Analysing Impact of US – China Trade War on Large Tech Stocks
Forecasting Price of Large Tech Stocks using ARIMA Modelling and the Comparison of Returns from US and Chinese Stocks

[1]Pramit Das, [2]Subhrajyoty Roy
[1] Masters student in Statistics, [2]Undergraduate student in Statistics,
[1]Indian Statistical Institute, Kolkata, India

Abstract : This study has been undertaken to investigate the effect of US-Chinese trade war on the returns of large tech stocks based on both these countries. Due to the US-China trade war and other regulatory concerns, there has been lot of volatility in the Chinese tech stocks. As a result, as reported by CNBC on 20th September 2018, more than $168 billion had been wiped off from the total market cap of major Chinese tech stocks, creating an international concern over them. We use ARIMA modelling in order to predict the returns of the four major tech stocks based in US and China, in next 3 months using past 1 year's data. This also helps us to scientifically explain the reason of steady growth in US stocks, and the downfall of major Chinese tech stocks, with the support of past data on these stocks.

IndexTerms **– Stock, Trade, Finance, Time series, US-China trade war.**

I. INTRODUCTION

Baidu, Alibaba, Xiaomi and Tencent are major Chinese tech companies that are the most important rivals of their US counterparts, viz. Alphabet (Google), Amazon, Apple and Facebook. Recently, due to the US-China trade war and other regulatory concerns, there has been lot of volatility in the Chinese tech stocks. As a result, as reported by CNBC on 20th September 2018, more than $168 billion had been wiped off from the total market cap of Baidu, Alibaba and Tencent. Alibaba shares were down over 11 percent year-to-date, while Tencent had dived below by 22.4 percent. Baidu, which performed relatively better, was more than 6 percent down .

During last September and October , there was a steady stream of international concern over these Chinese tech stocks, which are generally otherwise believed to be strong and steady growth stocks . The question of whether these stocks would recover and how much return can they provide in near future (i.e. whether one should now purchase these stocks at low prices and sell them in near future if prices go high enough), are still persistent. Detailed reference can be found in https://www.cnbc.com/2018/09/20/chinese-tech-stocks-versus-fangs-trade-war.html .

We have tried to predict the expected price and returns from these stocks in next 3 months using the past 1 year data using ARIMA modelling. Further, we wish to compare the expected returns of Baidu, Alibaba, Xiaomi and Tencent with that of Alphabet (Google), Amazon, Apple and Facebook for short term investment (next 3 months).

II. THEORETICAL BACKGROUND

2.1 Auto Regressive Integrated Moving Average (ARIMA) Model

The Autoregressive Integrated Moving Average (ARIMA) model is a very general class of time series models which can be used to model a non-stationary time series, with combination of autoregressive and moving average terms. The Autoregressive terms comprises of the lagged version of the forecasts for the time series in concern, while the moving average terms comprises only of previously lagged forecasted errors. An ARIMA model, in theory, can also be extended to capture seasonality based autoregressive and moving average terms. In ARIMA model, a non-stationary time series is made into a stationary time series by taking finite differences. For instance, it the series has a linear trend, then first difference should make the model stationary, while if it has a quadratic trend, then we may need to take second order differences. There are following three main components of ARIMA(p, d, q) model;

1. p is the number of autoregressive terms in the model.
2. d is the order of differencing needed to make the series stationary.
3. q is the number of moving average terms or the number of lagged forecast errors.

The mathematical equation of the model is given as;

$$\phi(B)(1-B)^d y_t = \theta(B)\epsilon_t \quad (2.1)$$

where y_t is the original time series, ϵ_t is the error of the forecasted value, $\phi(\cdot)$ is a polynomial of order p and $\theta(\cdot)$ is a polynomial of order q and B is the Backshift operator such that $By_t = y_{t-1}$. We also assume that the errors ϵ_t's are i.i.d. normally distributed with zero mean. In this model the expansion of the term $(1-B)^d$ is to be done by using the general binomial theorem. Various contributions have been made by researchers towards the estimation of the ARIMA parameters. Method of maximum likelihood estimation and minimising conditional sum of squares are the popularly used techniques to estimate ARIMA parameters. Detailed reference can be found in Adhikari, R., Agrawal, R.K.: *An introductory study on time series modelling and forecasting* (http://arxiv.org/abs/1302.6613) .

