Group Coursework Submission Form

Specialist Masters Programme

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Data Visualization

Lecturer:	**Submission Date:**
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The Aftermath of the 2016 Brexit Referendum

The United Kingdom Point of View

Preface

In this report, we analyzed the performance of a group of British, publicly-listed companies in the aftermath of the 2016 Brexit Referendum. Specifically, we conducted an analysis on the stock price, return on total assets, and debt-to-asset ratio of these British companies from 2014 to 2018. In addition, the performance of a group of publicly listed companies based in France and Germany will be provided alongside in order to offer the counterfactual data to estimate how British companies could have performed in case of no-leave.

In a nutshell, we concluded that the UK is benefiting more from the Brexit compared to other countries in the European Union. Having the performance of the German and French companies as a reference, we estimated that the UK economy would have continued experiencing a downturn in case of no-leave.

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Stock Price Analysis

Introduction

Stock price movement is directly affected by investors demand towards a company stock in the overall market, thus, it is one of the most important indicators that reflects the impact of Brexit on the current performance and potential positive or negative growth of companies and their respective industries. In our project, we are interested in analysing the impact of Brexit on the UK stock market, therefore, we have decided to use the long term data (monthly) because in the short term (daily data) stock prices are generally dominated by speculation. Two data transformation processes are performed on the monthly stock price from the dataset “financials_long_term.csv” before creating our visualisation.

Data Transformation (Stock Price)

Stock prices to the percentage change in stock prices

- The average monthly stock prices in the UK stock market varies greatly with the ones in France and Germany. The average stock prices in the UK fluctuates around £1000, while France and Germany fluctuate around €100. Therefore, a direct comparison between the stock prices in the UK to France and Germany yields little significance as the difference in prices is approximately 10 folds. Therefore, we have decided to compare the percentage change in stock price between the stock market of the countries.

Monthly to quarterly stock prices

- When using the monthly data, our line charts suffered from overcrowding problems with the lines exhibiting a characteristic of extremely high frequency to the extent that causes observation difficulties from the visualization. Hence, we have decided to transform the data from monthly to quarterly to avoid the overcrowding issue.
- Conventionally, quarters are recorded using their end frequency, for example, Q2 (June) and Q3 (September). However, in our scenario, because the Brexit referendum happened on 23rd June, therefore, we have decided to take the quarter-start frequency instead, such that, Q1 (Jan), Q2 (April), Q3 (July), and Q4 (Oct). This allows us to create a more accurate visualization on the impact of Brexit as it happened 8 days prior to July (Q3), using the

quarter start frequency approach, rather than 3 months prior to September (Q3) when using the quarter-end frequency approach.

- As a result, in our visualisation and analysis, the Brexit date is approximated to 1st of July (Q3).

Data Visualisation **Figure 1 Stock Price Analysis**

- After completing the data transformation, we create 6 sub-plots, each representing one of the industries found in the dataset, by utilising the groupby function to compare between the average quarterly change in stock price across the stock markets in three countries: UK, France, and Germany.
- Furthermore, we have also created a summary plot showing the average quarterly change in stock price performance across those three stock markets by taking their industries average.

Graph Design

- We chose to plot line charts because we wanted to track changes in the average stock prices in different markets and industries over a period. To do so, we have calculated the percentage change in stock prices and transformed data from monthly to quarterly to avoid the overcrowding of data points.

- Since the charts will be included in the next issues of The Economist to complement a commentary written by an economic journalist, we have decided to use the same graph style as the graphs published in The Economist. The color palette of those charts is mainly composed of different shades of blue or neutral shades such as black, white or gray. The red color is used to highlight important information (such as the Brexit referendum date in our case).

Insights from the plots

- **Consumer discretionary**

Prior to Brexit, the stocks of the consumer discretionary sector in the UK was highly volatile. The average percentage change in stock price fell by approximately 20 percentage points, from 10% (Jan 2015) to -10% (Jan 2016). While the stock price of the sector in France and Germany was less volatile and entered a bullish trend around Jan 2016. The sector in the UK begins performing better and breaks through to the positive growth territory on a date close to Brexit. In the short run of post-Brexit, the UK consumer discretionary sector was experiencing stable and small growth and was outperformed by the other two countries.

