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# BREXIT Election: Forecasting a Conservative Party Victory through the Pound using ARIMA and Facebook's Prophet

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## ABSTRACT

On the 30th October, 2019, the markets watched as British Prime Minister, Boris Johnson, took a massive political gamble to call a general election to break the Withdrawal Agreement stalemate in the House of Commons to “Get BREXIT Done”. The pound had been politically sensitive owing to BREXIT uncertainty. With the polls indicating a Conservative win on 4<sup>th</sup> December, 2019, the margin of victory could be observed through increases in the pound. The outcome of a Conservative party victory would benefit the pound by removing the current market turbulence. We look to provide a short-term forecast of the pound. Our approach focuses on modelling the GBP/EUR and GBP/USD Fx from the inception of BREXIT referendum talks from the 1<sup>st</sup> January, 2016 to the conclusion of the BREXIT election on the 12<sup>th</sup> December, 2019, focusing on forecasted increases in the pound from the 4<sup>th</sup> December, 2019. We construct two machine learning models in the form of an Auto Regressive Integrated Moving Average (ARIMA) financial time series and an additive regression financial time series using Facebook’s Prophet to investigate the hypothesis that the polls prediction of a Conservative victory could be validated by forecasted increases in the pound. The efficiency of the forecasted models was then tested based on MAPE and MSE criteria. Our results found that the ARIMA and Prophet models were effective and proficient in forecasting the polls prediction on the 4<sup>th</sup> December, 2019 of a Conservative win by validation of forecasted increases in the pound. The ARIMA (4,1,0) model resulted in forecasts with the lowest MAPE and MAE.

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## CCS CONCEPTS

• Human Centric Computing • Machine Learning • Information systems

## KEYWORDS

BREXIT Election, Time series forecasting, ARIMA, Facebook Prophet

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## 1 INTRODUCTION

After three calls for a UK General Election, Prime Minister, Boris Johnson, got the majority vote in the House of Commons to call a General Election. On the week of the 27<sup>th</sup> October, 2019 there still was no majority for the unconditional departure from Europe that Johnson’s right-wing Conservatives party stood for. The 2019 UK General Election was dubbed the BREXIT election which was essentially a gamble intended to create a majority and to weaponise the Conservatives as the “Leave party”, on Prime Minister Johnson’s terms and conditions. The BREXIT election was effectively a second referendum. After three volatile years, the pound and domestically-focused shares were expected to rally if the Conservatives secured a majority [1]. The forecasting of the pound was important as it was seen that the rise in the pound could be seen as a potential Conservative party victory and thus bringing about an end to the BREXIT uncertainty that has hung over businesses and markets for more than three years. BREXIT once meant a weaker pound but not anymore [2]. The pound, a barometer of BREXIT confidence since the 2016 vote to leave, has risen on the likelihood that a government with a working majority will be able to wrench Britain’s government out of its gridlock and spare the country from the potentially chaotic effects of leaving the European Union without a divorce agreement. With a majority, Mr. Johnson will be better able to push through Parliament the Withdrawal Agreement he negotiated in October 2019 with the European Union. The outcome also meant that Britain was more likely to formally leave the

European Union with a deal at the end of January 2020 [2]. The forecasting of the pound was not only important to the political party strategists but also to foreign governments, the European Commission, the European Central Bank, in addition to the investment community. A weak pound would indicate a faltering economy, influence foreign government direct investment and investment strategies with a potential to globally fueling short selling strategies against the pound. In economic terms, foreign governments would have a requirement to ensure domestic fiscal policy was aligned to the outcome of the BREXIT election in case of British currency devaluation, Bank of England Interest rates cuts and increases or decreases in EU/UK tariffs. To that end, we can see that the ability to forecast the pound has the potential to drive investment decision making in addition to EU, WTO trade policy and regulation. The instigation for this study is an extension from [3] [4] which is essentially a migration from casual to predictive analysis.