2.2 Box – Jenkin's Methodology

Statisticians George Box and Gwilym Jenkins developed a practical approach to build ARIMA model, which best fit to a given time series and also satisfy the parsimony principle. Their concept has fundamental importance on the area of time series analysis and forecasting.

The Box Jenkins method does not assume any particular evident pattern in the data, rather it tries to use an iterative algorithmic procedure in order to find the best fitting ARIMA model to the data. The key steps are as follows;

1. Postulate a general class of ARIMA model.
2. Perform exploratory analysis on data in order to find out some suitable model for the data which can be entertained.
3. Estimate parameters for that suitably chosen model.
4. Running diagnostics criterion in order to validate the model.
5. If the model is not adequate, return to step 2 to find a new model, else go to next step.
6. If the model is adequate, then generate forecasts from the model.

A crucial step in selecting an appropriate model is the determination of optimal model parameters from the exploratory analysis on the data. One criterion is that the sample ACF and PACF, calculated from the sampled data should match with the corresponding theoretical or actual values to some extent. Other widely used measures for model identification are Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC) which are defined as follows;

$$AIC(\Omega) = n\,ln\left(\frac{\sigma_e^2}{n}\right) + 2p \quad (2.2)$$

$$BIC(\Omega) = n\,ln\left(\frac{\sigma_e^2}{n}\right) + p + p\,ln(n) \quad (2.3)$$

where Ω denotes the model, n is the number of observed samples, σ_e^2 is the sum of squares of residuals after forecasting with the model and p is the number of free parameters in the model Ω. It can be readily seen that both AIC and BIC goes up as the residual sum of squares or number of parameters increases. As a consequence, the optimal model selection is based on the criteria of minimising AIC or BIC.

2.3 Augmented Dickey Fuller test

Augmented Dickey Fuller (ADF) test or Unit root test is a popular test performed to check whether a time series is stationary or not. If the test returns a p-value of less than 0.05 (or 0.01, depending on level of significance), we conclude that the corresponding time series is stationary. Otherwise, we make the time series stationary by successive differencing.

III. METHODOLOGY OF ANALYSIS

3.1 Data and Sources of data

This study has been conducted based on the secondary data on the daily adjusted closing prices of stocks provided by Yahoo Finance. We have primarily chosen GOOGL (Alphabet Inc.), AMZN (Amazon.com Inc.), AAPL (Apple Inc.) and FB (Facebook Inc.) as the four primary tech stocks based on US. On the other hand, we have chosen BABA (Alibaba Group Holdings Limited), BIDU (Baidu, Inc.), 18010.HK (Xiaomi Corporation) and 0700.HK (Tencent Holdings Limited) as the four major tech stocks based on China. The data on the past 1 year, starting from January 12, 2018 (if available) on the daily adjusted prices for each of these stocks has been collected.

3.2 Exploratory Analysis of data

An exploratory analysis on each of the time series shows that a multiplicative model might be good in order to get a well-fitted model of the data. Therefore, we have applied log transformation to the time series data. Based on this transformed time series, we try to check whether there is any trend or non-stationarity present in the time series (**Fig.1**). This can be verified using Augmented Dickey Fuller (ADF) test.