- **Financials**

  Before the Brexit referendum, we could observe that the average stock prices of the listed companies in the financial sector in the UK, Germany and France were fluctuating in the positive area roughly between 0 and 10%. During that period, Germany generally outperformed the other two countries. However, in 2016 Q1, the average stock prices fell to -8% change for the three countries. From 2016 Q1 until one-year post referendum, the average stock prices increased in the three countries in a stable way in the positive growth territory. However, throughout 2018, the three countries suffered from declining and negative growth until the end of 2018 with Germany performing better than the UK and France.

- **Energy and materials**

  Prior to Brexit, the stocks of the energy and materials sector in the three countries were highly volatile. We can observe a significant increase in the stock prices for the three countries in 2016 Q1, especially for UK stocks which reached 10% average change, a value it has never reached in the 2 years before. However, in 2016 Q2, the German and French stock prices slightly declined before they increased again during the 3 months following the referendum. On the other hand, the UK stock prices kept declining constantly post Brexit. In the long-run, we can observe a decreasing trend post Brexit for the 3 countries especially after 2018.

- **Consumer staples**

We cannot observe any particular effect on the average stock prices for consumer staples. We can notice a slight increase in stock prices in 2016 Q1 and Q2 and then a small decline for all the countries following the referendum. However, this fluctuation seems to repeat itself each year: an increase in average stock prices in Q1 Q2 and a decrease in Q3 and Q4.

- **Industrials**

  Prior to Brexit, the stocks of the industrial sector in France and Germany were highly volatile and simultaneously fluctuating between - 10% and 20%. The UK stocks were less volatile, primarily in the negative area and with a percentage change lower than France and Germany. However, in 2016 Q1, the stock prices of the three countries equalized and started increasing similarly until entering the positive area in 2106 Q2. After the referendum, the UK stock prices started to immediately decrease but with a positive stock price change. On the other hand, the stocks for France and Germany kept increasing in the positive area. However, from 2017 Q4, France and Germany stock prices started decreasing significantly, joining the UK stocks. Overall, we can observe that after Brexit, the industrial sector experienced a more stable evolution of the stock prices and a smaller gap between the UK stocks compared to the German and French ones which used to outperform prior to Brexit.

- **Utilities**

  Prior to Brexit, the Germany stock prices of the Utilities sector decreased tremendously between 2014 Q3 (5%) and 2017 Q3 (-30%) while the stock prices of the UK and France were steadily and simultaneously fluctuating around 0. However, from 2016 Q1, we could observe a stable increase in stock prices for the three countries until the 2 or 3 months preceding the referendum after which the stock prices decreased strongly for the three countries throughout 2016 Q3, especially for Germany. After 2016 Q3, the average stock prices started increasing significantly for the 3 countries with Germany outperforming the UK and France. Overall, we can observe that after Brexit, the Utilities sector experienced more volatile and higher stock prices for Germany/France and more volatile and lower stock prices for the UK.

- **Summary plot**

  The average percentage change in the stock prices for the three countries increased in a constant and similar way between 2016 and the referendum. Prior to Brexit, the stock prices for France and Germany were highly volatile, fluctuating between 12% and -8% while the UK stocks were less volatile. After a constant increase and a breakthrough to the positive area for the 3 countries in 2016 Q1 and Q2, the stock prices decreased post-Brexit. The general long term trend after the referendum for the average percentage change in the stock prices for the three countries is a constant slow decrease until 2018 Q2. However, since then, the average stock price change entered the negative area and decreased sharply and similarly for the UK, Germany and France.

ROTA & D/A Analysis

Introduction

- In our visualization, the following terminologies are introduced to produce meaningful analysis. Most of the variables are derived from the data given by the dataset “financials__long_term.csv” because both “operating” and “debt_to_assets”, the two main variable data we will be using, do not show a significant change during the short term period.

