Interactive Qualifying Project

Can we predict a Stock's Price?

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Term: *E-2014*

Department of Electrical and Computer Engineering

Student Signature: ……

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Abstract

Getting honestly, responsibly wealthy with as little work as possible is the desire of all humankinds. One way to achieve that goal is investing in the Stock Market. This project will try to derive a model which predicts the price of a stock for short period of time. Doing so will help me, an avid investor, new, and experts investors to have a tool at our disposal to predict the price of the stock.

Executive Summary

Do you want to make money? Are you an informed risks taker? If you answer yes to both questions, this Interactive Qualifying Project is designed exclusively for you. If your answer is yes for only one of the two questions, and I suspect that it is “yes, I want to make money”, this project is for you too. If your answer is neither of them, this IQP is actually more for you than any other persons because you will learn more about the stock’s price, loaded with new knowledge and start enjoying making money without fearing of taking informed risks.

Before we all get excited in starting making money, let take a time to have a global idea of how a stock price moves or changes. Indeed, to understand how it changes, just believe that by the time you read this executive summary, a particular stock can change ten times or so. In order to follow those quick changes, we need to have a model or functions that change with the stock price. In Mathematics, Sine and Cosine function are well suited to do that. While there are thousands of ways and models to predict the price of stock, we are using in this project a model called Fourier Series Expansion Model. We are using this model because it is inexpensive and can be used by average, new investors. There is no need to spend thousands of dollars to buy those expensive tools for stock price prediction, tools that are often wrong in their predictions. The only thing you need to know to use our model is the use of computer equipped with Microsoft Excel and Matlab programming.

With that in mind, we use the following 3 steps to design and test our Fourier series expansion model:

1- select ten technology stocks with following price range: 3 stocks with price over $100.00; another group of 3 companies which stock price range between $20.00 and $100.00 and finally, we choose 4 companies which stock are under $20.00.

2- From www.yahoo.com we get the historical price of all stocks for one year (week-end excluded) and download them into excel Spreadsheet.

3- Using Matlab we import the data (price) of these stocks into Matlab environment and use Malab programming to plot the trend, the autocorrelation, the regression line, the difference between the regression line (best fitting line) and the stock trend up to the relevant data. After that, we use Polyfit command, and the fit command to plot Fourier series expansion along with the actual stock trend. The difference between the Fourier Series Expansion and the stock trend give us the noise. And finally, the prediction is determined by the sum of the Best Fitting Line and the Fourier Series Expansion that we plot along the actual stock price trend.

All the above procedures were completed and generate predictions that are not 100% accurate for the entire 30 days prediction. Some stocks prediction is correct with minor deviation from the real price and some are totally off the “chart”. One of the skills needed for plotting the

graphs for analysis is Matlab programming and we got a help from our advisor, Professor Humi during the project.

In order to know how well the prediction is, it is important to plot the graph including the 95 % Confidence Interval (CI) where the predictions curve is the mean value, and the Confidence Interval constituted the difference between the upper and lower curve from the mean. Our recommendations of improving this project is by plotting the Confidence Interval and use other degree of the best fitting line to see which one will work best with the prediction. With the direction and advice of Professor Humi Mayer, the Fourier Series Model is completed.

Introduction

Originated in 12th Century, in France, the idea of trading or exchange started with les courretiers de change: "The courretiers de change" that has function of negotiating the value of mobile objects and financial instruments. They were the first brokers who were managing and regulating the debts of the agriculture communities on behalf of the banks. This idea of been a broker evolved and expanded to millions of brokers who trade stocks in common place called Stock Exchange. Beside brokers, ordinary individual investor can trade stock using the monumental advance of technology and education of today. For an experienced or a new stock trader, the goal is to buy the shares of companies at lower price and sell them when the stock price is higher that the purchase value, and make profit.

In order to make that profit, stock buyers and sellers must be able to predict the price of the stock in the future. Hmmmm… Interesting!!!! This seems complicated; and unachievable. Among others, the price of the stock depends on millions of factors: Natural Disaster, Man-made Disaster, Terrorisms, Wars, Companies Breaking News (layoff, firing, financial reports, closing…etc.), Political News (Federal Reserve Bank announcement), and Psychology of consumers (High or low confidence on economy…etc.).

