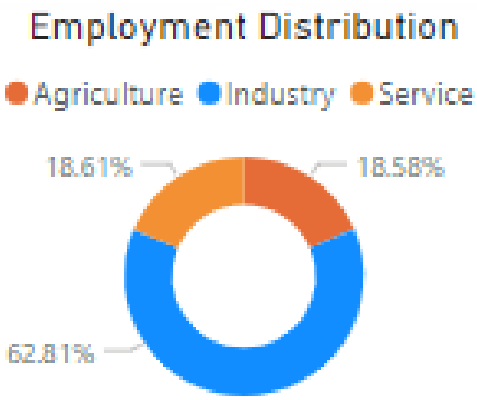


Figure 5.5 Employment Distribution



Forecasting

Forecasting unemployment rates can be a complex task, as it involves predicting future economic conditions and their impact on the labour market. There are many factors that can affect unemployment rates, including economic growth, job creation, and changes in the overall labour force. To forecast unemployment rates, analysts typically use a combination of economic data, such as GDP growth rates and job creation figures, as well as other factors such as consumer confidence and inflation rates. Additionally, they may use statistical models and historical data to help make their predictions. However, only population growth and GDP per capita has been considered. Using the Line chart, using the feature that allows further analysis – Forecast, setting the Units to points, forecast length to 10 and setting the confidence interval to 99%. Figure 5.6 shows the forecast in 10 years

Figure 5.6 Forecast of Total Percentage of unemployment by Time

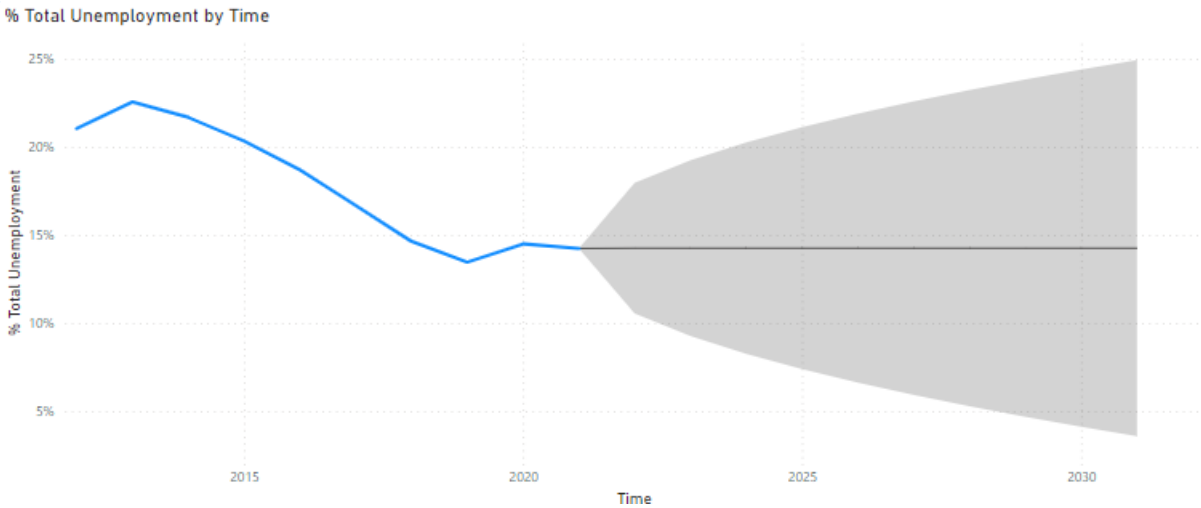
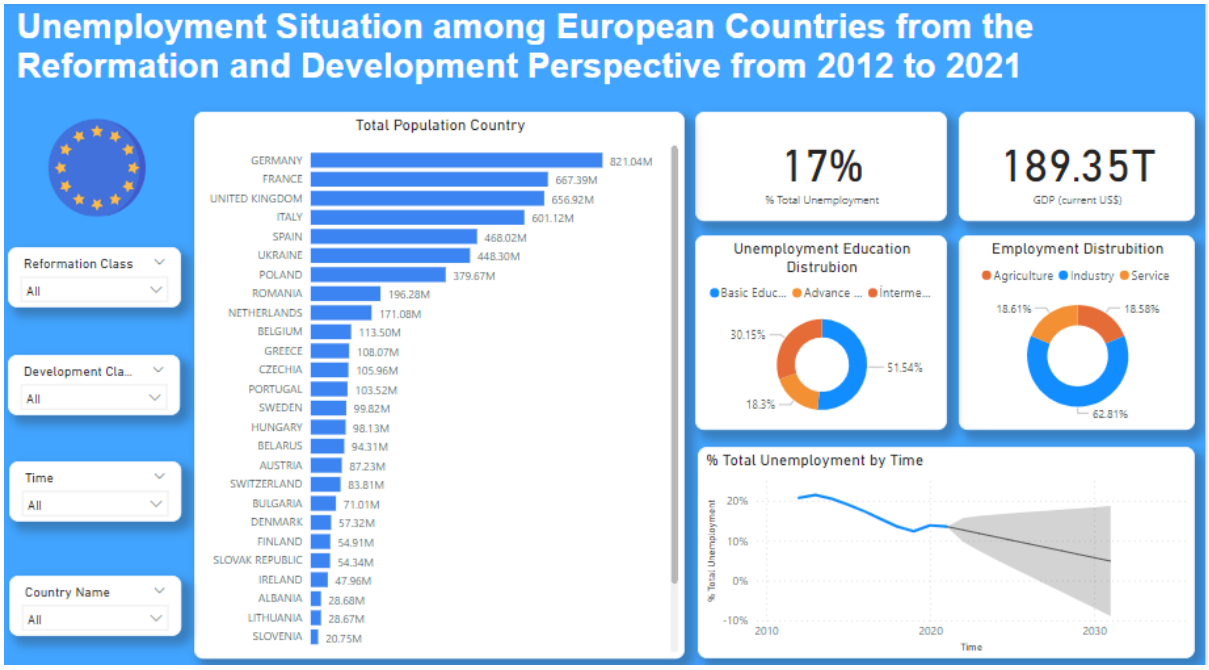


Figure 5.7 Interactive dashboard design for Unemployment situation in EU countries (Reformation and Development)



6. Conclusions

Through this project and the formation of interactive dashboard design as shown in figure 5.7, I hoped to shed more insight into the unemployment situation in EU countries by classifying them into four groups under two class. And, to forecast reformation and development on unemployment in EU based on population growth, and GDP per capita. This is to inform the implementation of employment strategy in EU and focuses on the root where there is a high unemployment rate. There was a similar trend for the New EU and Underdeveloped EU. A forecast shows there would be around 7% unemployment rate for the New EU in 2025, for the Underdeveloped, it was predicted to be around 8%. Old EU also has this similar trend with Developed EU, the forecast shows Old EU would be around 14% and Developed EU would be around 14% as well. The increase is twice of what was observed for both New EU and Underdeveloped. And can be explained since more New EU member states who are underdeveloped would likely converge towards the development class. The impact of the introduced employment strategy on the EU was on all the classes and the underdeveloped group moves towards developing group. However, seeing a high rate of unemployment coming from the groups of people with basic education, and high employment in industry, an interest should be either on encouraging a strategy that enforces more employment in service and agriculture. The question about employment strategy impact on reformation and development in the EU is there satisfied and answered. Either New EU or Old EU, there is a convergence where the underdeveloped move towards the Old EU group.

Part Two:

A Statistical Approach to Understanding the Unemployment Situation Among European Countries from the Reformation and Development Perspective

1. Introduction

Unemployment is a key indicator of a country's economic health. A high employment rate indicates that a larger number of people are earning a living according to the country's standards and their own capabilities. Conversely, a high unemployment rate indicates that a larger number of people are not earning a living according to these standards and their own desires and abilities. However, there are quite a good number of explanations given to unemployment, Muhammed et al (2014), According to the International Labour Organization (1996), unemployment is measured annually as the percentage of the labour force that is unable to find work. Unemployment is defined as being without a job and actively searching for one in the last four weeks or being available to work within the next two weeks. This definition applies to individuals aged 16 or older. Studies have been carried out by many researchers to investigate the different factors that causes unemployment, and other have caried out impact of these factors statistically on unemployment. As a further study to the previous exploration of unemployment rate in two class of the EU countries created, population and GDP tend to be+ a factor of interest to consider. It is commonly said and according to researchers that one of the factors that influences unemployment is the growth in economy. In theory, a significant rise in rate of economic development can lead to a reduction in unemployment as businesses and the government become more capable of creating jobs. This is because a growing economy typically leads to increased demand for goods and services, which can create new job opportunities.

Unemployment is a serious problem for any country, as it can lead to social unrest, political unrest, poverty and more crime. For this reason, it is important to continually attend to the issue of unemployment. There are many factors that can contribute to high unemployment rates, and these causes can vary depending on the specific situation and context. In order to effectively address unemployment, it is

important to understand the underlying causes and take appropriate action to address them.

The aim of this research was to analyze the relationship between population growth, GDP, and unemployment in two classes of EU countries: the Reformation class and the Development class. For this purpose, with the help of descriptive statistical analysis, regression analysis and time series analysis I will identify which class had the highest correlation to unemployment from the economic factor view since population growth and GDP would be used as the factor for efficient decision-making regarding measures to be taken for each class.

2. Background Research

Other research has been conducted in areas similar to this work. However, much of the existing research focuses either on the growth of unemployment rates in the EU, or on comparisons with other countries. Most of the factors being considered are also woven around the economic factor and only few as read focuses on another factor such as educational factor. There are not many existing studies that statistically analyse the unemployment rate from the development of EU and its reformation standpoint. Of course, there are some who address this from the developed and underdeveloped perspective. Other who handled this studied merely analysed the impact of these factor on the EU countries from the reformation perspective.

The initial part of my background investigated will briefly focus on proof of similar literature and the second strand focus specifically on the reviews which seem to be related to previous research work that focus on EU.

In a study conducted by Bhally et al in 2013, the factors that influence unemployment in Pakistan were examined using data from 1976 to 2012. The study analyzed data on various economic indicators, including unemployment, population, foreign direct investment, gross domestic product, inflation, and external debt. The findings showed that GDP, population, inflation, and foreign direct investment all have a significant impact on unemployment in both the short and long term. These results suggest that policymakers should take these factors into account when developing strategies to address unemployment.

Gorlich et al (2013) noted that there is a general agreement on the various causes of unemployment, with economic growth and GDP being particularly influential. The unemployment rate tends to fluctuate along with the state of the economy. Many studies have shown that there is a negative relationship between unemployment and real GDP. This indicates that an increase in real GDP is likely to be accompanied by a decrease in the unemployment rate. Arthur Okun in the 20th century developed the idea that 1% increase in unemployment causes a 2% fall in GNP (which is a part of the GDP). He made clear that the changes in output are associated with changes in labor force participation, changes in number of hours worked per person and changes in productivity (Okun, 1962).

Laku and Deda in their 2013 study, explored the relationship between unemployment and population growth in Kosovo. They discussed the current state of the labor market in Kosovo, including existing policies and their impact on employment. Through the use of tables, they highlighted the disproportionate impact of unemployment on young people. The rates of both urban and rural unemployment are increasing and pose a significant threat to the younger generation and overall social and economic development. The study also found that the population of Kosovo is growing year over year, with over 60% of the population being of working age. The authors suggest that urgent action is needed from the government to address this issue, as an increasing population should not be accompanied by rising unemployment.

Orumie (2016) used multiple regression models to investigate the relationship between unemployment, population growth, and gross domestic product. The results of the study showed that since 1970, the unemployment rate and population have increased while gross domestic product has declined. The findings also indicate that both unemployment and population growth have a significant impact on gross domestic product, with unemployment having a slightly larger effect. The results of the study are in line with previous research on the topic. Bernd and Wolfgang (2003) used correlation analysis to investigate and assess subjective economic well-being in Eastern Europe from 1991 to 1995. At the end of their study, they compared the indicators of subjective and objective well-being at a macro level and found that using a standard macro variable like real GDP per capita for cross-country comparisons of well-being can be misleading during the early stages of transformation.

Shegay et al (2015) likewise in their study analysed the reason for unemployment situation in Europe in 2012 with the help of regression analysis they identified the factors which had the highest correlation with unemployment level. The analysis they performed was in three separate blocks – Economic factors, educational factors, and Demographic factors. According to their regression analysis, economic factors were proven to be overall significant, as all the alternative hypotheses were accepted mainly because of the share price index, general government deficit/surplus and share of employees in research and development. In Shegay et al (2015) summary, the economic and the demographic blocks had more significant results than educational block. Nevertheless, it doesn't mean that the education should not be considered.