Data Transformation (WARTA & WADA)

ROTA: return on total assets

- Formula:
  Return on Total Assets (ROTA) = EBIT / Total Assets
  Where Earnings Before Interest & Taxes (EBIT) = Net Income + Interest + Taxes
- Explanation:
  This ratio is given by dividing a company’s operating income before interest and taxes (EBIT) by its total assets, which equivalents to the definition of the variable “operating” provided in the dataset “financials__long_term.csv” except the “operating” variable is defined by dividing EBIT by a companies’ “book value of total assets” instead of “total assets”. Therefore, in this report we assumed that “the book value of total assets” is the same term as “total assets”.

  Another issue that we find trouble dealing with is the definition of EBIT, which is given by “operating income before interest and taxes”, where “net income” is used instead of “operating income” in all secondary resources that we found. We had to assume that the EBIT is the sum of net income, interest, and taxes in order to simplify the situation.

  This ratio measures how efficiently a company is generating earnings before interest and taxes are paid. The difference between ROTA and ROA is that ROTA eliminates the effect of capital structure and different tax rates when making comparisons between different companies[1]. In our visualization, we will be mainly using the weighted average of ROTA because the size of firm matters when taking an average of the industry ROA and the country ROA.

WARTA: the weighted average return on total assets

- Formula:
  ROTA * (aggregated assets by industry & year / total assets of each country & year)
  ROTA * (aggregated assets by country & year / total assets of three countries & year)
- Explanation:
  We decided to use the weighted average method instead of the arithmetic method to calculate the mean because the size of assets of each firm determines the level of impact this firm could have on the average value. A big-size firm usually associates with a larger value of assets, which will exert more impact on the mean of ROTA.

  To calculate the WARTA by countries and industries, we defined a function named "getWeightedMean(df)" in our code. This function will return a dataframe called "dfMean", which contains a time list, a ROA list (weighted average of ROA), and a debt-to-assets list (weighted D/A). **Figure 2 define a function to calculate the weighted average**

  We then grouped the dataframe into three sub-dataframes by countries in order to plot line charts that compares the WARTA of each country from 2014 to 2018.
  Figure 3 grouped by countries Figure 3 grouped by countries

  In addition, we also grouped each sub-dataframes into 6 * 3 sub-sub-dataframes in order to prepare the data for the line charts illustrating the trend of WARTA of each sector within these three countries during the same period. The following screenshot gives a snippet of the code work for this process. **Figure 4 grouped by sectors**

[1] KenFaulkenberry, 2019. Return on Total Assets - Ratios & Calculations. *Arbor Asset Allocation Model Portfolio (AAAMP) Value Blog*. Available at: https://www.arborinvestmentplanner.com/return-on-total-assets-ratios-calculations/ [Accessed November 7, 2020].

Debt-to-Asset

- This variable is given in the dataset "financials__long_term.csv", and we used this information to calculate the weighted average debt to asset ratio.
- This is a leverage ratio that indicates the percentage of assets that are being financed with debt. The higher the ratio, the greater the degree of leverage and financial risk[2].

WADA

- the weighted average debt to asset ratio, similar to the idea of WARTA, we used assets as weight and calculated the WADA for each country as well as each sector/industry within every country.

Theme Style

The whole theme is chosen to match the style of The Economist newspaper, which is our target audience. The primary colors consist of red, mid-blue, and dark grey, representing the UK, France, and Germany respectively. The rest of colors are chosen from the secondary palette, which consists of light grey (consumer discretionary), beige (consumer staples), dark-green (energy and materials), turquoise (financials), mid-blue (industrials), and bright-turq (utilities)[3].

Data Visualization

ROTA & D/A Analysis (1/2) ***Figure 5 ROTA & D/A Analysis (1/2)***

<u>Plot 8</u>

We decided to put WARTA and WADA in the same graph because a biased analysis will be produced by looking at only one of them. In the first part of the "ROTA & D/A Analysis" graph, we obtained the WARTA of each country 2 years apart from the Brexit, both before and after, as

[2] Anon, 2020. Debt to Asset Ratio - How to Calculate this Important Leverage Ratio. *Corporate Finance Institute*. Available at: https://corporatefinanceinstitute.com/resources/knowledge/finance/debt-to-asset-ratio/ [Accessed November 7, 2020].