This paper aims to provide a short-term forecast for the pound from the surfacing of BREXIT referendum talks from the 1<sup>st</sup> January, 2016 to the 12<sup>th</sup> December, 2019 focusing on increases in the pound from the 4<sup>th</sup> December, 2019 to the conclusion of the BREXIT Election on the 12<sup>th</sup> December, 2019 using a machine learning Auto Regressive Integrated Moving Average (ARIMA) model and Facebook's Prophet additive regression model to investigate the hypothesis that the polls prediction on December 4<sup>th</sup> 2019 of a Conservative win could be validated by forecasting increases in the pound. Section 2 looks at related works. Section 3 presents our data acquisition and preparation. Section 4 looks at the Methodology. Section 5 deals with the analysis and results and in Section 6, we conclude and discuss future work.

## 2 RELATED WORK

The ARIMA model is a combination of the Autoregressive (AR) model and Moving Average (MA) models. The Box Jennings autoregressive moving average model remains one of the most popular used ARIMA models today [5]. [6] demonstrated a simple method to estimate both univariate and multivariate MA processes by exploiting the recursive relation between the Moving Average process and its Auto regressive representation. Autoregressive Integrated Moving Average (ARIMA) model is a model that doesn't incorporate an independent variable in forecasting [7]. The ARIMA model is a time-series forecasting technique which is only based on the observed behaviour of variable data. As stated, ARIMA models disregard the independent variable and use the present value and past values of the dependent variables to produce accurate short-term forecasting. ARIMA suits observation of time series that are statistically correlated with each other or dependent [8]. For this study, the ARIMA forecasting model is an appropriate model as the correlated dependent variable is the pound. The model is most renowned in financial forecasting,

historically this includes future index value and the trend of the Indian stock market. [9] [10] used the ARIMA model for successful prediction of Rupiah against the US dollar. The ARIMA method was successfully used for forecasting Irish inflation and in some cases, has outdone other complex forecasting models.[11] ARIMA statistical methods for time-series data modelling are used across many disciplines such that [12] utilises the use of ARIMA for forecasting three types of oil palm prices by considering the minimum of mean absolute percentage error (MAPE). [13] used Prophet and ARIMA models to forecast Bitcoin prices and they found that Prophet outperformed the ARIMA model in terms of accuracy. [14] produced machine learning models to forecast and examine the pre- and post-BREXIT periods on whether a sudden depreciation in the GBP/USD Fx is the reaction of market participants to BREXIT or whether the exodus of the UK from the EU had little impact on the exchange rate. They found that their daily forecasting models adhere closely to the evolution of the exchange rate and that most of the depreciation is based on the uncertainty caused by BREXIT. [15] examined pre-BREXIT and post-BREXIT referendum periods on movements between the British pound against the euro and US dollar. The study found that the loss of correlation in the GBP/EUR Fx has not fully recovered during the post-BREXIT referendum period, which could be attributed to the uncertainty about the final impact of BREXIT on British and Eurozone economies. [16] examined the BREXIT vote on the intraday correlation and volatility transmission among major currencies; the findings include decreases in sterling and the euro currencies.

## 3 DATA ACQUISITION AND PREPARATION

### 3.1 Political Climate

Prime Minister, Boris Johnson, and his Conservative Party vowed at the start of their BREXIT election campaign that if they reclaimed their Conservative majority in Parliament, they would deliver BREXIT by moving to negotiate a free-trade agreement with the European Union by year end 2020. Labour, the biggest opposition party in the House of Commons led by Jeremy Corbyn, alternatively propositioned to renegotiate the BREXIT deal and give the British public an opportunity to vote on whether they wanted to leave the EU on the basis of his renegotiated and improved deal. The Conservative party's position in the polls accelerated due to a change in strategy by Nigel Farage's BREXIT party who publicly stated that they were going to stand down 317 seats previously won by the Conservative party, thus aiding Prime Minister Johnson bid to "Get BREXIT done" [17]. Mr Farage said his party would focus its efforts on trying to take seats held by Labour, whom he accused of "betraying" its Leave-supporting voters [17]. The pound was expected to rally if the Conservatives secured victory. Signs in the markets had indicated that short selling the

pound has been truncated such that the pound and FTSE exhibited positive trajectories [1]. It was expected that the possibility of a "Hung Parliament" would have stagnated the pound and FTSE [1]. Similarly, a Labour party win would have also signaled a drop in both pound and FTSE due to Jeremy Corbyn's nationalisation plan [1]. The nationalisation plan proposed to nationalise rail, mail, water, energy and broadband. These utility companies would also have faced an increase in corporation tax according the Labour manifesto from 19 percent to 26 percent thus effectively reducing post tax earning per share for the FTSE 100.