3. Exploration of Data Set

The following dataset contains information on 30 EU countries altogether, two classes have been created to further investigate which of the EU class has the correlation with unemployment rate from the economic factor. Under each class are two sub-class or sub-group, making four groups as extracted from the previous study under visualization. Reformation class with two sub-class of the EU countries namely, New EU and Old EU, and the development class with two sub-class namely, Developed EU and Undeveloped EU. As this tends to investigate further the impact of economic variables on unemployment in these two classes or group: reformation and development class (RC and DC).

3.1 Data preparation

To see the impact of these economic variables, the last year has been chosen from the dataset. The data used in this study were obtained from the World Bank and include unemployment rates, population totals, and GDP per capita. Unemployment is measured as a percentage of the total labor force using the International Labor Organization's estimates, while population is measured as the total number of people. GDP per capita is expressed in current US dollars.

Unemployment is a negative phenomenon in any human society as it's adversely affected in different dimension and directions. Thus, the main independent variables used as the economic variables for this investigation and analysis are

population growth which is measured as total population at a given period, Gross domestic product (GDP) which represents the sum of added value by all its producers. The dependent variable is the unemployment rate. 2012 to 2021 time series data was retrieved. However, for this study and analysis data from 2021 was chosen for specific analysis. And 10 years was chosen for the time series analysis.

For the selected time frame, no value was found missing, table 3.1 shows the classifications and the data variables used.

Table 3.1 Countries Classification

EU Countries	Old-EU	New-EU	Underdeveloped EU	Developed EU
Albania	Austria	Bulgaria	Bulgaria	Austria
Austria	Belgium	Cyprus	Czechia	Belgium
Belarus	Denmark	Czechia	Estonia	Cyprus
Belgium	Finland	Estonia	Hungary	Denmark
Bulgaria	France	Hungary	Latvia	Finland
Cyprus	Germany	Latvia	Lithuania	France
Czechia	Greece	Lithuania	Poland	Germany
Denmark	Ireland	Poland	Romania	Greece
Estonia	Italy	Romania	Ukraine	Ireland
Finland	Luxembourg	Slovak Republic	Albania	Italy
France	Netherlands	Slovenia	Belarus	Luxembourg
Germany	Portugal	Albania		Netherlands
Greece	Spain	Ukraine		Portugal
Hungary	Sweden			Slovenia
Ireland	United Kingdom			Spain
Italy	Belarus			Sweden
Latvia	Switzerland			United Kingdom
Lithuania				Slovak Republic
Luxembourg				Switzerland
Netherlands				
Poland				

Portugal
Romania
Slovak Republic
Slovenia
Spain
Sweden
Switzerland
Ukraine
United Kingdom

3.2 Outlier detection

Knowing that outliers are extreme values that differ from most other data points in a dataset, they can have big impact on the statistical analyses and skew results of my hypothesis tests. Carefully identifying the outliers would help to make proper assumptions and summary of findings. Using Boxplot on all the independent variables and dependent variable Unemployment rate, The EU countries tends to have significant number of outliers most of which are from the independent variables, GDP per capita and Total population. As showed in Figure 3.2.1 below. All outliers were retained because they lined up with other measurements taken from the same dataset.

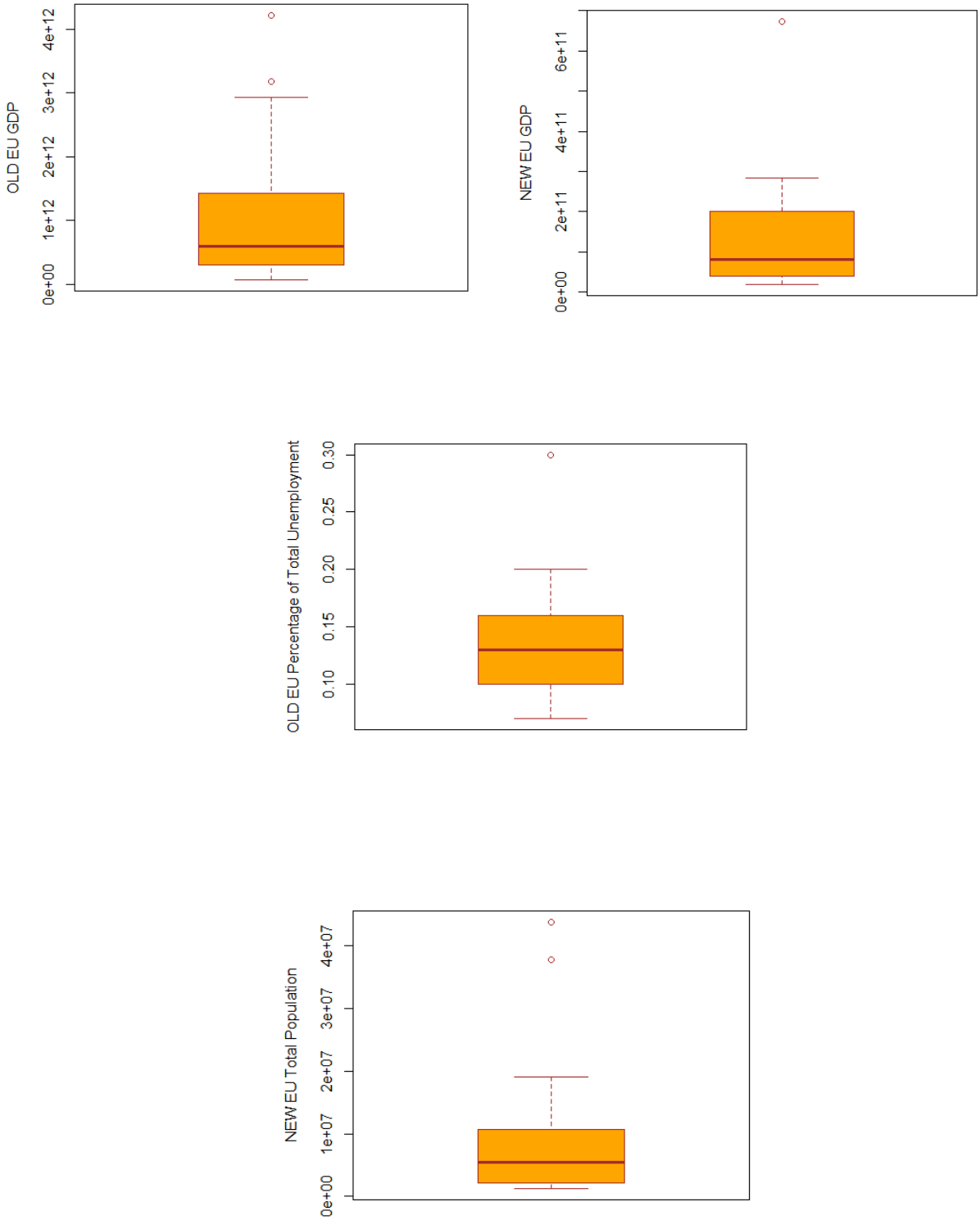


Figure 3.2.1 Outliers under reformation class variables

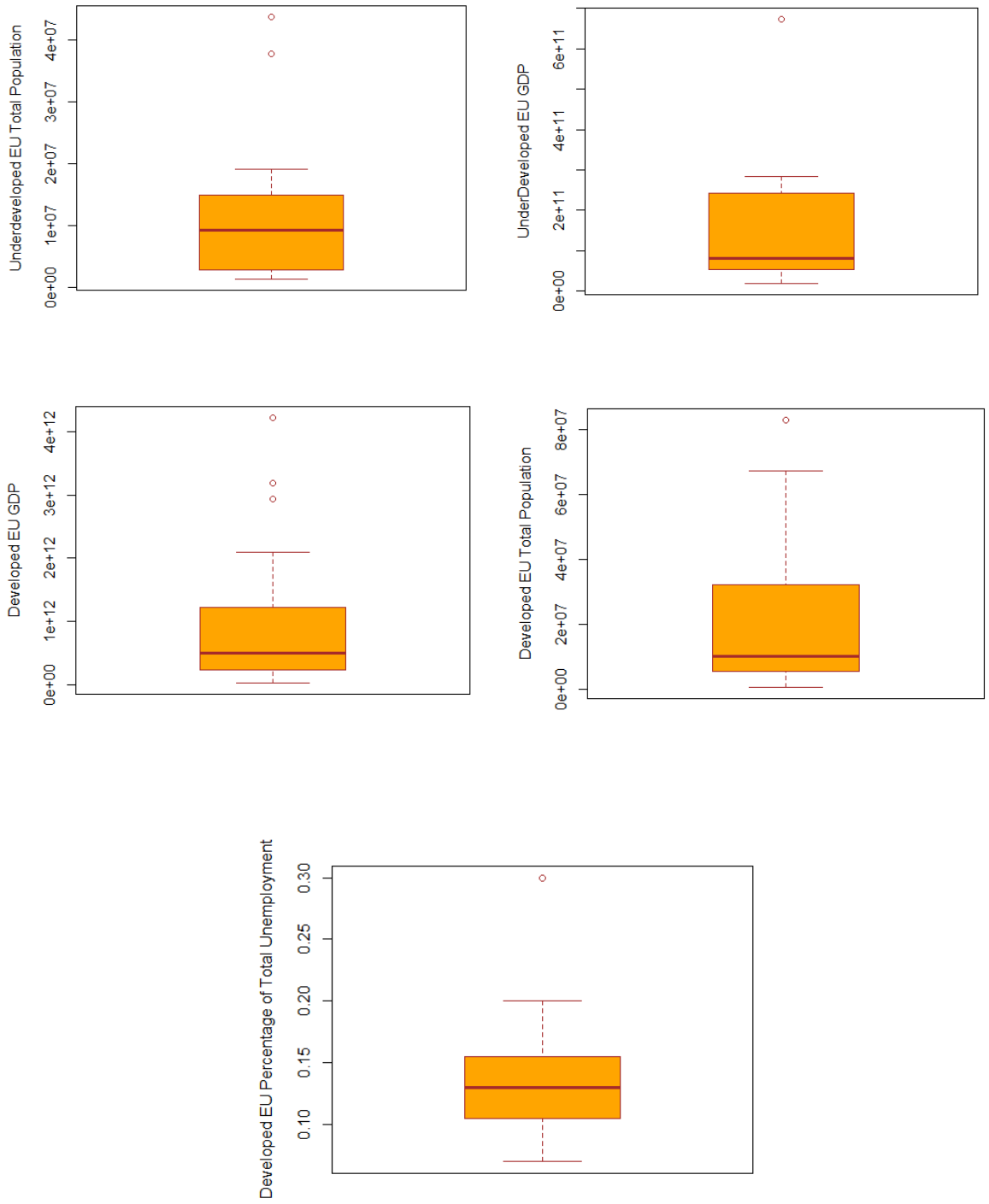


Figure 3.2.1 Outliers under development class variables

3.3 Dealing with missing data.

The dataset and the timeframe chosen has all needed data for analysis, hence working on missing data was not needed in this case.

4. Analysis

4.1 Descriptive Statistical Analysis

The results of the estimations and descriptive statistics for the dependent and independent variables for the two classes studied are presented in this section. These statistics are for the grouped EU countries as follow: Development class contained Developed countries and Underdeveloped countries. The following values would be found using R on RStudio, the mean of variables, the median, mode, standard deviation, skewness, and kurtosis of each variable under each classification would be estimated and compared.