Right now, with the extraordinary advance of the Technology and Sciences, we cannot predict what will happen in the few hours of today's date. How can we predict the stock with so many variables in the future? Accurately predict the Stock Price in the future is to be able to

predict that a terrorist attack will occur on September 11, 2011 starting at 6:00 AM and the North Tween Tower will be struck at 8:46:30 AM. It is to be able to predict that there will be a natural disaster (Tsunami in China, earthquake in Haiti) or Man-made disaster (nuclear wars). Not only that, it is to be able to predict with certainty that on May 02, 2011, the President Of The United State (Barak Obama) will say to the whole world: “United States of America has killed Osama Bin Laden”; it is to have the power to predict that Russia will invade Ukraine tomorrow and in addition to that, company X or Z will announce a positive or negative financial report. And since the move of the stock price depends on the psychological aspect of the consumers, we must be able to predict the mood of the people in the economy. All these to predict one and only one thing: the Stock Price.

So, **Can we predict a Stock Price?**

In my attempt to accomplish that seemly difficult task with the help of my advisor, Professor Humi Mayer, I will start with the approach base of the following idea: “Know the past data to understand the present ones and use the present to predict the future data”. I believe that with my education at WPI where I took courses like Discrete Signals and Systems Analysis, Calculus, Matlab Programming, Statistic and Probabilities, I will be able to predict closely to the reality than previously attempted by others. To do so, I will choose 10 Technology Companies which stock’s one year history I will use for my analysis, simulation and prediction. There will be a total of 252 days since the holidays and weekend will not count in the data analysis. After this

long history analysis, I will then have a review of my executive summary, give recommendations and conclusion of my work.

Why this is an Interactive Qualifying Project (IQP)?

At Worcester Polytechnic Institute, we have a mandatory two projects to complete as degree requirements before graduating. One is called MQP which essentially is concentrated on designing, conceiving (manufacturing) and testing a prototype of developed idea in our major field.

The second is called IQP which take both the science and society and use the science to develop model, algorithm, etc. to try to help solve the problems or issues of the society.

Our Institute defines IQP and put it at best in this term "The Interactive Qualifying Project, or IQP as it is known on campus, is WPI's most distinctive academic requirement, and is unique in higher education. The IQP challenges students to address a problem that lies at the intersection of science or technology with social issues and human needs and is done under the direct guidance of one or more faculty advisors, usually I teams of 2-4 students."

The goal of IQP is clearly spelled out by our Institution to help students to follow what IQP must be. As WPI says, "The objective of this interdisciplinary requirement is to enable WPI graduates to understand, as citizens and as professionals, how their careers will affect the larger society of which they are part. Generally, these projects

involve some analysis of how technology affects, and is affected by individuals and communities."

Arm with this definition and objective of our Institution, we are going to answer the most important question" Why this is an IQP?

This IQP's objective is to predict the price of stock using the science and technology available to us. The goal of everyone in our society is to live comfortably by having enough money to continue surviving. One way to get enough money is to invest in stock of a company of our choice. There is a danger of losing a lot of money if the society does not have tools in place to help it before taking the risk of owing part of company which is basically buying low and selling high a stock of a particular company. Even though, there are thousands of ways to predict stock, it is often difficult to get it right. As prospective engineers, we are trying to use our knowledge of Fourier Series Expansion along with Matlab programming to model and plot ten stocks that we chose for our project. The success of this project will help us and people in our society to have good tool at their disposal to predict the price of a stock and decide to buy when the prediction shows a low trending of the stock in particular day and sell when the prediction shows that the stock price will be trending high in particular day or range of days.

Because our project uses the technology, science and mathematics to create a tool that will help investors in society to make informed decision before buying stocks, our project responds to the definition and objective of an IQP set by Worcester

Polytechnic Institution. Therefore, we could say with confidence that this project is and IPQ.

Factors affecting Stock Price

Thousands of factors affect the outcome of the Stock price (with some listed in the figure1 below), the ultimate question is: Can we predict a Stock Price?

While a 100% prediction seems impossible, this report is an academic project that will attempt to predict a stock Price.

Figure 1

Source: http://en.wikipedia.org/wiki/List_of_stock_market_crashes_and_bear_markets

Let's take at least two of these factors above and see how the affected the market. We know that these events were unpredictable but affected the stock price in big way.