### 3.2 Pound Dataset

We used a Yahoo! Finance python library to scrape the closing GBP/EUR and GBP/USD Fx prices from the Yahoo! Finance website. Yahoo Finance is a media platform that provides financial news, data about stock quotes, press releases, and financial reports. The data was stored in a SQL lite database. We collected a total of 1219 Fx rates for the GBP/EUR and 1241 GBP/USD Fx rates from the period of the 1<sup>st</sup> January, 2016 to the 12<sup>th</sup> December, 2019. We excluded the European and US bank holidays from the dataset. The time-series frequency consists of the closing Fx prices on the given day. The features of this data set are: timestamp titled as "created at" in DD/MM/YYYY format and the GBP/EUR, GBP/USD Fx closing rates.

### 3.3 ARIMA Python Libraries

We used numerous python libraries for this study. We extracted the pound Fx rates using the aforementioned Yahoo! Finance python library. For the financial time series, we utilised python scripts for basic time-series modelling such as non-stationary variables, autocorrelation, partial autocorrelation in addition to hyperparameter selection, modelling and forecasting. Further, we used Facebook's Prophet python library run our Prophet forecasts.

### 3.4 Prophet Forecasting Model

Our Prophet forecasting model was also executed using python. Prophet is an open source software that is available in python and R for forecasting time-series data. Prophet was produced by Facebook's Core Data Science team. Prophet excels where the time series consists of hourly, daily, or weekly observations with at least a few months (preferably a year) of history, strong multiple seasonality impacts: day of week and time of year, important holidays that occur at irregular intervals that are known in advance, a reasonable number of missing observations or large outliers, historical trend changes, for instance due to product launches or logging changes and trends that are non-linear growth curves, where a trend hits a natural limit or saturates. [18] The forecast package includes many different forecasting techniques inclusive of exponential smoothing [18]. Prophet strives to provide a simple to use

model that is sophisticated enough to provide meaningful insights and results. The modeling solution provides numerous parameters that analysts and data scientists alike can alter easily to suit their modelling requirements. Our implementation is on Windows and using PyPI which is the Python Package Index and known as the official third-party software repository for Python.

## 4 METHODOLOGY

Our requirement now after capturing the closing GBP/EUR and GBP/USD Fx market activity is to investigate the hypothesis that the polls prediction of a Conservative win could be validated by forecasted increases in the pound. We now apply our python machine learning to the time series. The ARIMA equation is a linear equation for stationary time series and is denoted by  $(p, d, q)$  where  $p$  indicates the order the autoregression,  $d$  indicates the order of converting non-stationary variables into stationary variables and  $q$  indicates order of the moving average. The ARIMA predictors comprise of lags of the dependent variables or lags of the forecast errors such that the predicated estimation of  $\gamma$  is equal to a constant or a weighted sum of the recent values of  $\gamma$ . Our financial time series can be classified as non-seasonal as the random fluctuations in the data are roughly constant in size over time. The model can be written as

$$\phi_p (B)(1-B)^d y_t = \mu + \theta_q (B)\epsilon_t \quad (1)$$

We first checked for non-stationary variables by plotting autocorrelation and partial correlation graphs for each financial time series (*i.e. GBP/EUR and GBP/USD*) in addition to calculating the mean and variance. Our findings indicated the mean and variance values for each of the financial models were similar, such that the mean and variance were not equal indicating that each financial time series may not be stationary. To confirm non-stationary Dickey Fuller tests were implemented for stationary such that  $d = 0$ , where  $d$  represents differencing. To convert to stationary, we apply the differencing function to the python script. The use of the log difference equation in equation 2 was satisfied once the two time series were converted to stationary. The GBP/EUR time series is denoted as  $gbpeur_t$  this essentially defines the daily net increase and decreases in the GBP/EUR Fx, essentially this is the delta between  $gbpeur_t - gbpeur_{t-1}$  similarly, we use  $gbp/usdt - gbp/usdt-1$  for the sterling US dollar Fx rate.