4.1.1 EU Reformation Class statistical and comparative analysis

The analysis shows that the average unemployment rate for the New EU countries is around 0.12 (12%) and the average population is around 1.12E+7. The average GDP per capita is approximately 1.59E+11. The total population for the New EU is positively skewed, as indicated by the positive skew coefficient (approximately 1.5) and positive kurtosis (approximately 3.8), However the GDP for New EU is also positively skewed having an approximate coefficient of 1.9 and kurtosis of 6.1. The unemployment skewness is also positive with an approximate coefficient of 0.8 and its kurtosis is 3.2 as showed in Table 4.1.1

For the Old EU Countries, the average unemployment rate is observed to be 0.14 (14%), while that of the total population in this group is 2.5E+7. The average GDP per capita is approximately 1.13E+12. The Total population for the Old EU shows a positive skewness as well as other variables, as showed in the Table 4.1.2

Table 4.1.1 Descriptive Statistics for Old EU group

NEW EU	**UNEM**	**TPG**	**GDP**
Mean	0.1262(13%)	11200958	1.589e+11
Median	0.1200(12%)	5447247	8.027e+10
Maximum	0.2400(24%)	43814580	6.740e+11
Minimum	0.0600(6%)	1215588	1.826e+10
Skewness	0.7	1.51	1.9
Kurtosis	3.2	3.8	6.1
Jarque-Bera	1.3004	5.2765	13.219
P-Value	0.5219	0.07149	0.001348

Table 4.1.2 Descriptive Statistics for Old EU group

OLD EU	**UNEM**	**TPG**	**GDP**
Mean	0.1441(14%)	25229956	1.131e+12
Median	0.1300(13%)	10415811	5.999e+11
Maximum	0.3000(30%)	83129285	4.223e+12
Minimum	0.0700(7%)	639070	6.822e+10
Skewness	1.4	1.03	1.33
Kurtosis	4	2.39	3.52
Jarque-Bera	6.0712	3.2899	5.236
P-Value	0.04805	0.193	0.07295

4.1.2 EU Development Class statistical and comparative analysis

The analysis reveals that the average unemployment rate for the Developed EU countries is around 0.14 (14%) and the average population is around 2.25E+7. The average GDP per capita is approximately 1.019E+12. The total population for the Developed EU is positively skewed, as indicated by the positive skew coefficient (approximately 1.18) and positive kurtosis (approximately 2.7), However the GDP for Developed EU is also positively skewed having an approximate coefficient of 1.46 and kurtosis of 3.9. The unemployment skewness is also positive with an approximate coefficient of 1.5 and its kurtosis is 4.5 as showed in Table 4.1.3

For the Underdeveloped EU Countries, the average unemployment rate is observed to be 0.13 (13%), while that of the total population in this group is 1.3E+7. The average GDP per capita is approximately 1.76E+11. The Total population for the Underdeveloped EU shows a positive skewness as well as other variables, as showed in the Table 4.1.4

Table 4.1.3 Descriptive Statistics for Developed EU group

DEVELOPED EU	**UNEM**	**TPG**	**GDP**
Mean	0.1426(14%)	22544146	1.019e+12
Median	0.1300(13%)	10299424	4.986e+11
Maximum	0.3000(30%)	83129285	4.223e+12
Minimum	0.0700 (7%)	639070	2.772e+10
Skewness	1.50	1.18	1.46
Kurtosis	4.5	2.74	3.94
Jarque-Bera	9.0789	4.4497	7.4406
P-Value	0.01068	0.1081	0.02423

Table 4.1.4 Descriptive Statistics for Underdeveloped EU group

UNDERDEVELOPED EU	**UNEM**	**TPG**	**GDP**
Mean	0.1255(13%)	13289357	1.755e+11
Median	0.1100(11%)	9340314	8.027e+10
Maximum	0.2400(24%)	43814580	6.740e+11
Minimum	0.0600(6%)	1329255	1.826e+10
Skewness	1.4	1.03	1.33
Kurtosis	4	2.39	3.52
Jarque-Bera	6.0712	3.2899	5.236
P-Value	0.04805	0.193	0.07295

4.2 Correlation Analysis

This section presents the step and results of the correlation analysis performed in this study. However, it is important to know the reason for this analysis was to see, compare the findings amongst the selected EU countries and select best fit for the regression model. New dataset was created for all extracted numerical variables to build correlation matrix with a prefix 'Reduced'. The hypothesis formed is as follow:

H0: There is no reasonable impact of Total Population and GDP on unemployment rate in New EU, Old EU, Developed and Underdeveloped EU countries.

H1: There is reasonable impact of Total Population and GDP on unemployment rate in New EU, Old EU, Developed and Underdeveloped EU countries.

Using corrplot to plot and visualize the correlation between all the variables on all the EU group reduced data set, the correlation between the variable is shown in table 4.2

Table 4.2 Pearson Correlation between variables

PEARSON CORRELATION	**UNEM**	**TPG**	**GDP**
Reduced New Eu	1	-.1**	-.5**
Reduced Old Eu	1	.04**	-.14**
Reduced Developed Eu	1	.06**	-.11**
Reduced Underdeveloped Eu	1	-.14**	-.53**

The above analysis shows the New EU and Underdeveloped EU has a strong negative correlation result which can be used for the regression model and other findings. Whilst it is important to note a positive yet major similarity in the correlation results for Old EU and Developed EU, this could be used as well to form another model for these two classes. Hence, all results are considered useful for the multiple linear regression model.

4.3 Regression Analysis

The model draws on previous research that defines unemployment as a function of total population and views GDP per capita in a similar way. (Belen et al 2015). Since only two independent variables are said to be correlated with unemployment, As assumed by other researchers, there is a relationship between Unemployment (dependent variable) and Population growth and GDP which are the other two independent variables. Hence the formula used is valid:

$$yi = \beta 0 + \beta 1x1i + \beta 2x2i + \cdots + \beta kxki + \varepsilon i$$

Then the fitted regression line based on the group created would be:

$$yi = \hat{\beta}0 + \hat{\beta}1x1i + \hat{\beta}2x2i + \cdots + \hat{\beta}\hat{k}xki = b0 + b1x1i + b2x2i + \cdots + bkxki$$

For each EU group to ensure accuracy the above model is developed,

Where yi = Unemployment Rate

$\beta 0 =$ intercept

$\beta 1 =$ Slope of $x1i$ where, $x1i =$ GDP,

$\beta 2 =$ Slope of $x2i$ where, $x2i =$ TPG

The following tables shows the regression analysis results

Variables Entered/Removed

Model	Variables Entered	Variables Removed	Method
1	GDP, TPG		Entered

Table 4.3.1 Model Summary for Reformation Class

Model	P-value	R Square	Adjusted R Square	Std. Error of the Estimate	vif
New EU 1	0.04836	0.4544	0.3452	1.522e-02	2.299578
Old EU 2	0.009312	0.4873	0.4141	1.735e-02	14.84018

Predictors: (Constant), GDP, TPG

Table 4.3.2 Model Summary for Development Class

Model	P-value	R Square	Adjusted R Square	Std. Error of the Estimate	vif
Developed EU 1	0.00089	0.5843	0.5324	1.328e-02	17.1673
Underdeveloped EU 2	0.1096	0.4246	0.2808	1.979e-02	2.116054

Predictors: (Constant), GDP, TPG

Table 4.3.3 Coefficients for Reformation Class

New EU

Model	Estimate	Std. Error	t value	Pr(>|t|)

(Intercept)	1.445e-01	1.522e-02	9.494	2.55e-06
Total_Population	2.287e-09	1.239e-09	1.845	0.0948
GDP_US_DOLLARS	-2.763e-13	9.694e-14	-2.850	0.0172

Dependent Variable: UNEM

Old EU

Model	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	1.457e-01	1.735e-02	8.395	7.78e-07
Total_Population	6.501e-09	1.820e-09	3.572	0.00307
GDP_US_DOLLARS	-1.464e-13	4.020e-14	-3.642	0.00267

Dependent Variable: UNEM

Table 4.3.4 Coefficients for Development Class

Developed EU

Model	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	1.444e-01	1.328e-02	10.871	8.49e-09
Total_Population	7.422e-09	1.583e-09	4.688	0.000247
GDP_US_DOLLARS	-1.660e-13	3.514e-14	-4.723	0.000230

Dependent Variable: UNEM

Underdeveloped EU

Model	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	1.451e-01	1.979e-02	7.329	8.16e-05
Total_Population	1.961e-09	1.440e-09	1.362	0.2104
GDP_US_DOLLARS	-2.602e-13	1.097e-13	-2.372	0.0451

Dependent Variable: UNEM

From the regression and correlation analysis, this is obvious that there is a good correlation between Unemployment and Population and GDP for both Old EU and Developed EU compared to New EU and Underdeveloped EU. From the Pr(>|t|)

column for all the EU classes, all the three coefficients are significant at the 0.05 level even the intercepts for Old EU and Developed EU. Hence the model for Old EU and Developed EU is considered. The MLR equation which can be therefore used would be:

UNEM_reformation = 1.457e-01 - 1.464e-13*GDP + 6.501e-09 * TPG

And,

UNEM_development = 1.444e-01 - 1.660e-13*GDP + 7.422e-09* TPG

4.4 Time Series Analysis

Time series or forecasting means what will happen to the desired event in the future, which would have a lot of uncertainties, prior to the objective within the scope of work, this section shows the steps and different econometric time series models employed on the four EU groups: Holtwinters and Arima Models

The general form of the Holt-Winters model is written as:

Holt-Winters (l, s, b)

where l is the length of the level component, s is the length of the seasonal component, and b is a Boolean value that indicates whether the trend component is additive or multiplicative.

The specific equation used to make predictions using the Holt-Winters model is:

Y(t) = level (t) + trend(t) + Seasons(t)

where y(t) is the forecast value at time t, level(t) is the level component at time t, trend(t) is the trend component at time t, and season(t) is the seasonal component at time t. The values of level(t), trend(t), and season(t) are determined when the model fits to the time series.

Steps done in R:

Packages installed and libraries imported: stats, TTR and forecast and data were loaded. Different time series were plotted. The objective was defined, here

percentage of total unemployment and years was put in a new data frame. Time series was read. I converted the time series by finding out the natural log of the original data.

Decomposition and adjustment were performed using decompose. Prediction model for the log of yearly unemployment and forecast 4 years after the original data.

The general form of the ARIMA model is written as:

ARIMA (p, d, q)

where p is the order of the autoregressive component, d is the order of the integrated component, and q is the order of the moving average component.

The specific equation used to make predictions using the ARIMA model is:

$y(t) = c + \mu + \Sigma\ (p=1 \text{ to } p)\ \varphi(p)*y(t-p) + \Sigma(q=1 \text{ to } q)\theta(q)*\varepsilon(t-q)$

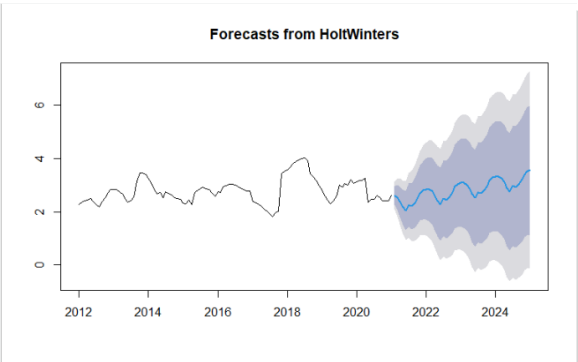
where y(t) is the forecast value at time t, c is a constant, μ is the mean of the time series, φ(p) is the coefficient for the pth autoregressive term, θ(q) is the coefficient for the qth moving average term, and ε(t) is the forecast error at time t. The values of c, μ, φ(p), and θ(q) are determined when the model is fit to the time series.

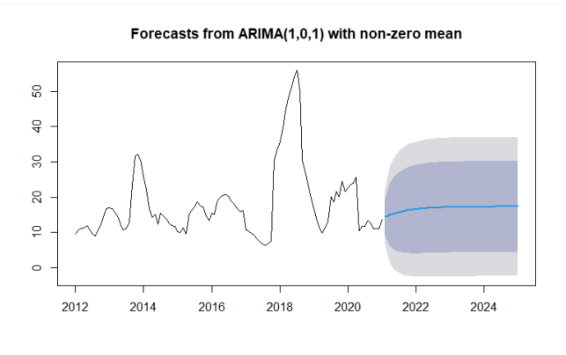
4.4.1 Time series Results for Development Class

Developed EU

	X squared	df	p-value	mean
Holtwinters	40.915	20	0.00382	-0.0277337
Arima (1,0,1)	55.048	20	4.039e-05	0.08340297

Variable: UNEM, Years

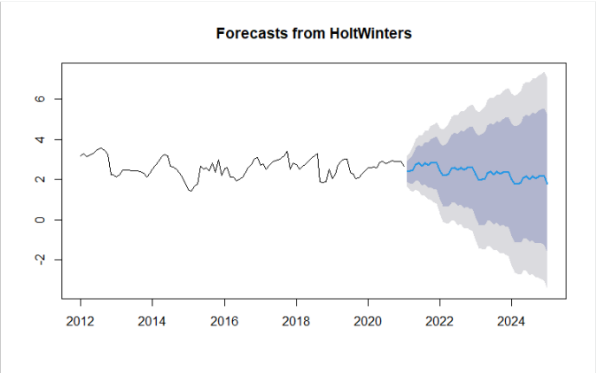




UnderDeveloped EU

	X squared	df	p-value	mean
Holtwinters	41.374	20	0.003334	0.05574218
Arima (1,0,0)	28.503	20	0.09802	-0.08714168

Variable: UNEM, Years



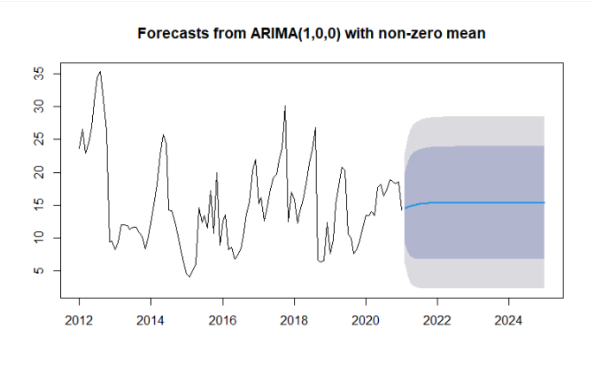
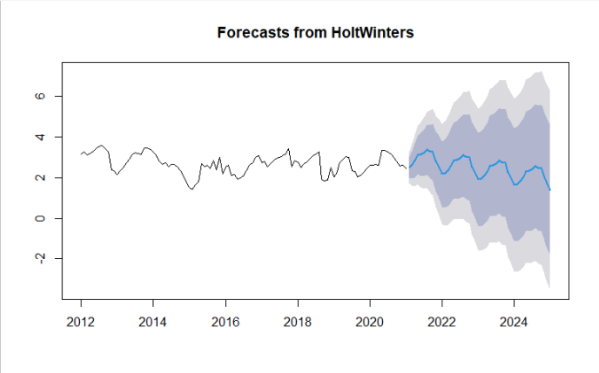