Terrorism Attack of September 11, 2001

a- Market reaction

"Anticipating market chaos, panic selling and a disastrous loss of value in the wake of the attacks, the NYSE and the Nasdaq remained closed until September 17, the longest shutdown since 1933. Moreover, many trading, brokerage and other financial firms had offices in the World Trade Center and were unable to function in the wake of the tragic loss of life and collapse of both towers.

On the first day of NYSE trading after 9/11, the market fell 684 points, a 7.1% decline, setting a record for the biggest loss in exchange history for one trading day. At the close of trading that Friday, ending a week that saw the biggest losses in NYSE history, the Dow Jones was down almost 1,370 points, representing a loss of over 14%. The Standard and Poor's (S&P) lost 11.6%. An estimated $1.4 trillion in value was lost in those five days of trading.

Major stock sell-off hit the airline and insurance sectors as anticipated when trading resumed. Hardest hit were American Airlines and United Airlines, carriers whose planes were hijacked for the terrorist attacks.

b – The Financial Aftermath

American Airlines (NYSE:AMR) stock dropped from a $29.70 per share close of September 11 to $18.00 per share close on September 17, a 39% decline.

United Airlines (NYSE:UAL) stock dropped from $30.82 per share close to $17.50 per share on the close on September 17, a 42% decline.

Similar steep declines hit the travel, tourism, hospitality, entertainment and financial services sectors, as a wave of temporary fear and uncertainty swept through the nation. Among the financial services giants with the steepest drops in share prices were Merrill Lynch which lost 11.5%, and Morgan Stanley which lost 13%.

Insurance firms reportedly eventually paid out some $40.2 billion in 9/11 related claims. Among the biggest losers was Warren Buffet's Berkshire Hathaway. Most insurance firms subsequently dropped terrorist coverage".

In the Figure 1 above, let take Company growth and see how it affects the outcome of stock price.

4.2 Company Growth

" Financial health of a company is also a factor. If a company looks like it's going to lose money perhaps the company just announced poor earnings then its stock has less value. Investors will pay more for a company with a history of earning strong profits and consistently paying healthy dividends.

While a company's past performance is important, even more important are its future prospects. A company that has not been making money might turn around, perhaps under new management, after increasing its efficiency, or by developing an innovative new product. Likewise, just because a company has made money in the past does not mean it will continue to do so.

A report that an individual or a company is trying to buy another business also can affect those business' stock prices. That's because the purchaser has to buy a majority of the stock to gain

control of the company. To do so, the suitor must persuade stockholders to sell their stock by offering an attractive price for their shares."

As we can see in both articles, stock price is very sensitive to multiple and unpredictable events. Predicting a price of stock is to face the challenge of predicting what will happen in the future. Since human being has no power to predict the future, we rely on God' giving intelligence that allow us to develop mathematical programs and algorithms to attempt to predict the future in short term.

Research

Trend and Fourier Expansion Model

The first step in my research is to look for the companies whose stocks' price I will be using in my project, and some factors out of millions that affect the price of stock (Figure 1 and Figure 2). This will be followed by the analysis of each of the figures in their specific way. Knowing the data of technology companies that I will be using for my project, I will plot the trend of each stock; find the relevant data to use by getting and plotting the autocorrelations for each stock. I will then proceed with the finding of the regression line also called the Best Fitting line. Using the Polyfit and fit functions I will then apply the Fourier expansion model to first fit the trend gives by the relevant data and then predict the stock price for 30 days.

COMPANY NAME	TICKER	YEAR IPO	CURRENT PRICE As of 05/30/2014	FORCASTED PRICE WITH THIS PROJECT
Apple Inc.	AAPL	**12/12/1980** IPO Price: $22.00	$636.48	Price will be available in the end of project
Google Inc.	GOOG	**09/19/2004** IPO Price: $85.00	$559.04	Price will be available in the end of project
International Business Machines Corporation	IBM	1986 IPO Price:	$183.76	Price will be available in the end of project
Microsoft	MSFT	**13/14/1986** IPO Price: $21.00	$40.26	Price will be available in the end of project
Facebook	FB	**05/18/2012** IPO Price: $34.00	$63.85	Price will be available in the end of project
Intel Corporation	INTC	**10/13/1972** IPO Price: $23.50	$26.96	Price will be available in the end of project
MRV Communications Inc.	MRV	**07/09/1989** IPO Price: $	$13.81	Price will be available in the end of project
Model N Inc.	MODN	**03/20/2013** IPO Price: $15.50	$11.0802	Price will be available in the end of project
Micrel Inc.	MCRL	**1994** IPO Price: $	$10.72	Price will be available in the end of project
Inteliquent Inc.	IQNT	**11/02/2007** IPO Price: $18.47	$14.98	Price will be available in the end of project

Figure 2

5.1 Companies profiles

Apple Inc.