$$\Delta Y_t = \frac{\ln(Y_t) - \ln(Y_{t-1})}{\ln(Y_{t-1})} \quad (2)$$

Two ARIMA models were developed using the GBP/EUR and GBP/USD to evaluate combinations of  $p$ ,  $d$  and  $q$  values. The parameters can be determined by observing the

autocorrelation function (ACF) and the partial autocorrelation function (PACF). In each case, we ran hyperparameter tests to source the best model. The results are illustrated in table 1

**Table 1: Arima Model**

| Component                    | Final Estimates |         |         |        |       |
|------------------------------|-----------------|---------|---------|--------|-------|
|                              | Type            | Coef    | SE Coef | T      | P     |
| GBP/EURO<br>ARIMA<br>(4,1,0) | Constant        | -0.0001 | 0       | -0.884 | 0.377 |
|                              | AR 1            | 0.0047  | 0.029   | 0.166  | 0.869 |
|                              | AR 2            | 0.0359  | 0.029   | 1.257  | 0.209 |
|                              | AR 3            | -0.006  | 0.029   | -0.209 | 0.834 |
| GBP/USD<br>ARIMA<br>(4,1,0)  | Constant        | -0.0001 | 0       | -0.632 | 0.527 |
|                              | AR 1            | 0.0075  | 0.028   | 0.381  | 0.703 |
|                              | AR 2            | 0.0209  | 0.028   | 0.736  | 0.462 |
|                              | AR 3            | 0.0018  | 0.028   | 0.026  | 0.979 |
|                              | AR 4            | -0.0648 | 0.028   | -2.307 | 0.021 |

Each case had 20 ARIMA models. The models were split in two: 70% for the initial training dataset and the remaining 30% for the test dataset. To select the best model case, we used the MSE equation illustrated below in equation 3.

$$MSE = \left(\frac{1}{n}\right) \sum_t^n (A_t - F_t)^2 \quad (3)$$

The Mean Squared Error is a model evaluation metric often used with regression models. The mean squared error of a model with respect to a test set is the mean of the squared prediction errors over all instances in the test set. The prediction error is the difference between the true value and the predicted value for an instance [19]. We define the MSE where  $A_t$  = actual GBP/EUR Fx, or GBP/USD Fx rate on tth date and  $F_t$  = forecasted GBP/EUR Fx, or GBP/USD Fx exchange rate on tth date, n = number of data samples. We choose ARIMA (4, 1, 0) because the it presented with the best MSE score and where  $P < 0.05$  based on the least difference value between the predicted and the actual values. The mathematical model infers  $Y_t = Y_{t-1} + (Y_{t-1} - Y_{t-2}) - (Y_{t-2} - Y_{t-3})$  where  $Y_t$  is linearly

dependant on values  $Y_{t-1}$ ,  $Y_{t-2}$  and  $Y_{t-3}$ . In simple terms, we are stating that the current GBP/EUR Fx rate is linearly dependent on the previously GBP/EUR Fx rate. The same is applicable to the GBP/USD Fx rate. Table 1 illustrates the final estimates of the parameters for each auto regression model. Prophet uses an additive regression model which is essentially a non-parametric regression method. This comprises of the following components where

$$y(t) = g(t) + s(t) + h(t) + \epsilon t \quad (4)$$

Such that where trend  $g(t)$  models non-periodic changes, Seasonality  $s(t)$  represents periodic changes and holiday component  $h(t)$  contributes information about holidays and events.