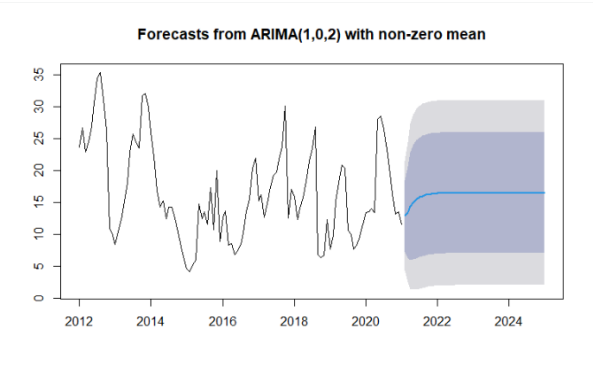
Table 4.4.2 Time series Results for Reformation Class

New EU

	X squared	df	p-value	mean
Holtwinters	48.078	20	0.0004149	0.02447
Arima (1,0,2)	14.036	20	0.09802	0.8286

Variable: UNEM, Years



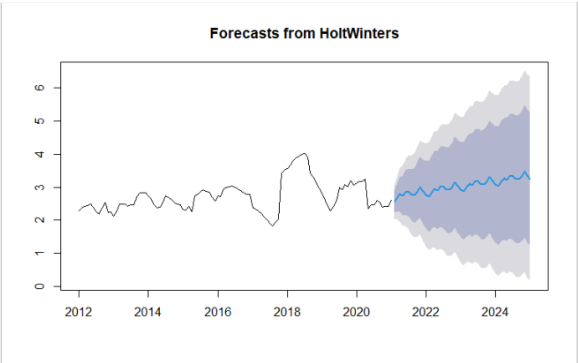


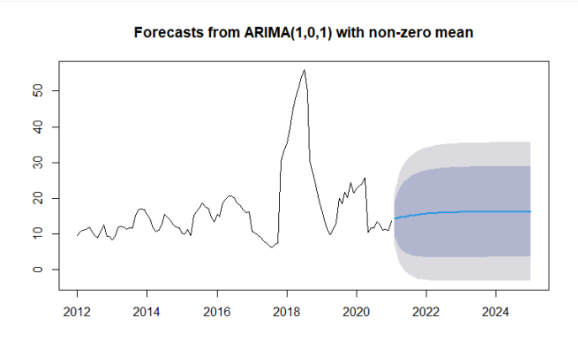
Old EU

	X squared	df	p-value	mean
Holtwinters	76.203	20	1.715e-08	-0.01039735

Arima (1,0,1)	67.786	20	4.169e-07	0.07649947

Variable: UNEM, Years





4.5 Decision on Hypothesis

Based on all the analysis, population growth and GDP per capita has great impact on unemployment rate in the Old EU and developed EU.

5. Discussion

In the multiple regression, R square is 48 per cent and 58 per cent for Old EU and Developed EU respectively, which means 58 per cent of unemployment development can be explained by the variables. The slight difference between R Square and adjusted R square is a good sign as it says R square is not only high because of the amount of variable but because of the quality of variables since the amount of variable used was not significant enough. For New EU and Underdeveloped EU, R square is 35 per cent and 42 per cent respectively, which also means for the underdeveloped EU, the variables tend to explain the unemployment rate than it does for the New EU. Belarus has observed in the previous study may be considered as the reason for this low R square gotten for the New EU. An Increase in the population does not necessarily affect the unemployment rate in Belarus. Hence, it is worth noting that the number of countries in a group doesn't mean a high or low unemployment rate, rather than the independent factors which are not considered in this study.

Forecasting the unemployment rate in the next four years, say 2025. For Old EU, Holtwinters and Arima were used, and the forecast error distribution were both roughly centroid on zero and is more or less normally distributed, although they seem to be slightly skewed to the right compared to a normal curve. However, the right skew

for Holtwinters is relatively small compared to that of Arima, hence it is plausible that the forecast error is normally distributed with mean zero as shown in figure 5.1 and 5.2. Holtwinters predict the unemployment rate in the Old EU group would be 3.25% in 4 years, Arima model could likewise be our best prediction from the analysis deduced from the first study. Table 5.1 and Table 5.2 shows the result for these two models for Old EU and Developed EU

Table 5.1 Old EU Unemployment in 2025

	Forecast	Lo (80)	Hi (80)	Lo (95)	Hi (95)
Holtwinters	3.25	1.22	5.28	0.14	6.359
Arima	16.28	3.64	28.92	-3.044	35.6

Table 5.2 Developed EU Unemployment in 2025

	Forecast	Lo (80)	Hi (80)	Lo (95)	Hi (95)
Holtwinters	3.56	1.143	5.977	-0.13	7.2
Arima	17.32	4.46	30.18	-2.34	36.9

Figure 5.1: Holtwinters forecast error for Old EU

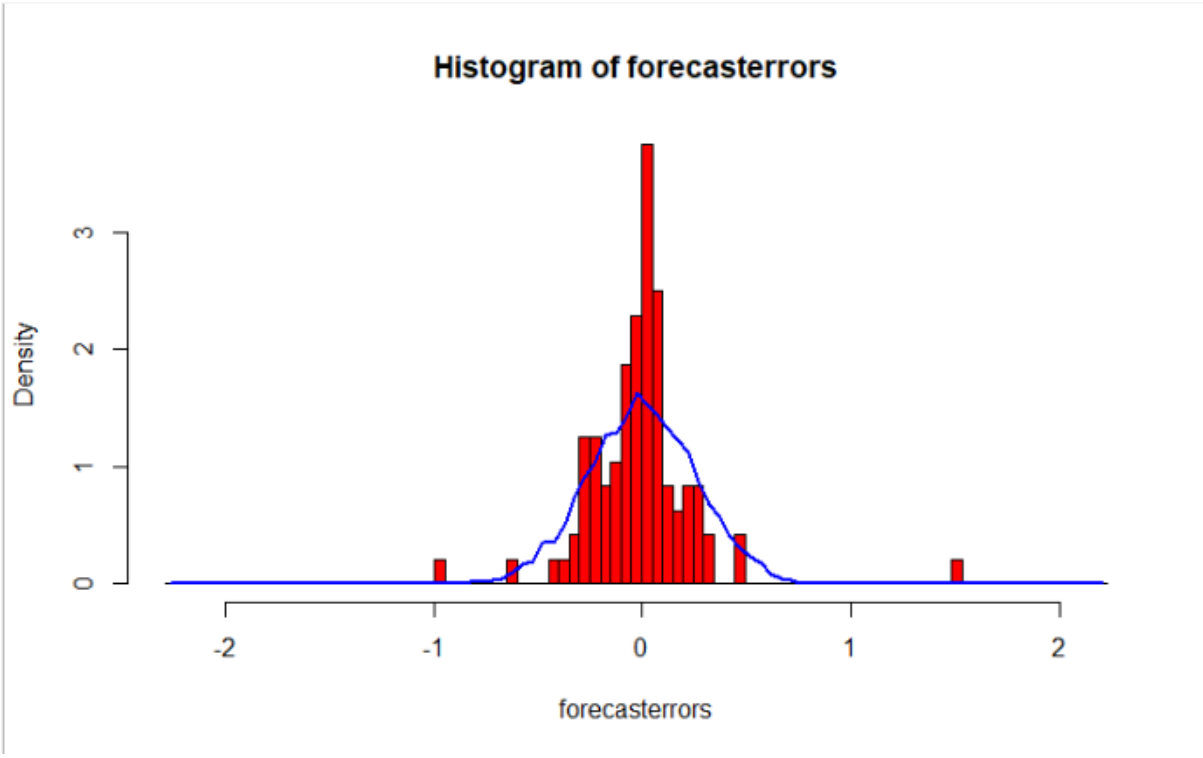
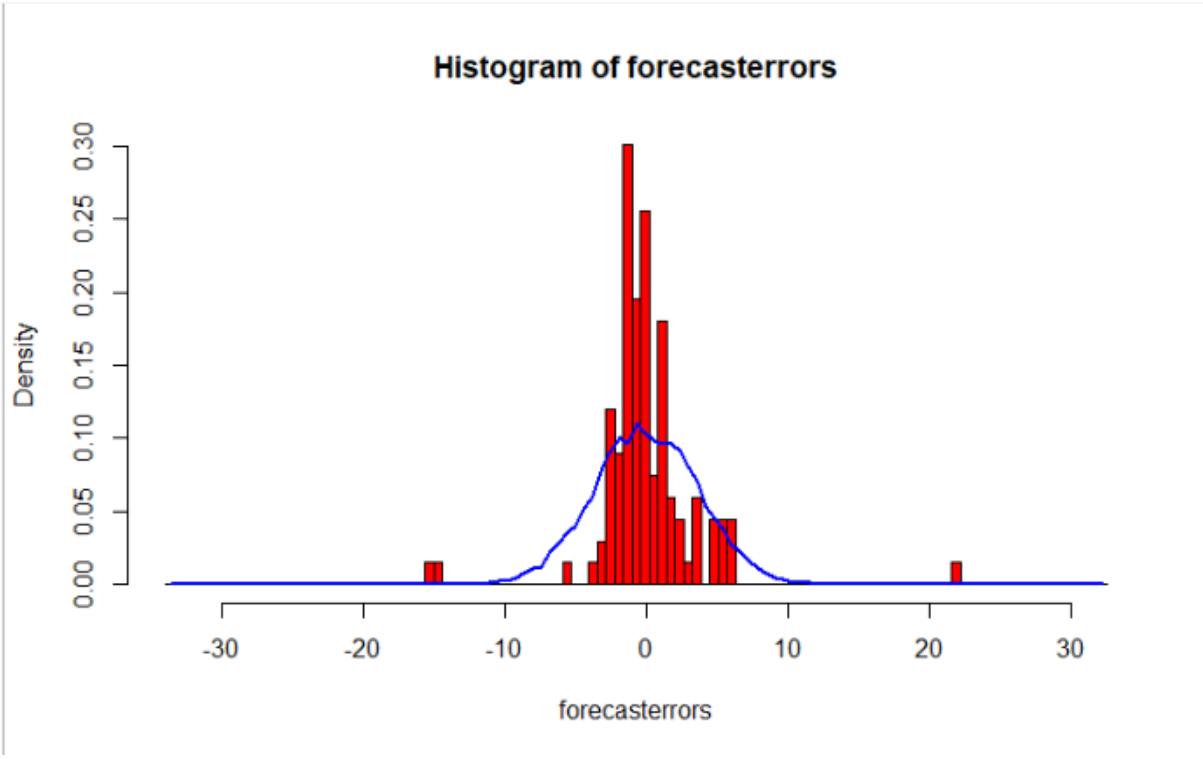


Figure 5.2: Arima forecast error for Old EU



At this point, little interest would be shown on New EU and Underdeveloped, since there was a doubt in the assumption which neglects the initial hypothesis, population growth or GDP doesn't significantly impact these group, other factors which are considered in this study may. However, forecasting the unemployment rate for these two similar groups, I found that Arima would be the best forecast model. New EU was predicted to have 16 per cent of unemployment rate in 4 years and Underdeveloped EU was likewise predicted to have 15 per cent. Eventually all EU group members would have an unemployment rate that is within 12 per cent to 30 per cent in 4 years.

6. Conclusions

Through this project I hoped to shed analyse and show the impact of population growth and GDP on the unemployment rate in EU countries, and to do this I decided to divide the union into four groups under two class, Reformation, and development class. Under reformation class there are two groups of EU which are New EU, and Old EU. And for the development class there are Developed EU and Underdeveloped EU. From the analysis performed, there was a strong impact of these variables considered on Old EU, and since most of the Old EU are also included in the developed EU, the impact was noted on the developed EU too.

The results were anticipated, the increase in GDP per capita, would cause unemployment to decrease and increase in population would cause a decrease in unemployment. Since was not a strong impact of these variables on the unemployment rate in New EU, this may inspire a new study that would consider more variables and factor that were not considered in this study.