Founded on April 1, 1976, Apple manufacture, market mobile communication and media devices, personal computers and portable digital music players in the world and sells software worldwide. Its Initial Public Offering (IPO) was $22.00 on December 12, 1980. As of May 30, 2014, its share's value is $636.48. Its Ticker (Trading symbol) is AAPL.

Google Inc.

Incorporated in 1998, Google creation started as research project and was called "PageRank". The name changed to Google which is a misspelling of the word googol (number 1 follow buy hundred zeros). Google is essentially a search engine that build product and provides services to organize the information. As of May 30, 2014, its share's value is $559.04 and its Ticker (Trading symbol) is GOOG.

International Business Machines Corporation (IBM)

Formally known as Computing-Tabulating-Recording Company (CTR), IBM present name dated back in 1924. International Business Machines Corporation (IBM) was founded in 1910. It is a Software company that provided Information Technology (IT) products and Services worldwide. As of May 30, 2014, its share's value is $183.76 and its Trading Symbol is IBM.

Microsoft Corporation

Founded in 1975, Microsoft Corporation develops licenses and supports software services, and hardware devices. As of May 30, 2014, its share value is $40.26. Microsoft Trading Symbol is MSFT.

Facebook Inc.

Founded in 2004, date of its incorporation, Facebook operates as a social networking company worldwide. Development and application programing interface are provided to enable developer to integrate with Facebook to create mobile and Web Applications. As of May 30, 2014, Facebook share's value is $63.85. The company Trading Symbol is FB.

Intel Corporation

Founded in 1968, Intel Corporation designs, manufacture and sells integrated digital technology platforms around the world. As of May 30, 2014, Intel share value is $26.96. The company Trading Symbol is INTC.

MRV Communication Inc.

The company was formerly known as MRV Technologies, Inc. and changed its name to MRV Communications, Inc. in April 1992. MRV Communications, Inc. was founded in 1988 and is headquartered in Chatsworth, California.

MRV Communications, Inc. (MRV) is a global provider of optical communications network infrastructure equipment and services to a broad range of telecom concerns, including multinational telecommunications operators, local municipalities, cable

multiple system operators (MSOs), corporate and consumer high speed Internet service providers, and data storage and cloud computing providers.

Model N Inc.

Founded in 1999, Model N Inc. Provides revenue management solutions for the Life Science, and Technology Industries. Its Trading Symbol is MDON and as of May 30, 2014, the company's share price is $11.0802.

Micrel Inc.

Founded in 1978, Micrel Inc. designs, develops, manufactures and markets analog, mixed-signal, and digital semiconductor devices. The company also offers power conversion products. As of May 30, 2014, Micrel stock price is $10.72. Its Trading Symbol is MCRL.

Inteliquent, Inc.

Founded in 2001, the company was formally named Neutral Tandem, Inc. In July 2013, the company changed its name to Inteliquent Inc. It provides voice telecommunications services on a wholesale basis in the United States and around the world. As of May 30, 2014, its stock price was $14.98. The Trading Symbol of Inteliquent is IQNT.