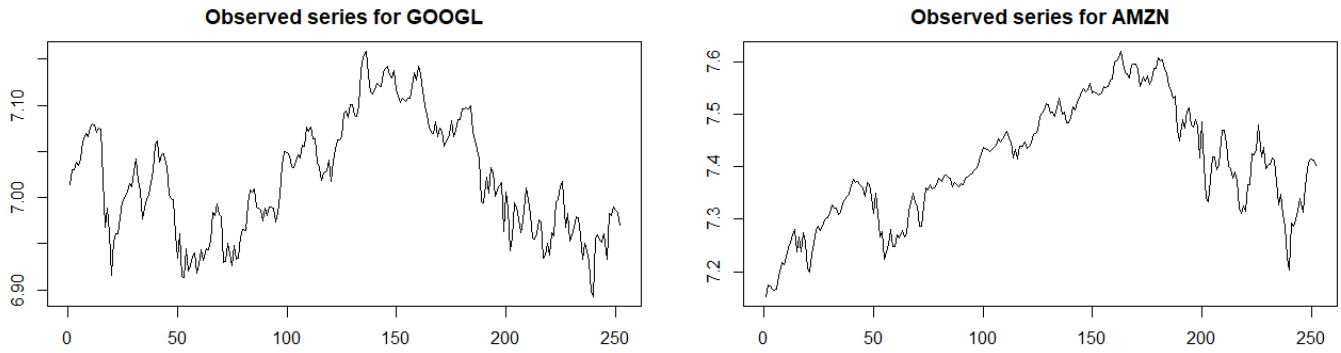

Figure 1: Comparison between a stationary and non-stationary log transformed series of US tech stocks. (The series for GOOGL on left hand side is stationary, while the series for AMZN on right hand side is not stationary)

We have found that if there is non-stationarity presented in the series, then taking the first difference would transform the series into a stationary one. This can again be verified using ADF test performed on the differenced series. Two differenced time series, for which the differenced series is stationary, one for Apple Inc. and one for Baidu Inc. has been presented in **Fig.2**.

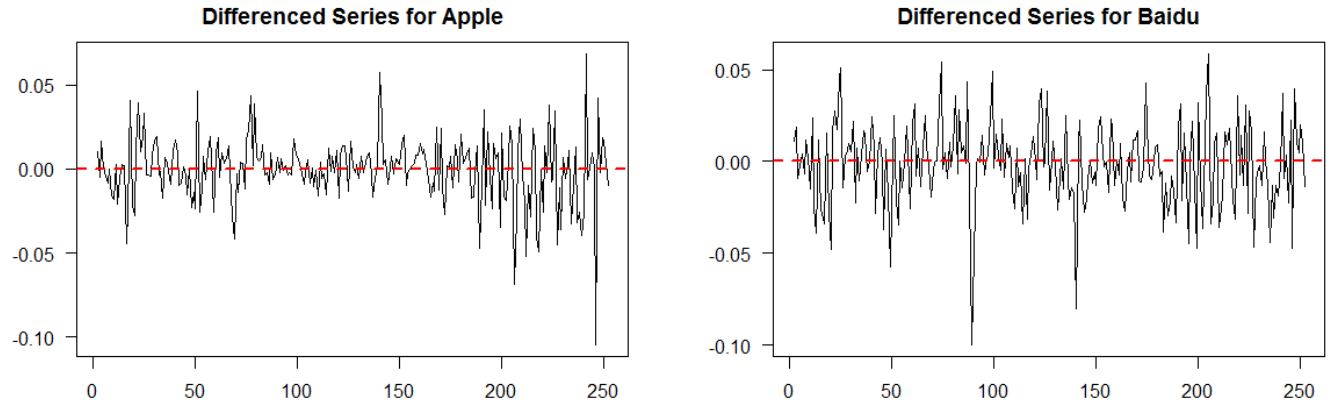

Figure 2: Differenced and Stationary time series for Apple Inc. and Baidu Inc.

3.3 Fitting of ARIMA models

Based on the suitable order of differencing, we try to fit ARIMA(p, d, q) model to each of the log transformed time series, where d, the order of differencing is either 0 or 1, and p and q being either 1 or 2 or 3. Among the 18 ARIMA models obtained for each time series, we choose the one model which has minimum AIC among these. The order of the appropriate ARIMA model obtained from minimising AIC for each of the log transformed time series has been presented in table 1. Column 5 in table 1 shows the minimum AIC obtained.