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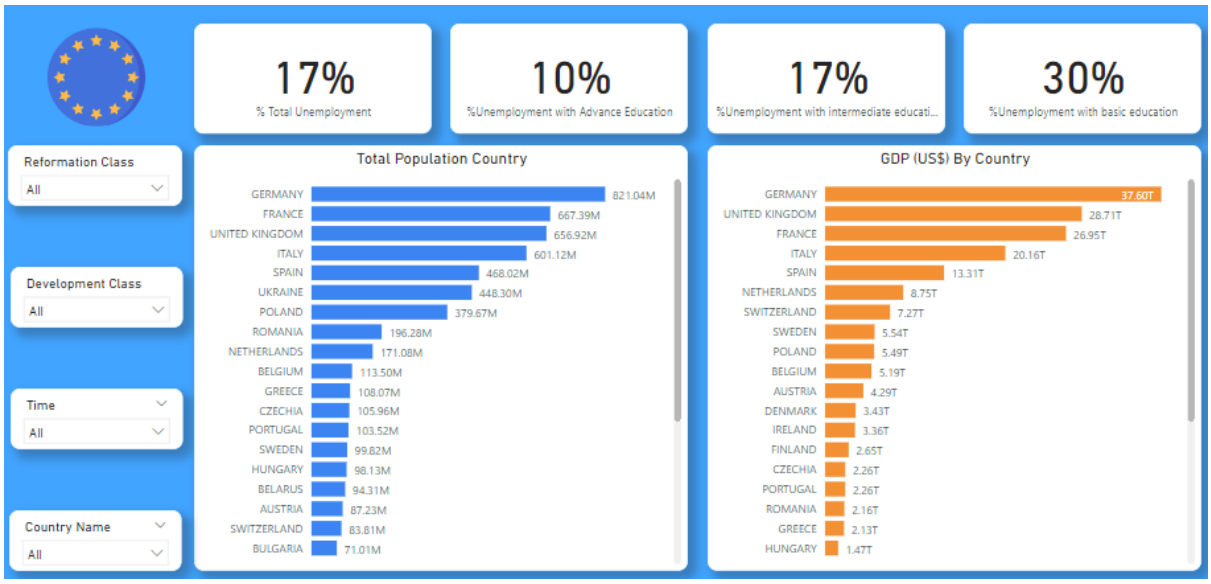
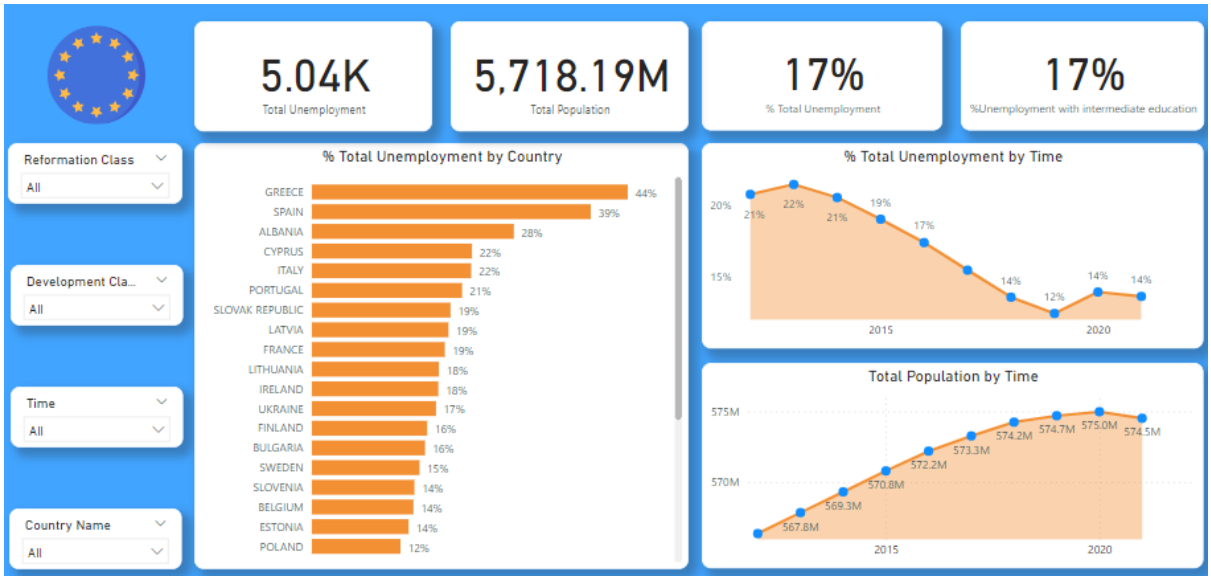
Appendices

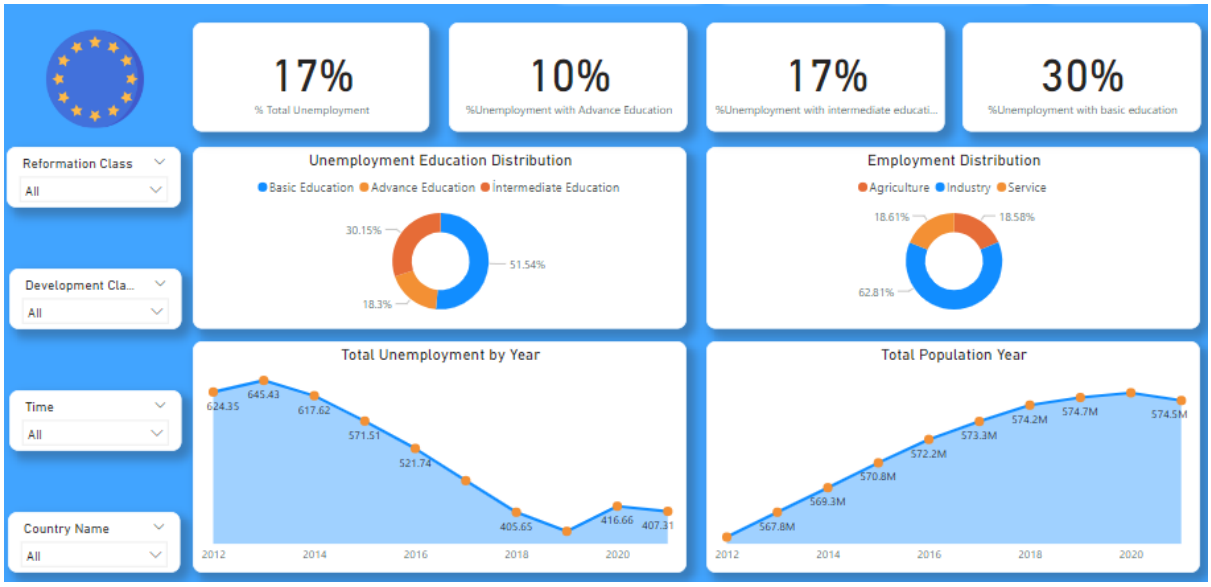
Appendix A – General statistics (Source: Self-created, Power BI)



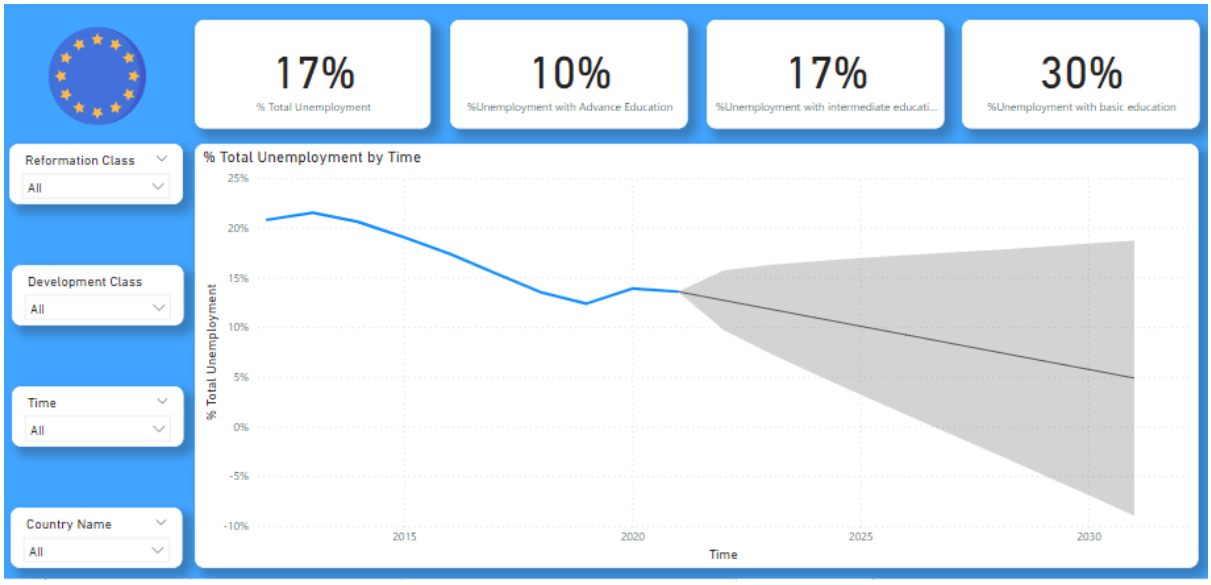
Appendix B – Unemployment trend (Source: Self-created, Power BI)



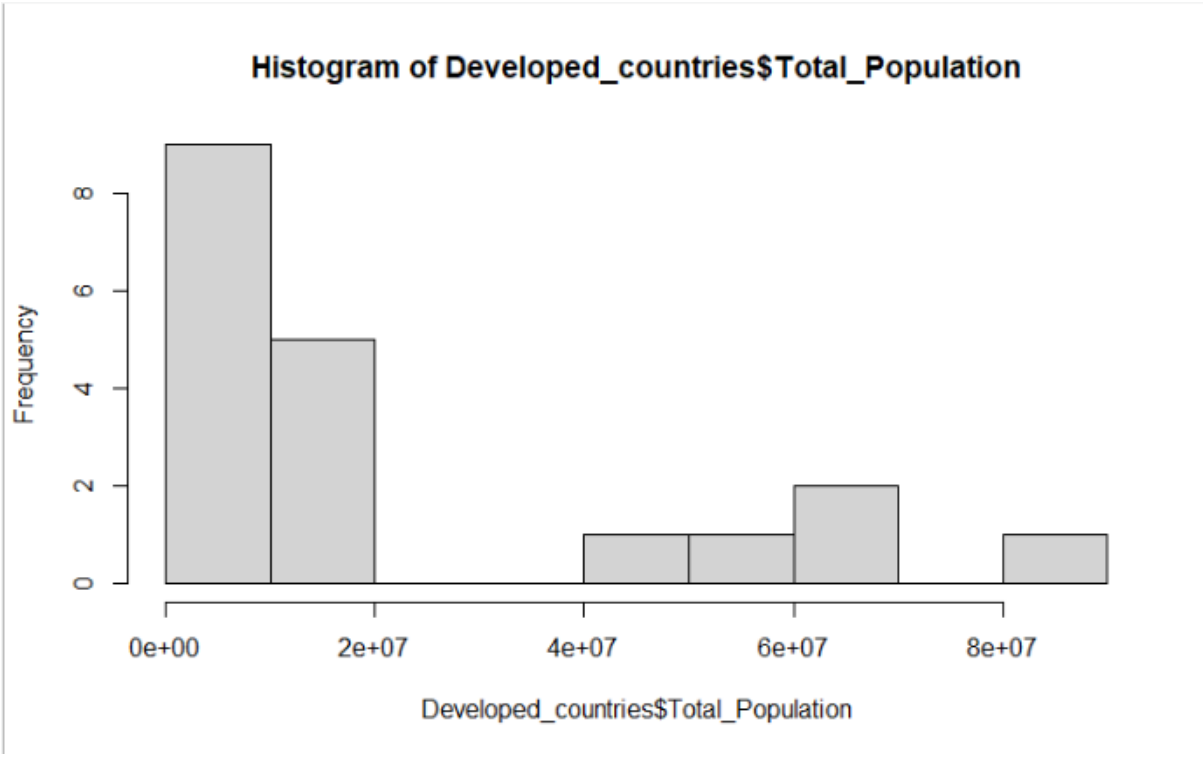
Appendix C – Employment and Unemployment Trends (Source: Self-created, Power BI)