5.2 - Graphs of Stocks Performance, Autocorrelation and analysis

A - Apple Inc. Performance and its Autocorrelation

See figures A-1 and A-2

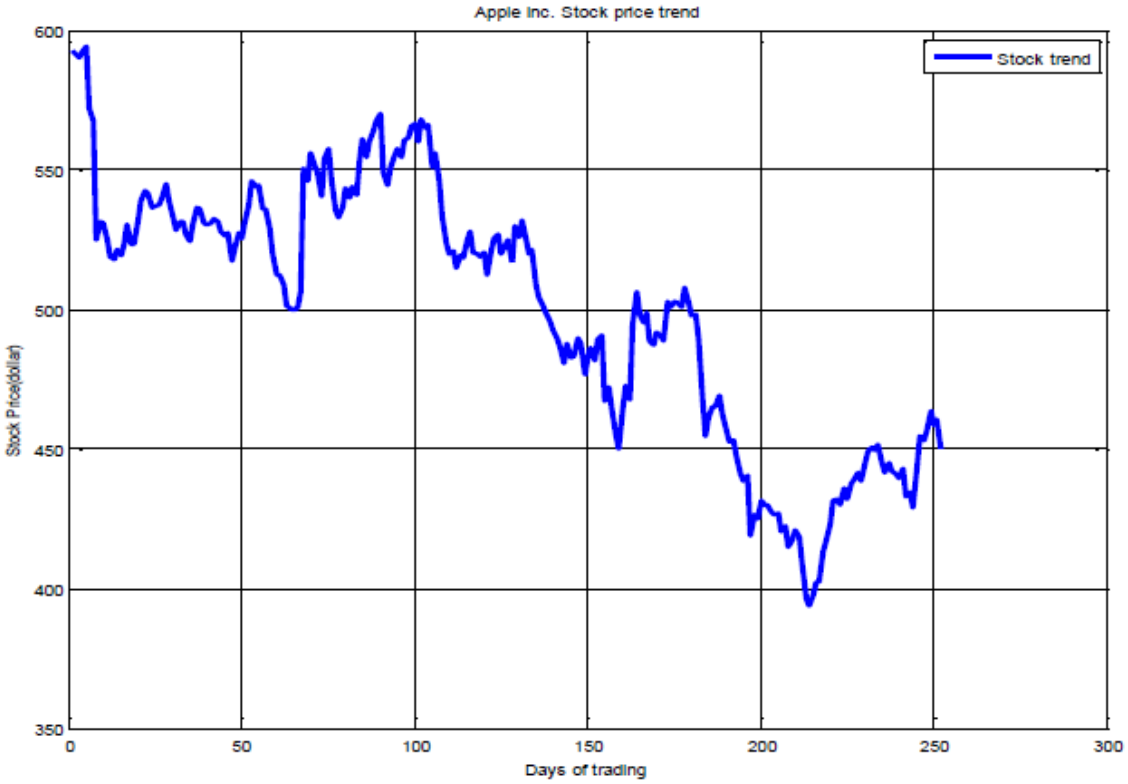


Figure A-1

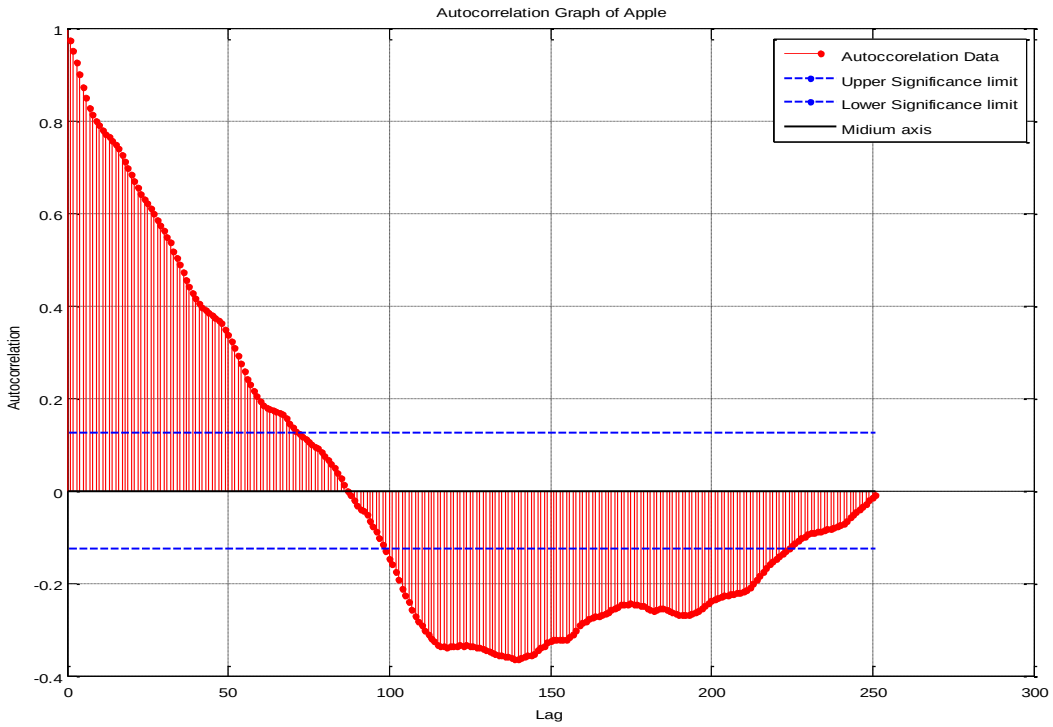


Figure A-2

The first graph of Apple Inc. shows the performance of its daily stock price over a period of 252 days. Before attempting to predict the price of the stock, we need to know the autocorrelation of the company stock price. This is represented by the second graph. There is a particular point of this autocorrelation graph that will help us to the range of data that are relevant to use for our prediction by finding the best fitting line using Polyfit commend in Matlab.

The most important point is where the Autocorrelation Graph intersect or cross the **axe X = 0**. For this company, this point which is the date when the line cross X = 0 is the **point 88.** The difference between the last day (252) and the point where the Auto Correlation line crossed X = 0 is valid or relevant data to use for our prediction. Here, we have a total of (252-89) relevant data. In another word, we **have 164 relevant data points.** The code that we write for these figures is below:

```
load 'Apple.mat';
p1=Closeap(:,1);
[m,n]=size(p1);
autocorr(p1,251);
p2=p1(1:88);
[m,n]=size(p2);
for i=1:88
    x(i)=i;
    y(i)=p2(89-i);
end
p=polyfit(x,y,1);
for i=1:88
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
```