Table 1: AIC Minimising ARIMA models

Name of the Stock	ARIMA autoregressive order	ARIMA differencing order	ARIMA moving average order	Minimized AIC
Apple Inc.	3	1	2	-1265.119
Alphabet (Google Inc.)	3	0	2	-1306.361
Facebook Inc.	1	0	1	-1136.604
Amazon.com Inc.	3	1	2	-1176.157
Alibaba	2	1	2	-1191.046
Baidu Inc.	2	1	2	-1201.13
Xiaomi	2	1	2	-500.1284

Tencent	1	0	1	-1143.768

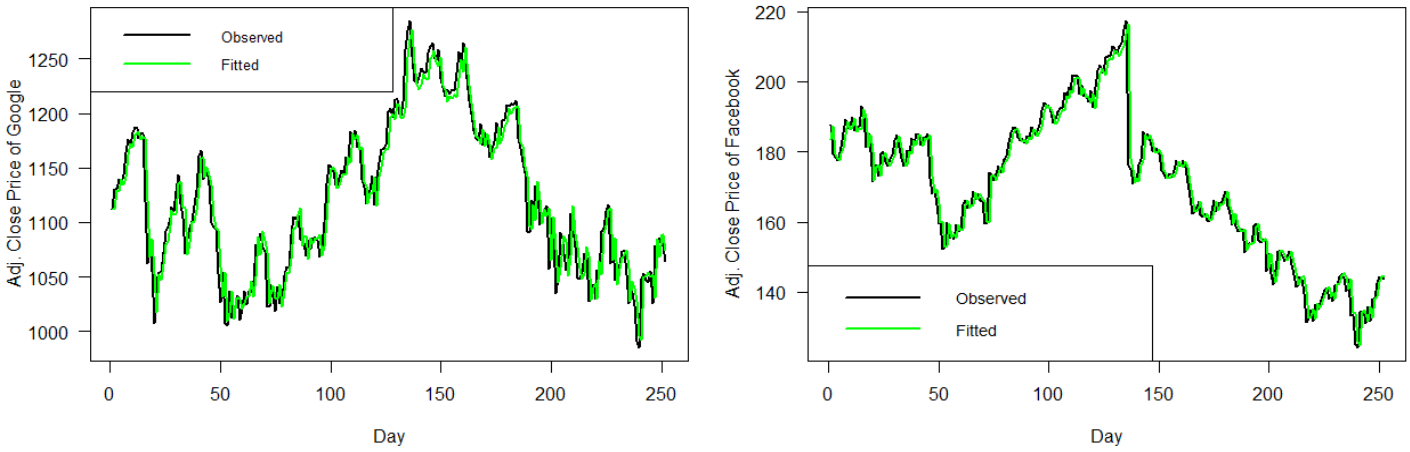

Figure 3: Fitted values against original observation for Google and Facebook, two US based tech stocks.

We find that the fitting of the ARIMA model according to table 1, gives visually good fitting on the past values (**Fig.3** and **Fig.4**). We used exponentiation to inverse the predicted values by the ARIMA model to go back to the original scale. Also, in terms of Root Mean Squared error (RMSE) and Mean Absolute error (MAE), the ARIMA model seems reasonably good. Table 2 presents the RMSE and MAE for each of the time series in its original scale.