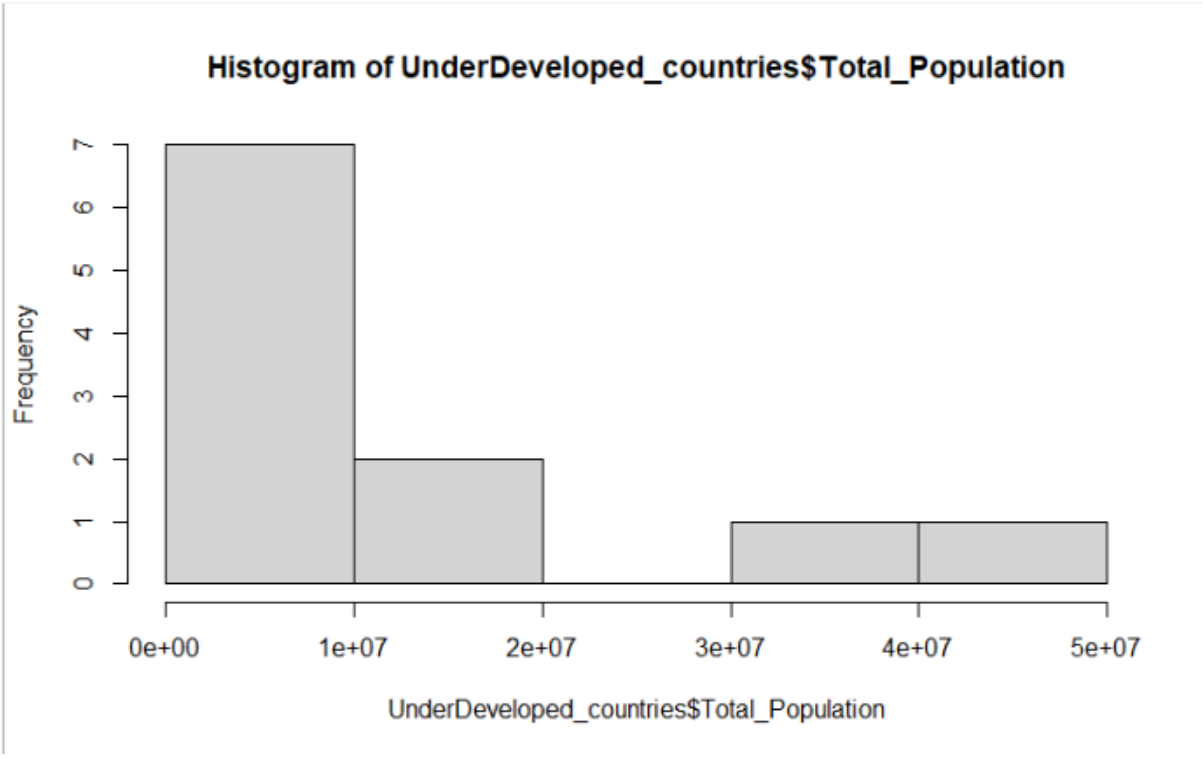


Appendix D – Forecasting (Source: Self-created, Power BI)

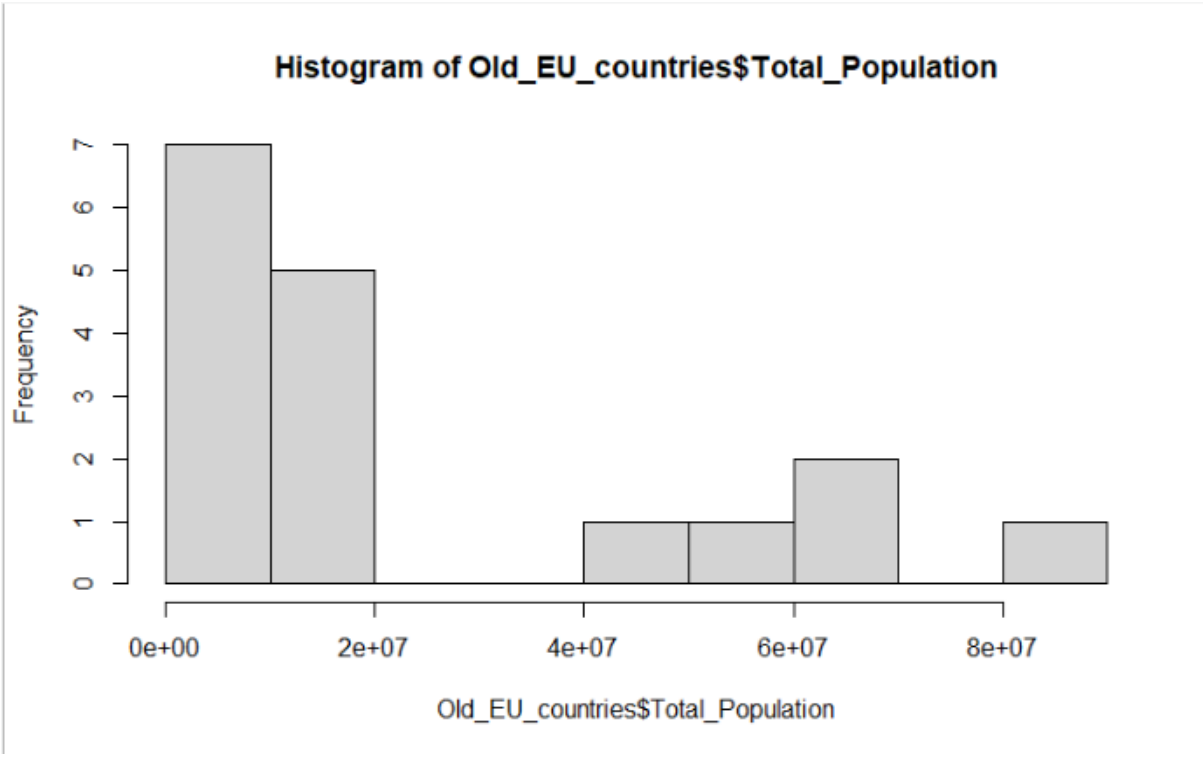


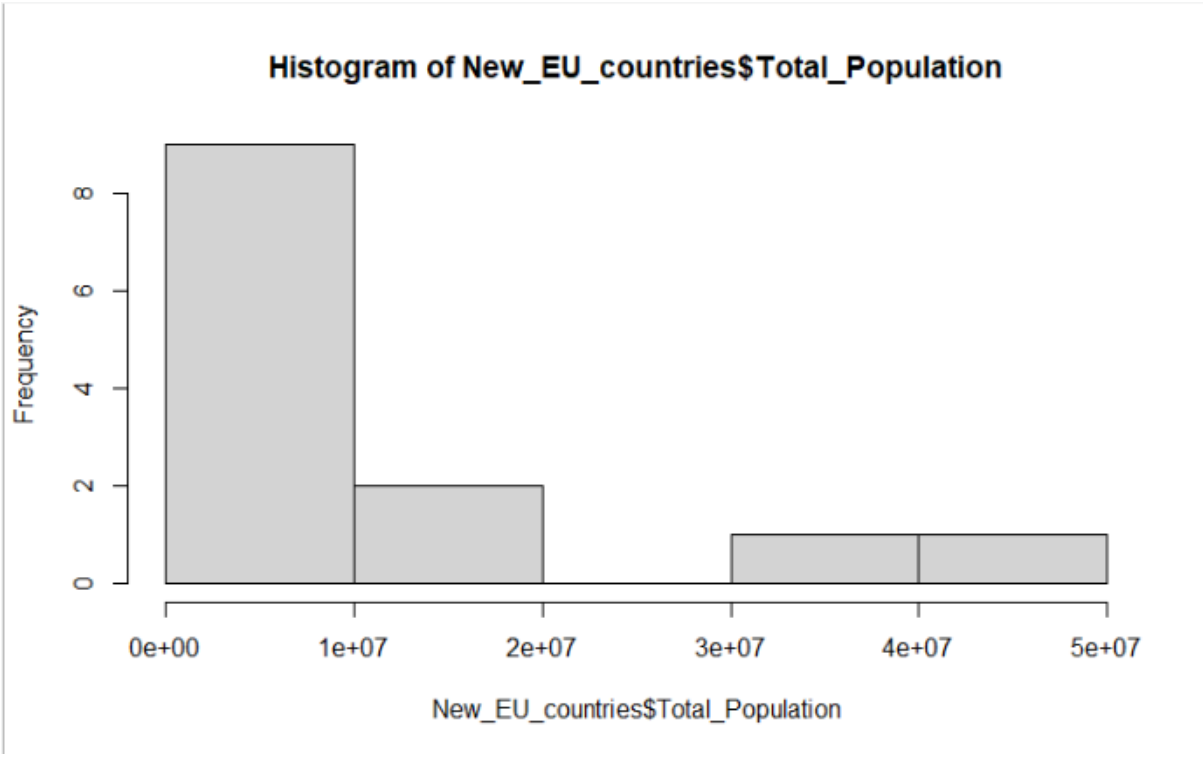
Appendix E – Histogram of developed and underdeveloped EU and Population (Source: Self-created, RStudio)



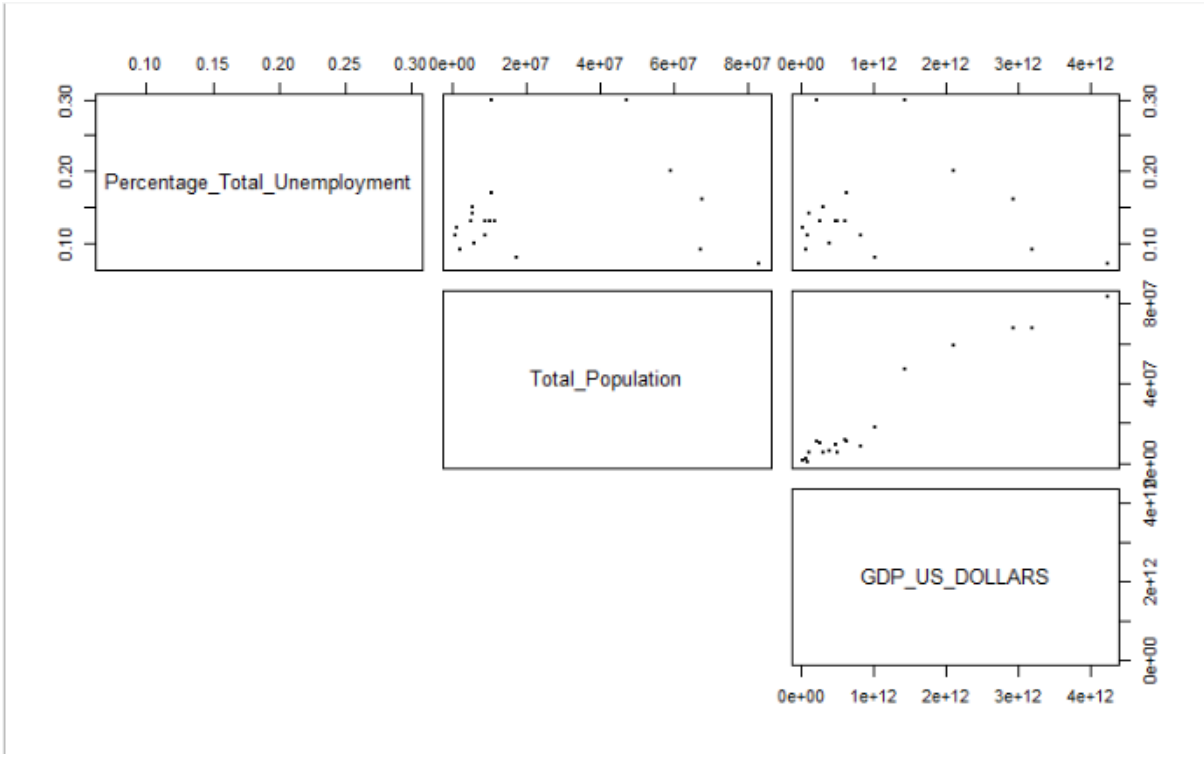


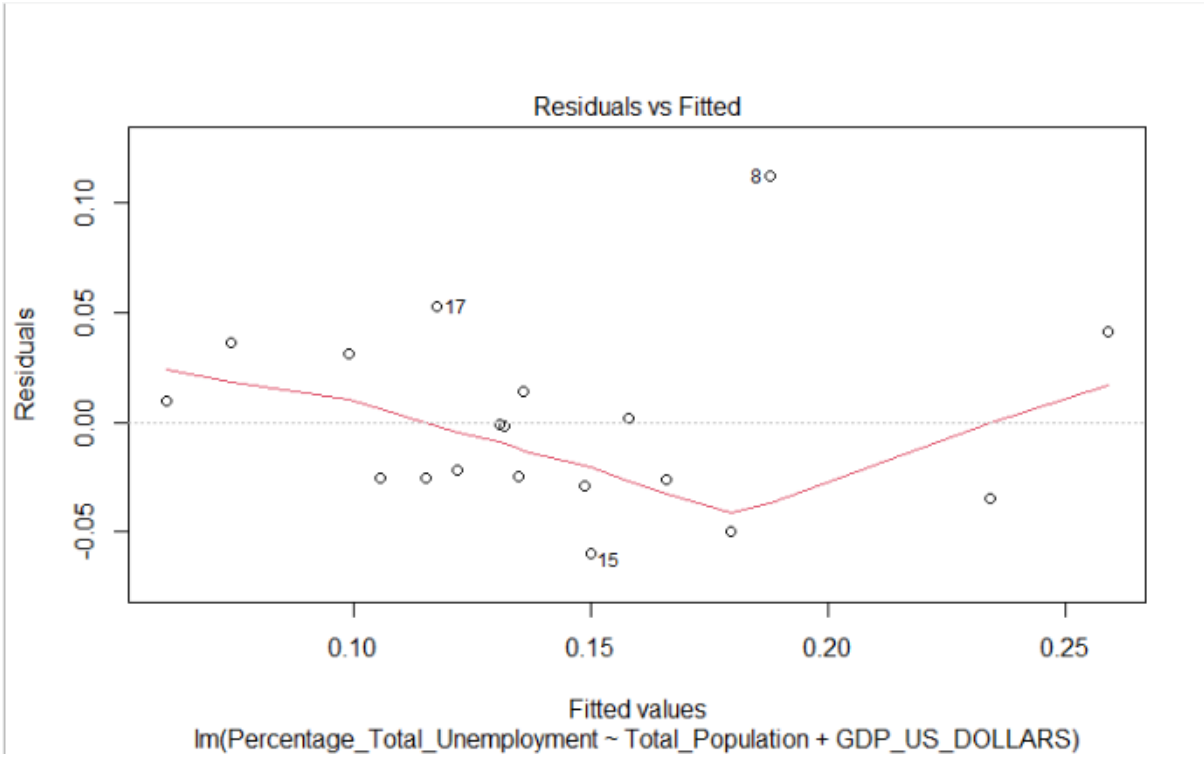
Appendix F – Histogram of Old and New EU and Population (Source: Self-created, RStudio)