[3] Anon, *The Economist*. Available at: http://pattern-library.economist.com/color.html [Accessed November 7, 2020].

well as the detailed WARTA of each sector within each country in order to see which sector was affected the most by the Brexit, and, therefore, contributed more to the frustration of the country-level WARTA.

We limit the range for both WARTA by country and WADA by country from 0% to 30% in order to get the maximum of frustration plotted within the limited space. The y-axis on the left side of the blue chart is for WARTA, however, we are only looking at the positive part. Similarly, only half part of the y-axis was used for WADA, except it is the right-bottom half that counts. The reason why we plot these two charts together and have them share the same y-axis is because we can compare the two value at the same timestamp (year), and clear contrast of trend can be seen from the graph.

<u>Plot 9 & Plot 10</u>

The weighted average value of firms grouped by sectors for each country is listed on the right-hand side of the graph, above which we have the WARTA and below which we have the WADA. Likewise, the WARTA and WADA for the same country are plotted on the same vertical line in order for us to capture the relationship between these two indicators. The purpose of this plot is to assess how different sectors of these three countries react to Brexit respectively.

ROTA & D/A Analysis (2/2) ***Figure 6 ROTA & D/A Analysis (2/2)***

<u>Plot 11</u>

In this part of the chart, we first calculated the WARTA and WADA for each sector within each country and placed them together in one chart, and then, we created a bar chart next to each plot in order to show the Brexit impact on these two measures for each country. The dotted grey line is located at a position of value 0 on the x-axis, where a bar on the left side of the line represents a negative impact, and a bar on the right side reflects a positive impact. In order to calculate this quantified value, we use the statsmodels library to fit two linear models using the data from 2014 to 2016 (before Brexit) and the data between 2016 and 2018 (after Brexit), and then, we calculated the difference between the two parameters (slope) and gave this difference a self-defined meaning; a positive difference indicates that there is a positive impact of the Brexit on this country for this sector, vice versa, a negative difference means the Brexit has a negative impact on this country within this sector; the greater the absolute value of the result is, the larger the impact Brexit has on this country. Figure 7 define a function to calculate the difference **Figure 7 define a function to calculate the difference**

Insights

Plot 8 illustrates the WARTA and WADA of Britain, Germany, and France during the Brexit period from 2014 to 2018. As we could see from the chart, the selected companies from the UK shows a significant improvement on their ROTA after 2016 (soaring from 8% to 18%), whereas the performance of France witnessed a modest decline (around 2%) during the same period. Although the ROTA of companies representing Germany also improved, the amount of improvement (approximately 2.5%) is relatively trivial compared to that of Britain. As the performance of France and Germany is representing the overall ROTA of the EU countries, we can conclude that Britain is benefiting more from the Brexit compared to other countries in the European Union. This might result from a freedom of the EU trade policies among members (customs union) and the ability to set its own regulations and cut its own trade deals ((Elliott, 2020).

Many economists predicted that the leave of EU for the UK would help the country fix its long-term economics problems (Elliott 2020), which the country has been dealing with ever since it joined the union. As can be seen from chart 8, even when the companies in the UK lowered the average debt-to-asset ratio from 2014 to 2016[4], the average ROTA still dropped by 7%. Therefore, it is predicted that the UK is most unlikely to revive its economy in case of no-leave.

Plot 9 shows that the Financials sector in the UK experienced the most significant improvement with its average ROTA after the Brexit, followed by the Energy and Materials sector and the Consumer Staples sector. On the other hand, the rest of three sectors: Utilities, Consumer Discretionary and Industrials, were not affected that much by the Brexit. All of them experienced a modest fluctuation in the first year after Brexit (2017) by an amount of 1.5%. The situation is rather different in the other two countries, however, since the economic structure and the selected

[4]A decrease in the debt-to-asset ratio indicates that the company is relying less on the debt, and therefore the company is expecting to generate more revenue as less money will be spent to serve the debt

companies are totally different for the same industry in different countries, it is hard to compare the same industry between countries. It is predicted that the ROTA of British companies will remain gloomy if it stays in the UN.