#### 4.1 Measure of Accuracy

The Mean Absolute Percentage Error (MAPE) and the Mean Square Error (MSE) are used to compare the performance of the models for forecasting the exchange rate values of sterling against the euro and the US dollar. We previously defined the MSE in equation 3. The error metrics for the MAPE can be defined as

$$MAPE = \left(\frac{100}{n}\right) \sum_{t=1}^n \frac{(A_t - F_t)}{x} \quad (5)$$

The mean absolute percentage error (MAPE) is the mean or average of the absolute percentage errors of forecasts. Error is defined as actual or observed value minus the forecasted value. Percentage errors are summed without regard to sign to compute MAPE. This measure is easy to understand because it provides the error in terms of percentages. Also, because absolute percentage errors are used, the problem of positive and negative errors cancelling each other out is avoided. Consequently, MAPE has managerial appeal and is a measure commonly used in forecasting. The smaller the MAE and MAPE the better the forecast. [20]

## 5 RESULTS

Table 2 and 3 illustrate the results of the ARIMA and Prophet accuracy metric tests. ADF tests were implemented for stationarity and the optimal number of lags were calculated according to the basic steps in time series analysis. We can reject the null hypothesis that the polls prediction on December 4th 2019 of a Conservative victory could be validated by forecasted increases in the pound such that evidence presented herein is indicative of short term forecasted increases in both the GBP/EUR Fx and the GBP/USD Fx rate from the indications of Conservative majority on December 4th until the conclusion of the BREXIT election on 12th December 2019. The results are presented in terms of measures in MAPE and MSE. The ARIMA model was found to be more accurate based on accuracy metrics. Figures 1,2,3 and 4 illustrate the forecasted ARIMA and Prophet GBP/EUR Fx and GBP/USD Fx

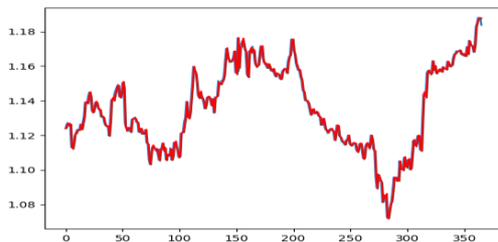
rate trajectories. One shortcoming was the weakness in the dataset of seasonality as the Prophet model works best with strong seasonal effects hence the slightly lower accuracy metrics.

**Table 2: Accuracy Metrics for ARIMA**

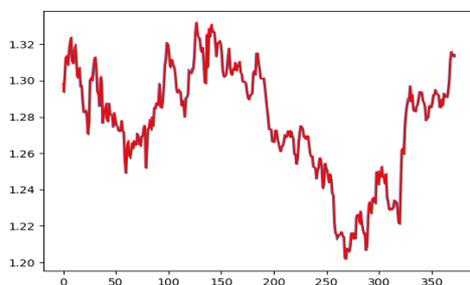
| ARIMA | GBP/EUR  | GBP/USD  |
|-------|----------|----------|
| MAPE  | 0.000023 | 0.000038 |
| MSE   | 0.000023 | 0.000038 |

**Table 3: Accuracy Metrics for Prophet**

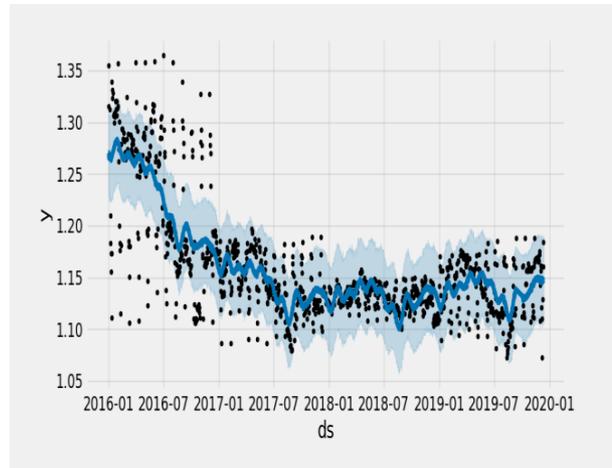
| Prophet | GBP/EUR  | GBP/USD  |
|---------|----------|----------|
| MAPE    | 0.015460 | 0.021661 |
| MSE     | 0.000437 | 0.001514 |