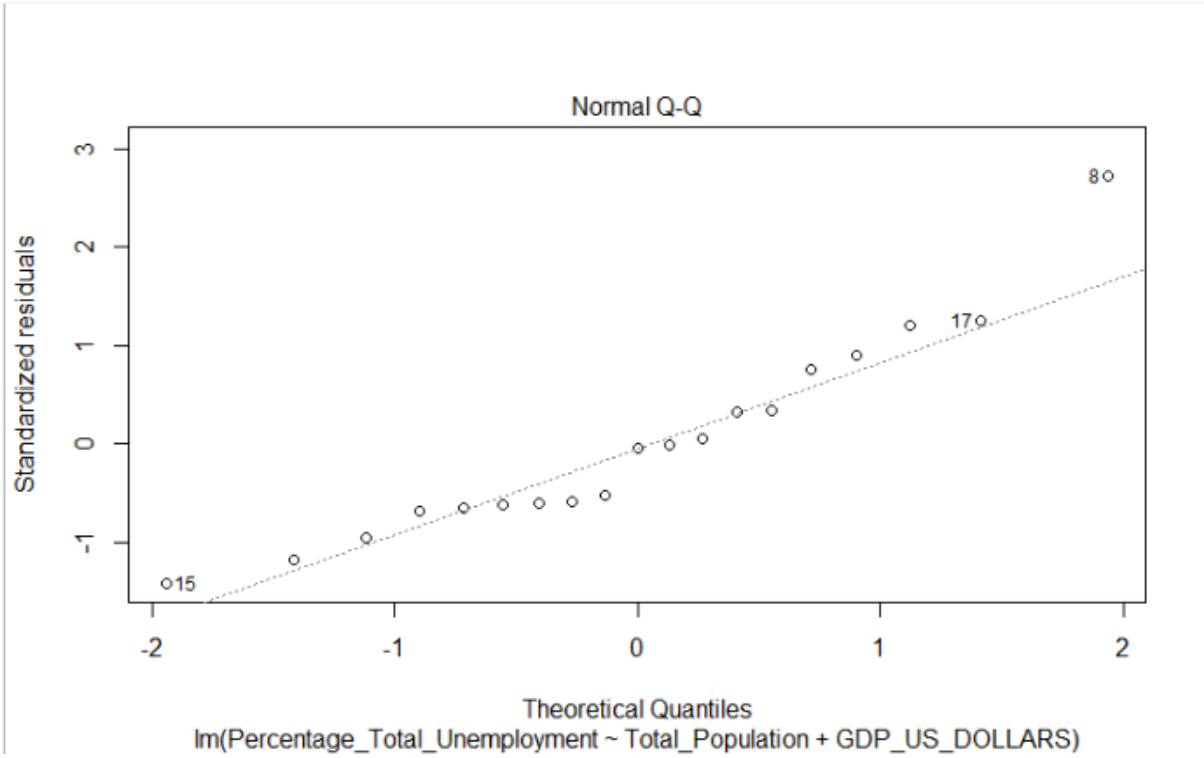


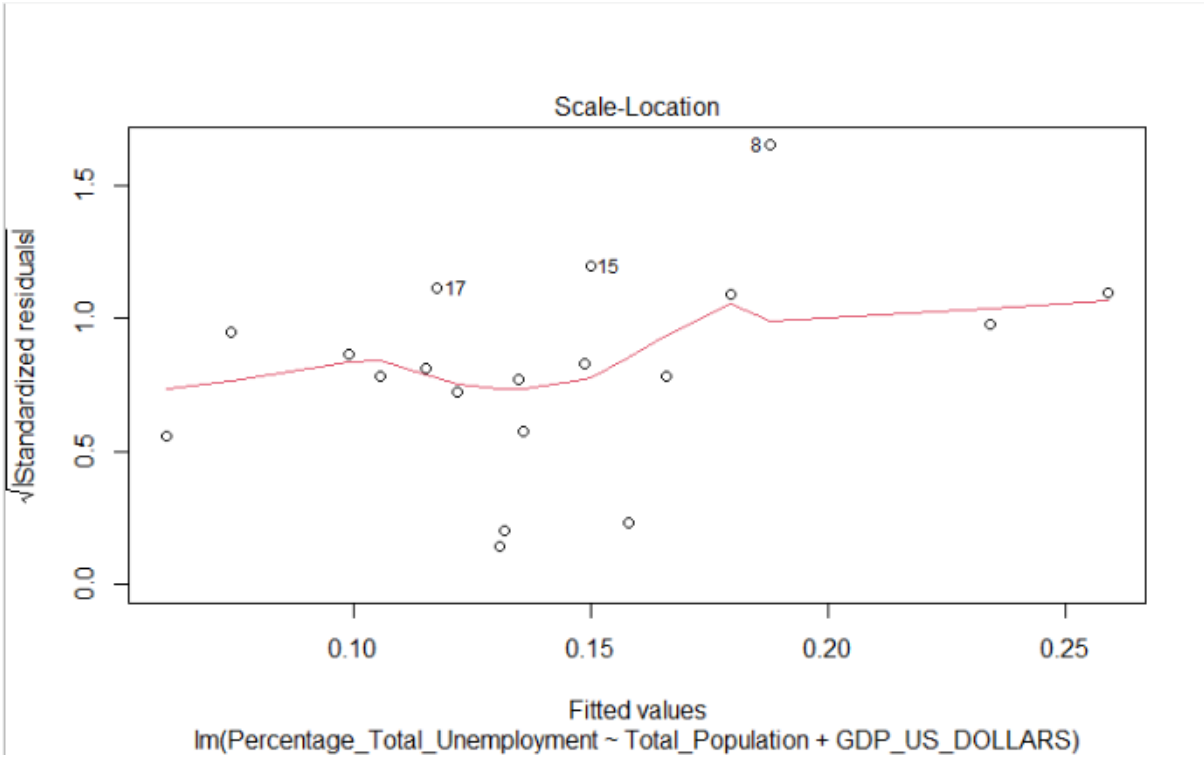


Appendix G – Multiple Regression *Developed EU* **(Source: Self-created, RStudio)**