Plot 10 describes the WADA of all 6 sectors by countries and we can see that the average debt-to-asset ratio of for each industry is rather stable in all countries throughout the whole period as it is not very wise to change the capital structure from year to year, however, we do observe that the Utilities sector in the UK has a relatively high leverage ratio (fluctuating at around 43%) compared to Germany and France. This shows that this sector is relying heavily on debt in the UK. Overall, there was a minor decrease in the average D/A ratio for most sectors in Britain after the Brexit.

We then combine the WARTA and WADA of three countries sector by sector in order to see the Brexit impact for each country within each industry. In general, we can see a positive impact on companies in most sectors, among which Energy and Materials sector (10.44), Financials (9.14), and Consumer Staples (5.84) witnessed significant growth in WARTA. As it was mentioned in plot 11, the WADA of Britain experienced a slight drop during the period of Brexit, which is quantified by approximately 1 using our defined function[5]. Overall, the ROTA of German companies and French companies only increased by a relatively small amount except for the Utilities sector in Germany (6.63). Therefore, we conclude that the UK economy will remain relatively stable or perform worse if it stays in the UN.

[5] The difference between the slope of the two regression lines for 2016-2018 and 2014-2016

Appendix List

Figure 1 Stock Price Analysis

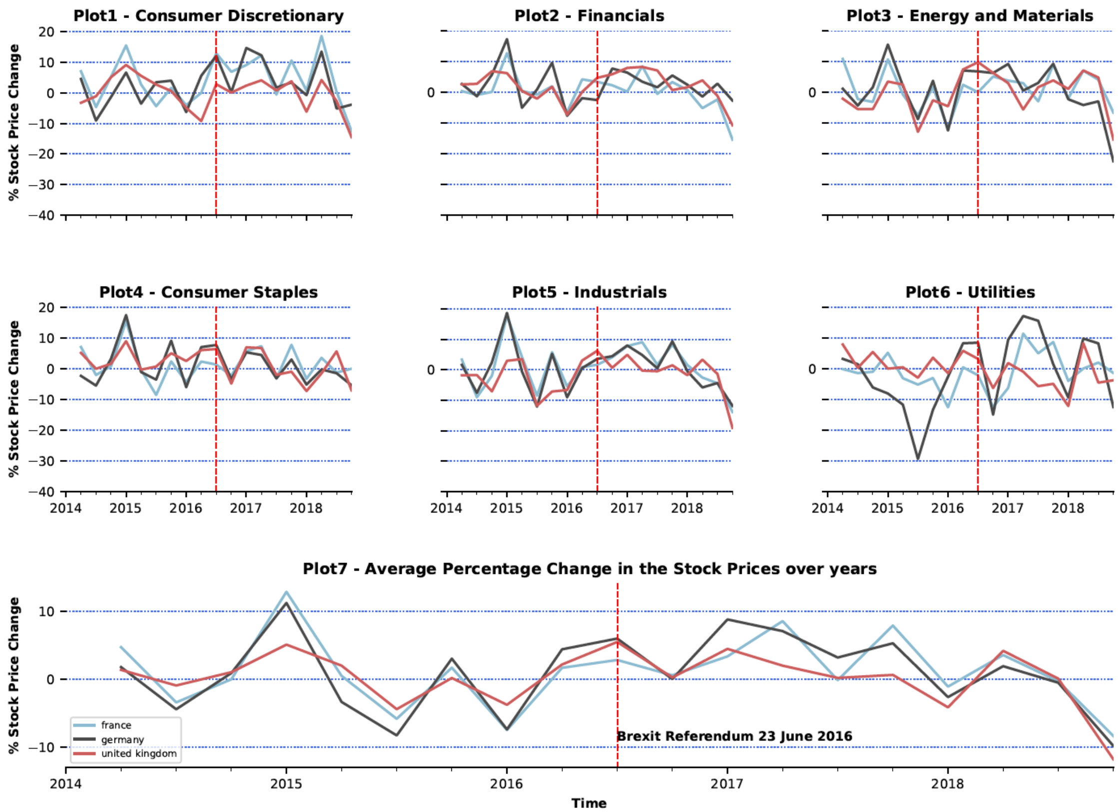

Figure 2 define a function to calculate the weighted average

```
# define a function to calculate the weighted average
def getWeightedMean(df):
    '''
    The function is designed to calculate the average number with weights.
    input: df --> the initial dataframe with data of 'company name','year', 'assets', 'operating' and
    output: dfMean --> the dataframe with results of weighted average of ROA and D/A by year
    '''
    timeList = sorted(list(set(df['year']))) # get the list of 'year'
    ROAList = [] # create an empty list to store the weighted average of ROA by years