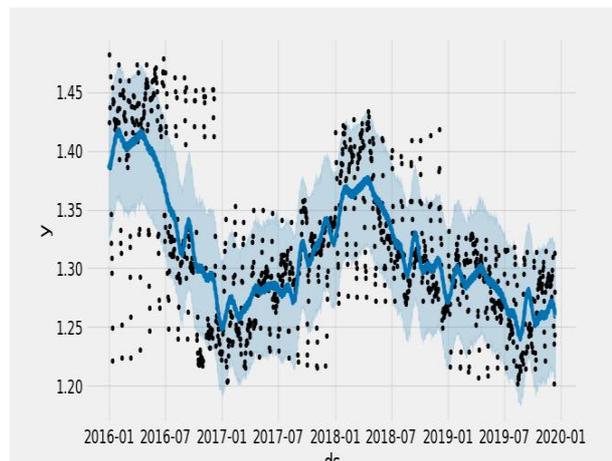
**Figure 1: ARIMA GBP/EUR forecast**



**Figure 2: ARIMA GBP/USD forecast**



**Figure 3: Prophet GBP/EUR forecast**



**Figure 4: Prophet GBP/USD forecast**

## 6 CONCLUSION

In this paper, we presented two machine learning models to determine if the polls prediction of a Conservative party victory on the 4<sup>th</sup> December, 2019 could be validated by short-term forecasted increases in the pound. Our results were obtained using historical data from the 1<sup>st</sup> January, 2016 until the 12<sup>th</sup> December, 2019. Both the proposed ARIMA and Prophet model indicated rises in sterling against the euro and dollar from the publication of the Conservative Party's lead in the polls on the 4<sup>th</sup> December, 2019 where sterling rose against the euro from 1.1680 to 1.1836 and where sterling rose against the Dollar from 1.294 to 1.313. We made a comparison between both model's performance by calculating the accuracy metrics displayed in table 2 and 3 respectively. We can determine that

both the ARIMA and Prophet models provide proficient performance metrics in terms of accuracy. The ARIMA model provided better accuracy in terms of the pound forecasting. Both ARIMA and Prophet would prove useful tools to forecast other BREXIT related parameters such as the demise of the FTSE 100 Index's domestic British blue-chip utility stocks after the unveiling of the Labour Party's Nationalisation plan as part of their election manifesto. In the current post BREXIT environment with European Central Bank interest rates at their record lowest, the European Commission has insisted on maintaining the integrity of the EU Single Market such that the Customs Union must be preserved and a level playing field must exist to guarantee robust commitments, and "dynamic alignment" of EU-UK rules.[21] British banks and British fiscal policy in general could be forced to make leveraged investments in illiquid assets ( i.e. *higher associated risk*) funded with short-term liabilities to profiteer, exactly the type of investing that destroyed Lehman Brothers in 2008. When those liabilities come due and if the UK reneges on its financial obligations to its foreign investors and sovereign governments, the expectancy would be sharp decreases in pound not withstanding a possible euro currency devaluation if the dynamic alignment of EU-UK rule are not preserved. Further, with ongoing geopolitical tension between the US and the Conservative administration fueled by the Conservative government's persistence to introduce a digital services tax on the technology sector [22] and a reluctance to accept the US position of an embargo on Chinese Technology manufacturer Huawei [23], we could see a short-term currency war escalate in sterling devaluation to maintain competitiveness against the dollar. The proposed ARIMA and Prophet models are useful tools in forecasting these currency trajectories. Future research is currently focused on BREXIT events. Considering the volatility of FIAT currencies during the BREXIT Withdrawal stalemate, we look to provide forecasts into the Crypto currency markets and the safe haven commodity, gold, with the use of additional forecasting methods such as neural networks. Recently, [24] [25] exposed revelations regarding the political influence of BREXIT psychometric micro targeting. Further research is concerned with the application of psychometric profiling methods to our datasets, in conjunction with causality and forecasts to understand which personality types and traits had casualty with the markets during BREXIT.

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