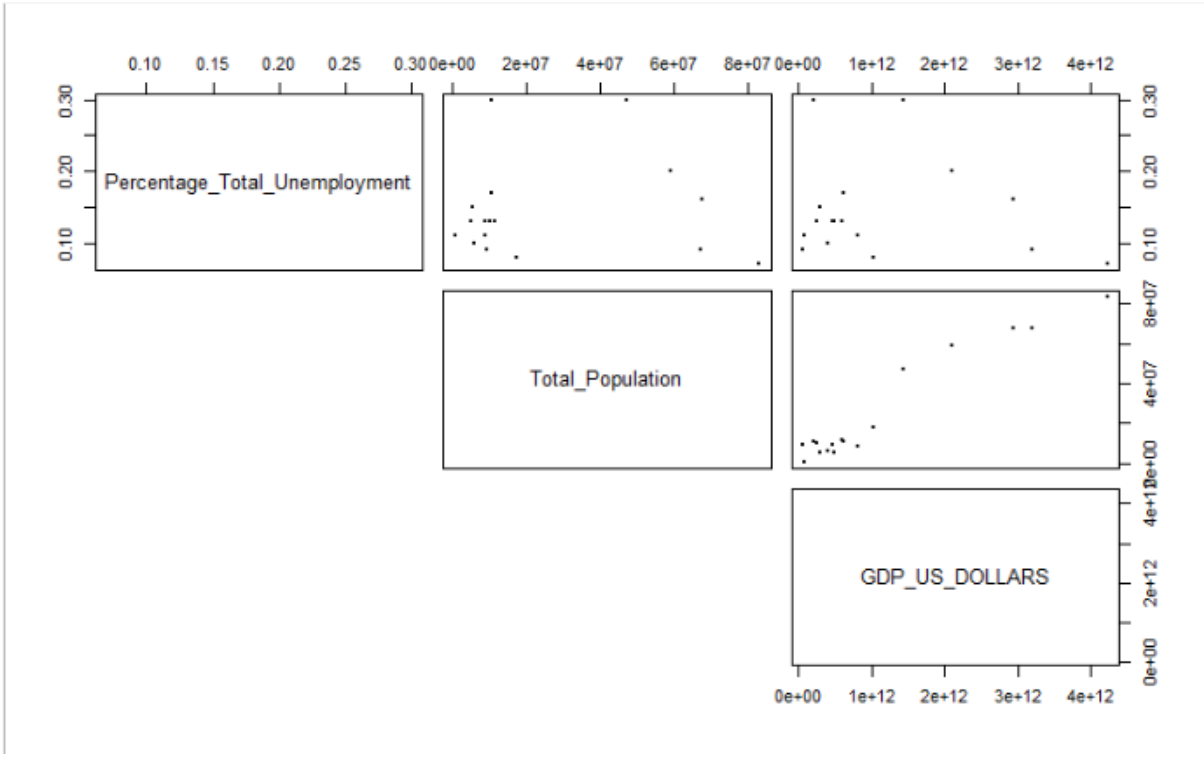


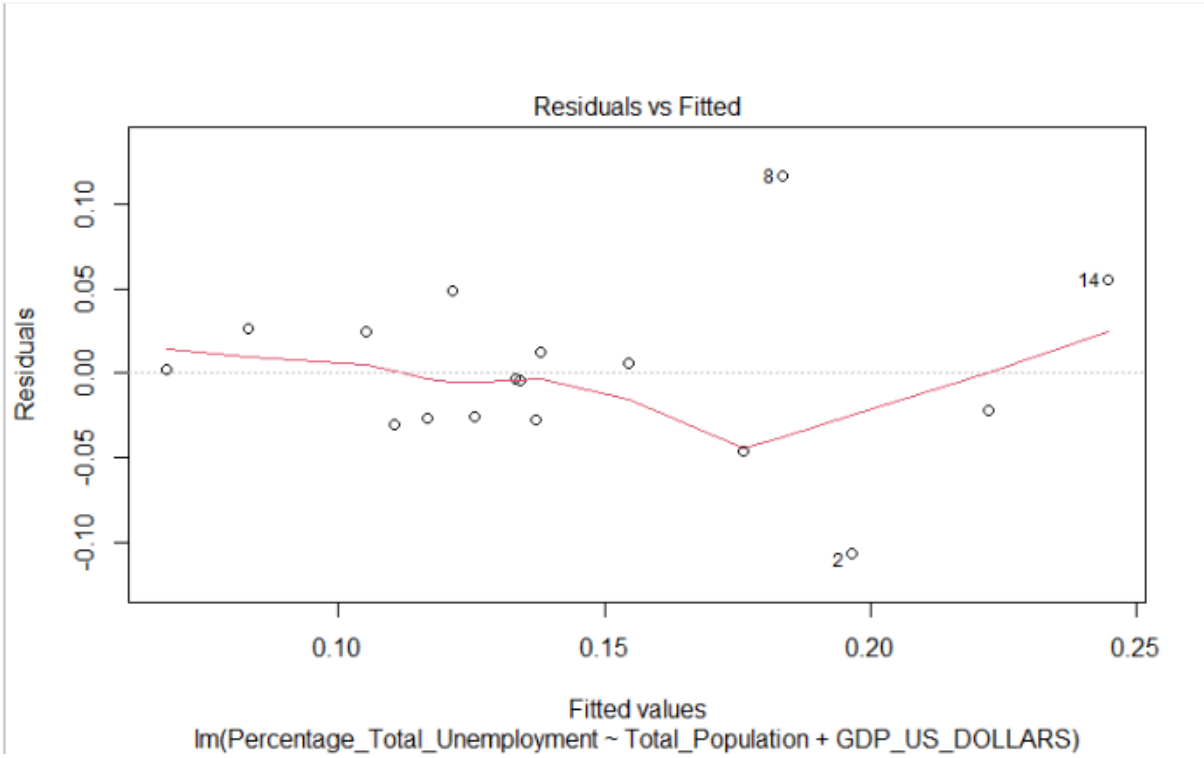


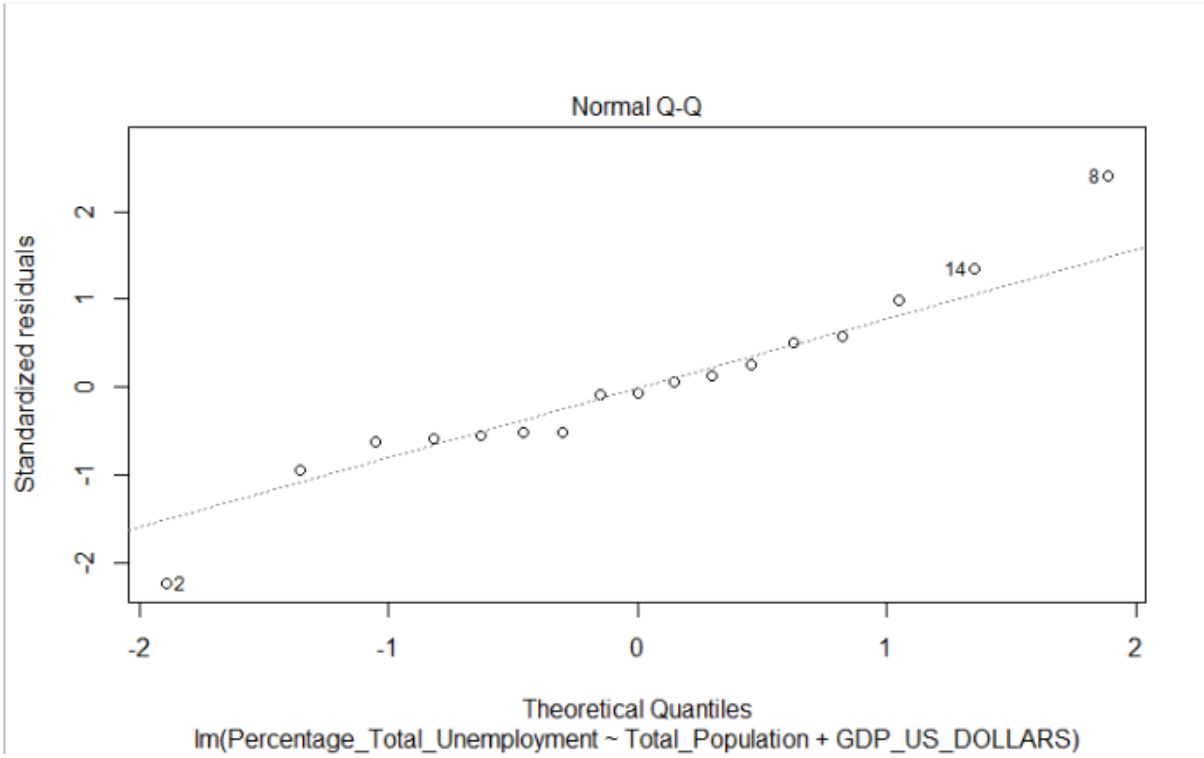

Normal Q-Q
Standardized residuals
Theoretical Quantiles
lm(Percentage_Total_Unemployment ~ Total_Population + GDP_US_DOLLARS)
8
17
15


Scale-Location
√|Standardized residuals|
Fitted values
lm(Percentage_Total_Unemployment ~ Total_Population + GDP_US_DOLLARS)
8
17
15

Appendix H – Multiple Regression *OLD EU* **(Source: Self-created, RStudio)**






Normal Q-Q
Standardized residuals
Theoretical Quantiles
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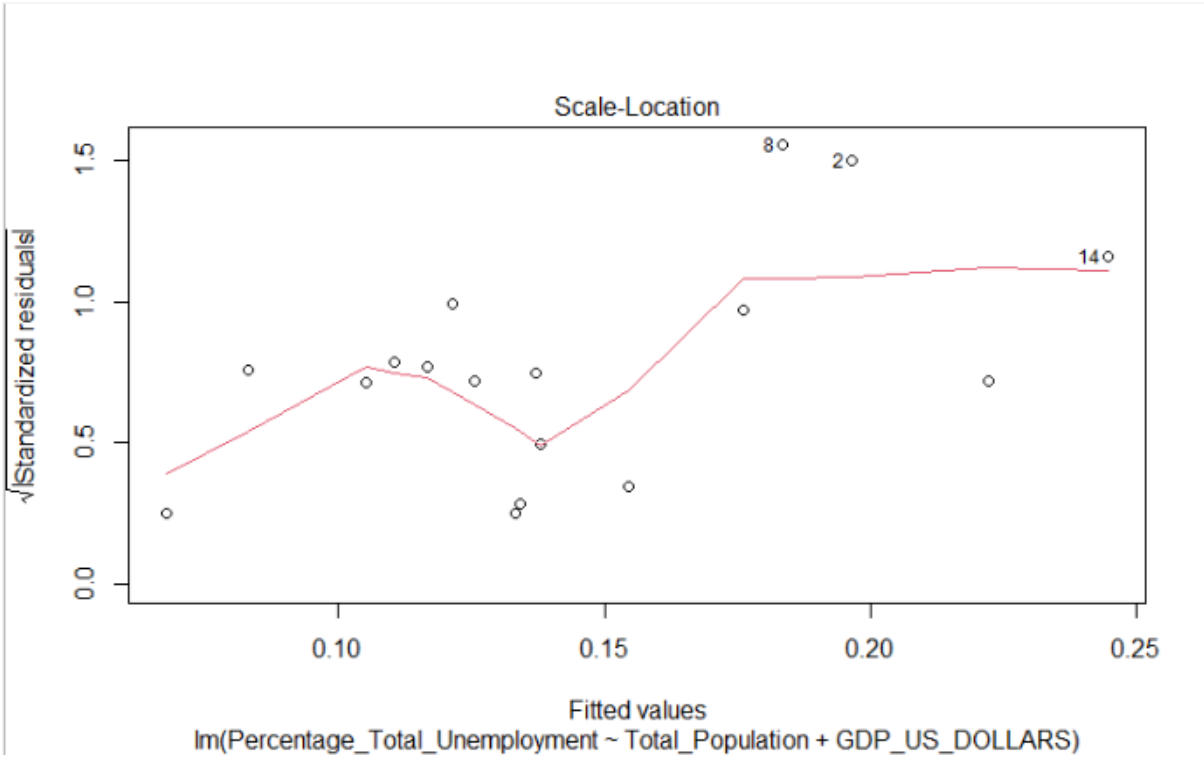
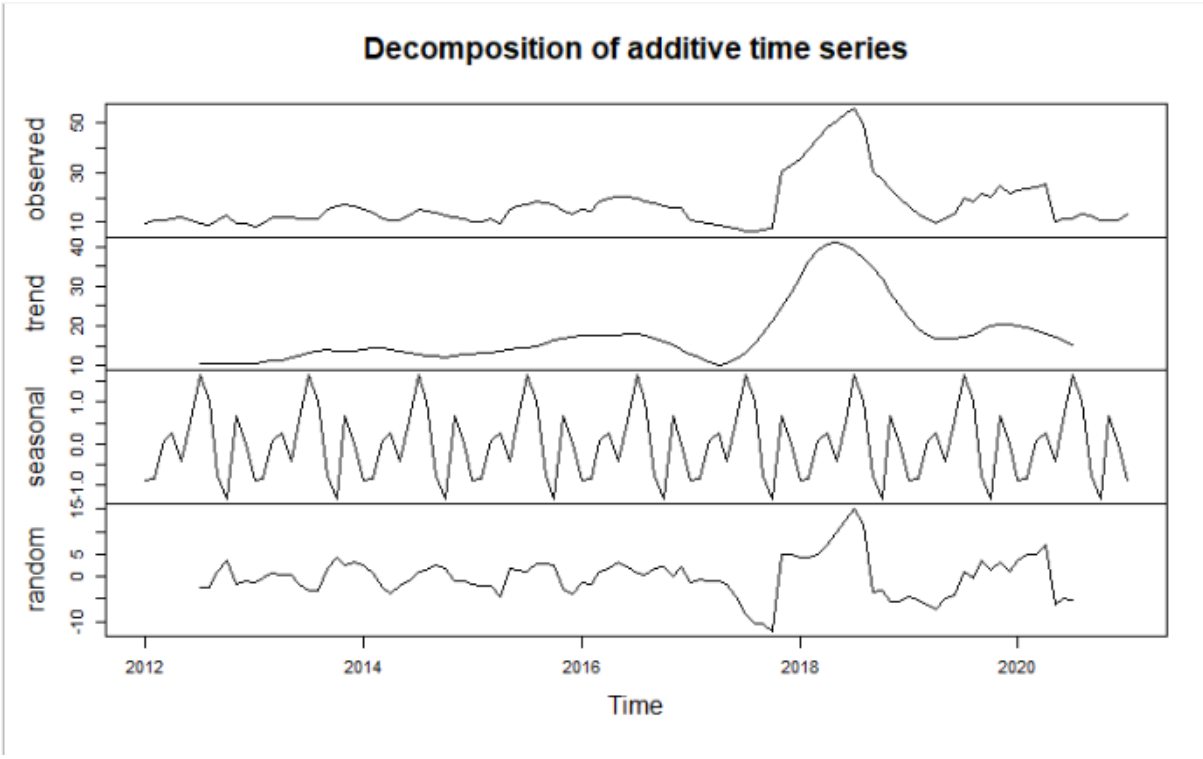
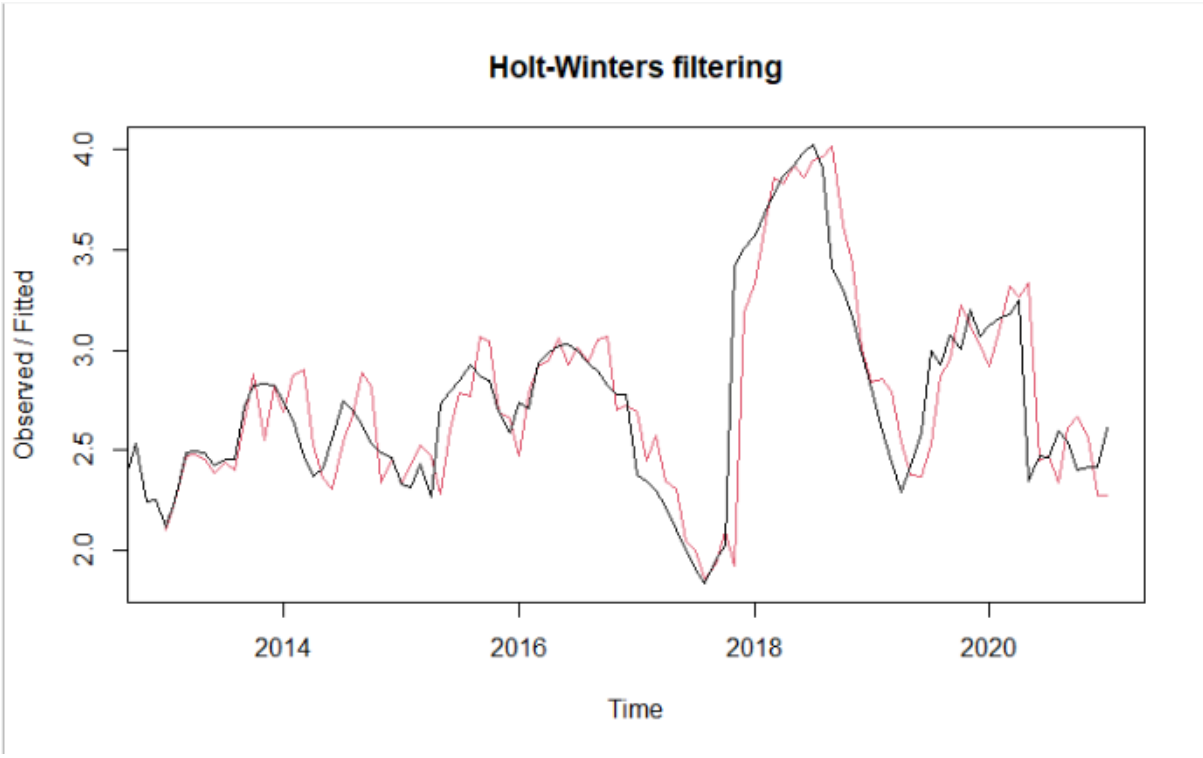
8
14
2


Scale-Location
√|Standardized residuals|
Fitted values
lm(Percentage_Total_Unemployment ~ Total_Population + GDP_US_DOLLARS)
8
2
14

Appendix I – Time series decomposition and Holtwinters Filtering *OLD EU*

(Source: Self-created, RStudio)





Appendix J – Time series decomposition and Holtwinters Filtering Developed *EU* (Source: Self-created, RStudio)