    DAList = [] # create an empty list to store the weighted average of D/A by years
    for year in timeList: # calculate the weighted average year by year
        dataset = df[df['year'] == year]
        totalAssets = np.sum(dataset['assets'])
        wts = list(dataset['assets']) / totalAssets # set the 'assets' to be the weight
        weightedROAMean = np.average(dataset['operating'], weights = wts)
        ROAList.append(weightedROAMean)
        weightedDAMean = np.average(dataset['debt_to_assets'], weights = wts)
        DAList.append(weightedDAMean)
    dfMean = pd.DataFrame({ # create a dataframe to include 'year' and 'weighted average of ROA'
        'year' : timeList,
        'operating' : ROAList,
        'debt_to_assets' : DAList
        })
    return dfMean
```

Figure 3 grouped by countries

```
# eliminate repeated data and calculate the weighted average
# clean by countries
# United Kingdom
dataB = pd.DataFrame(BritishLT.groupby(['company_name', 'year'])
    ['operating', 'assets', 'debt_to_assets'].aggregate(np.mean)).reset_index()
operatingByYearforB = getWeightedMean(dataB)
# Germany
dataG = pd.DataFrame(GermanyLT.groupby(['company_name', 'year'])
    ['operating', 'assets', 'debt_to_assets'].aggregate(np.mean)).reset_index()
operatingByYearforG = getWeightedMean(dataG)
#France
dataF = pd.DataFrame(FranceLT.groupby(['company_name', 'year'])
    ['operating', 'assets', 'debt_to_assets'].aggregate(np.mean)).reset_index()
operatingByYearforF = getWeightedMean(dataF)
```

Figure 4 grouped by sectors

```
# clean by countries by industries
# United Kingdom
#consumer discretionary industry
dataBCD = pd.DataFrame(BritishLT[BritishLT['sector'] ==
    'consumer discretionary'].groupby(['company_name', 'year'])
    ['operating', 'assets', 'debt_to_assets'].aggregate(np.mean)).reset_index()
dataBCDMean = getWeightedMean(dataBCD)
#consumer staples industry
dataBCS = pd.DataFrame(BritishLT[BritishLT['sector'] ==
    'consumer staples'].groupby(['company_name', 'year'])
    ['operating','assets', 'debt_to_assets'].aggregate(np.mean)).reset_index()
dataBCSMean = getWeightedMean(dataBCS)
```

Figure 5 ROTA & D/A Analysis (1/2)