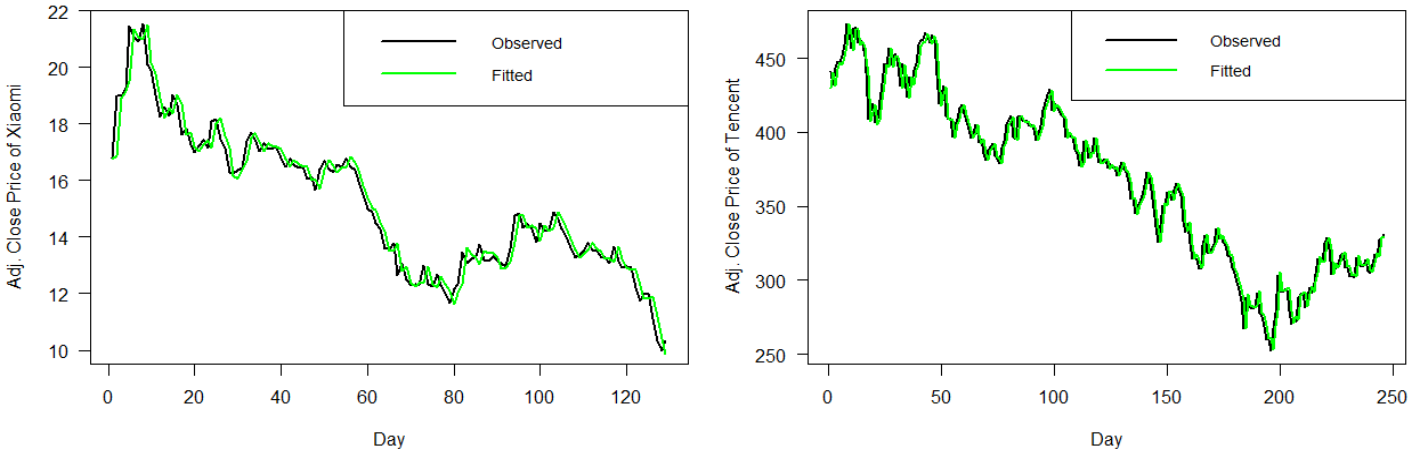

Figure 4: Fitted values against original observation for Xiaomi and Tencent, two China based tech stocks.

3.4 Numerical Results

We used the fitted model in order to predict the future close prices of these eight major tech stocks for a span of 90 days. The prediction for Amazon Inc. and Alibaba Group Holdings Ltd. for last 14 days of our prediction span of 90 days have been shown in table 3. Also, the expected returns for each of these tech stocks has been presented in table 4.

Table 2: RMSE and MAEs of fitted ARIMA models

Name of the Stock	RMSE	MAE
Apple Inc.	0.019	0.014
Alphabet (Google Inc.)	0.018	0.013
Facebook Inc.	0.025	0.016

Amazon.com Inc.	0.023	0.016
Alibaba	0.022	0.018
Baidu Inc.	0.022	0.017
Xiaomi	0.032	0.025
Tencent	0.023	0.018

Table 3: Predicted Adjusted Close Price for Amazon Inc. and Alibaba Group for 77-90 working days after 12 Jan, 19

Day 77-83			**Day 84-90**		
Number of the day	**Predicted Adj. Close price of Amazon Inc.**	**Predicted Adj. Close price of Alibaba Group.**	**Number of the day**	**Predicted Adj. Close price of Amazon Inc.**	**Predicted Adj. Close price of Alibaba Group.**
77	1647.67	151.6290	84	1657.99	151.6247
78	1657.15	151.6228	85	1650.44	151.6223
79	1655.73	151.6221	86	1639.99	151.6263
80	1645.11	151.6281	87	1638.98	151.6252
81	1637.90	151.6239	88	1648.57	151.6226
82	1642.57	151.6221	89	1657.47	151.6257
83	1653.64	151.6271	90	1655.09	151.6254

Table 4: Expected Returns for US and Chinese Tech Stocks

US based Tech Stocks		**China based Tech Stocks**	
Name of the Stock	**Expected Returns (%)**	**Name of the Stock**	**Expected Returns (%)**
Apple Inc.	0.5428	Alibaba Group Holdings Ltd.	0.2018
Google (Alphabet Inc.)	4.5151	Baidu Inc.	-0.1308
Amazon.com Inc.	0.8856	Xiaomi Corp.	-0.5146
Facebook Inc.	12.856	Tencent Holdings Ltd.	7.6632

3.5 Diagnostics Analysis

After the fitting of the ARIMA model, we wish to check whether the basic assumptions of normality of the errors ϵ_t holds. This can be checked by looking at the distribution of the residuals, and in a compact form, the Q-Q plot of the residuals, which plots the sample quantiles against the theoretical quantiles from normal distribution. **Figure 5** shows such plots for Google (Alphabet Inc.) and Baidu Inc. in order to assess the quality of the fit from the residuals' perspective.