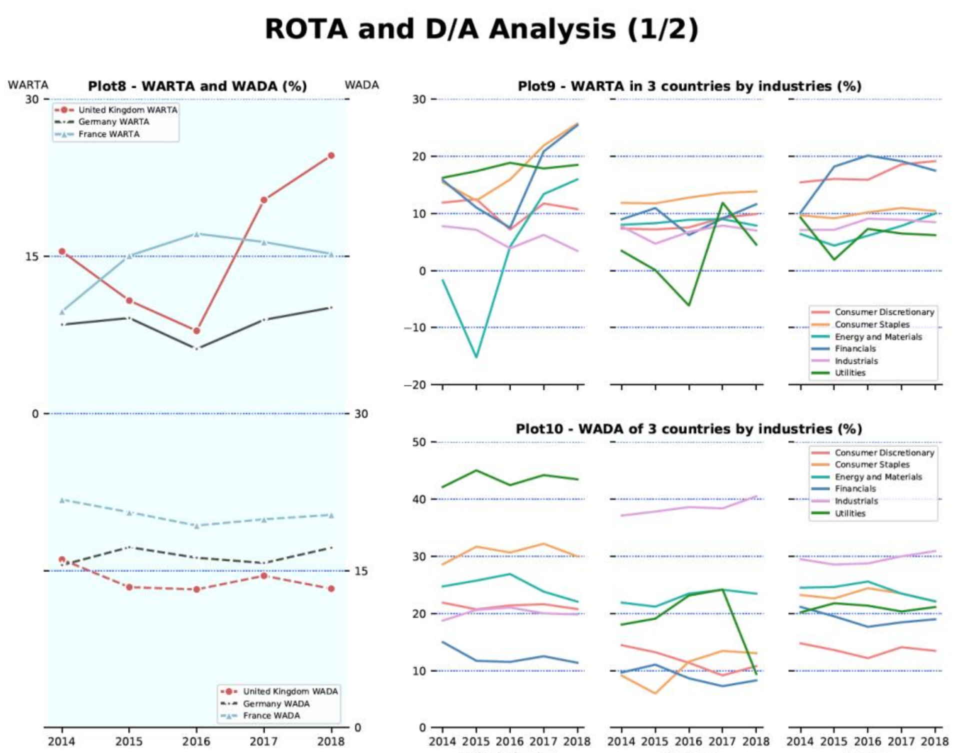

Figure 6 ROTA & D/A Analysis (2/2)

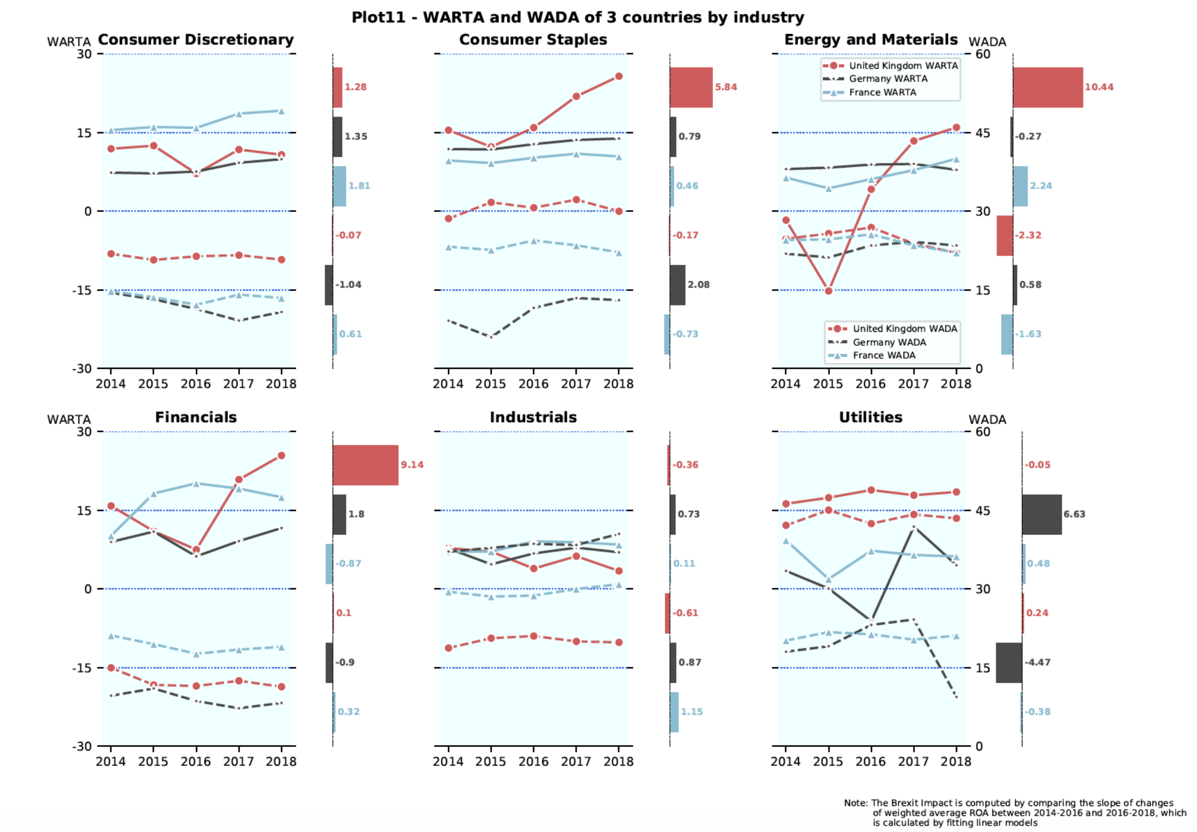

Figure 7 define a function to calculate the difference

```
#define the function to calculate the change term
def getChange(df):
    '''

    The function is designed to assess the Brexit Impact on ROA by industry by comparing the slope of ROA before and after the Brexit.
    The slope will be computed by statsmodels.OLS
    input: df --> the initial dataframe with data of year', 'operating' and 'debt to assets'
    output: change --> difference between the slope of ROA and D/A before and after the Brexit
    '''
    x = [0, 1, 2]
    ROAmodelBeforeBrexit = sm.OLS( # fit the model by ROA of 2014, 2015 and 2016
        endog = df['operating'][0:3],
        exog = x,
        hasconst = None).fit()
    ROAmodelAfterBrexit = sm.OLS( # fit the model by ROA of 2016, 2017 and 2018
        endog = df['operating'][2:5],
        exog = x,
        hasconst = None).fit()
    ROAslopeBeforeBrexit = float(ROAmodelBeforeBrexit.params) # get the slope before
    ROAslopeAfterBrexit = float(ROAmodelAfterBrexit.params) # get the slope after
    ROAchange = ROAslopeAfterBrexit - ROAslopeBeforeBrexit # get the difference

    DAmodelBeforeBrexit = sm.OLS( # fit the model by D/A of 2014, 2015 and 2016
        endog = df['debt_to_assets'][0:3],
        exog = x,
        hasconst = None).fit()
    DAmodelAfterBrexit = sm.OLS( # fit the model by D/A of 2016, 2017 and 2018
        endog = df['debt_to_assets'][2:5],
        exog = x,
        hasconst = None).fit()
    DAslopeBeforeBrexit = float(DAmodelBeforeBrexit.params) # get the slope before
    DAslopeAfterBrexit = float(DAmodelAfterBrexit.params) # get the slope after
    DAchange = DAslopeAfterBrexit - DAslopeBeforeBrexit # get the difference

    change = [ROAchange, DAchange]

    return change
```

Reference List

Anon, *The Economist*. Available at: http://pattern-library.economist.com/color.html [Accessed November 7, 2020].

Anon, 2020. Debt to Asset Ratio - How to Calculate this Important Leverage Ratio. *Corporate Finance Institute*. Available at: https://corporatefinanceinstitute.com/resources/knowledge/finance/debt-to-asset-ratio/ [Accessed November 7, 2020].

Elliott, L. (2020, January 31). Why Brexit is a chance to fix the UK economy's long-term problems. Retrieved November 08, 2020, from https://www.theguardian.com/politics/2020/jan/31/why-brexit-is-chance-to-fix-uk-economy-long-term-problems

KenFaulkenberry, 2019. Return on Total Assets - Ratios & Calculations. *Arbor Asset Allocation Model Portfolio (AAAMP) Value Blog*. Available at: https://www.arborinvestmentplanner.com/return-on-total-assets-ratios-calculations/ [Accessed November 7, 2020].