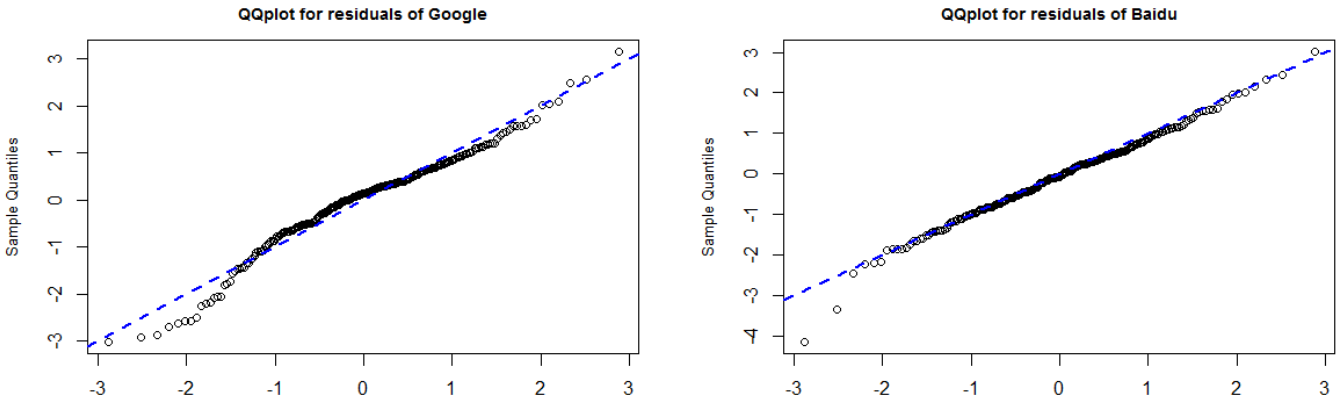

Figure 5: Q-Q Plot of residuals for Google Inc. and Baidu Inc. after fitting of the ARIMA models

From **Fig.5** it is evident that fit of the ARIMA model seems reasonably good as the distribution of residuals is "close" to a normal distribution. We also see that there are some slight departure from the "exact" reference line, which can easily be ignored as they contribute very few of the data points in the series.

3.6 Economical Interpretation

- The study shows that, the US tech stocks (Apple, Amazon, Facebook & Google) won't have any negative effect of the trade war on them in the coming 3 months, rather they'd grow. This is expected since, US being the most powerful economy on the earth during tensions in market , these large US tech stocks are more likely to benefit from investor confidence .

- Share prices of Google and Facebook are likely to increase significantly by about 4.5% and 12.8% respectively). This is expected since both these stocks has been in increasing trend since last 1 month. They're also likely to benefit from recently announced tax cuts by US government

- Among the large Chinese tech stocks, Tencent is expected to give high return of 7.6% in coming 3 months. Many investors feel that, the Tencent stock is currently cheap and has lot of potential to grow. Hence the deans for Tencent might increasing in future driving its price upward.

- Baidu and Xiaomi are expected to fall further in next 3 months and Alibaba is expected to give a 0.2 % return only. This expected poor performance may be due to falling investor confidence due to high volatility of these Chinese stocks and recent regulatory crackdowns by Chinese government. Further, Xiaomi might loose its hold on the US Smartphone market in future due to some unexpected regulation by US government.

IV. CONCLUSIONS

Our analysis shows that, large US tech stocks would largely be the gainer in the trade war, while Chinese stocks (except Tencent) might actually go further below. From an investor's perspective, one should currently prefer US tech stocks over the Chinese counterparts due to high volatility of these Chinese stocks. Even though Tencent has a predicted return of 7.66% in just next 3 months, their prices are largely volatile and might go down too (as all factors affecting stock prices can't be predicted well in advance). Companies like Google, Amazon, Facebook etc. have a much higher reputation across the globe and would continue to enjoy investor confidence in near future due to stable long term returns (as well as short term returns).

REFERENCES

[1] Box, George; Jenkins, Gwilym (1970). *Time Series Analysis: Forecasting and Control*. San Francisco: Holden-Day.
[2] Adhikari, R., Agrawal, R.K.: *An introductory study on time series modeling and forecasting*. CoRRabs/1302.6613(2013), http://arxiv.org/abs/1302.6613.
[3] Kharpal, A.: *Chinese tech stocks were meant to take on fangsbut $168 billion has been wiped off their value.* https://www.cnbc.com/2018/09/20/chinese-tech-stocks-versus-fangs-trade-war.html (20 Sept. 2018).
[4] Dickey, David and Fuller, Wayne A (1981). *Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root.* Econometrica, vol. 49, no. 4, p1057-72.
[5] *Yahoo finance* https://in.finance.yahoo.com