B – Google Inc. Performance and its Autocorrelation

See Figures B-1 and B-2

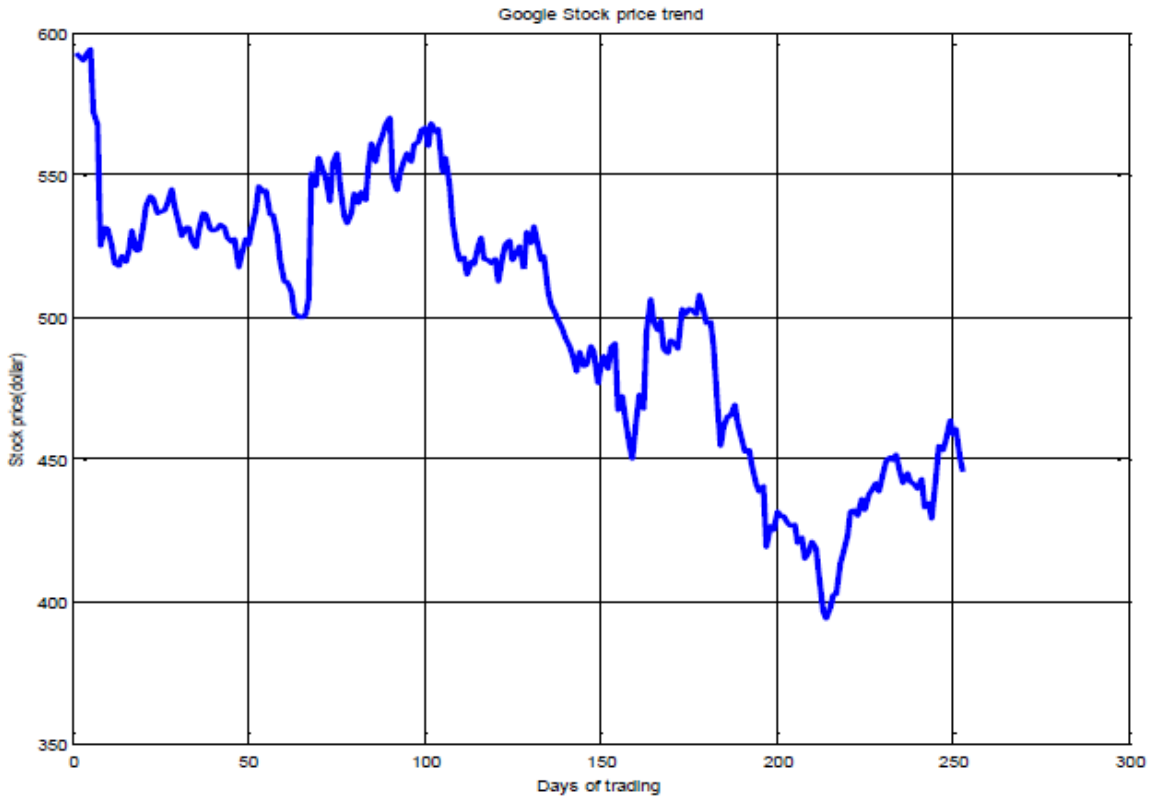


Figure B-1

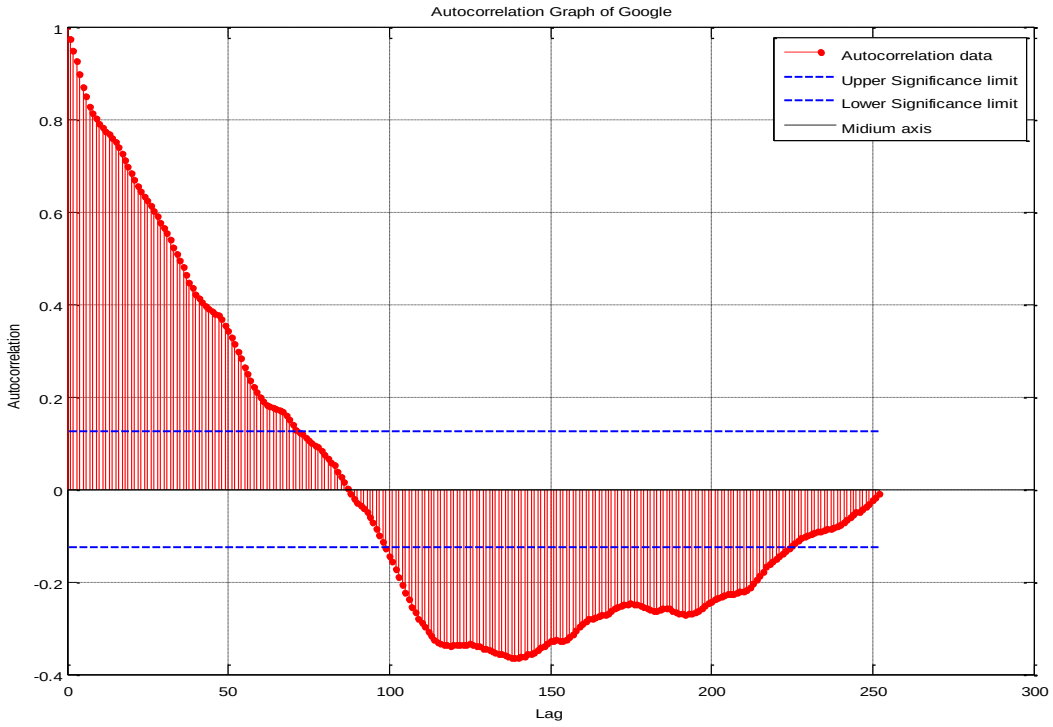


Figure B-2

The blue graph of Google Inc. is the performance of its stock for a period of 252 days. Before attempting to predict the price of the stock, we need to know the autocorrelation of the company stock price. This is represented by the second graph. There is a particular point of this autocorrelation graph that will help us to the range of data that are relevant to use for our prediction by finding the best fitting line using Polyfit commend in Matlab.

The most important point is where the Autocorrelation Graph intersect or cross the **axe X = 0**. For this company, this point which is the date when the line cross X = 0 is

the **point 89**. The difference between the last day (252) and the point where the Auto Correlation line crossed X = 0 is valid or relevant data to use for our prediction. Here, we have a total of (252-89) relevant data. In another word, we **have 163 relevant data points.** Following is the Matlab code written to plot the trend.

```
load 'Google.mat';
p1=Closeg(:,1);
[m,n]=size(p1);
autocorr(p1,252);
p2=p1(1:89);
[m,n]=size(p2);
for i=1:89
    x(i)=i;
    y(i)=p2(90-i);
end
p=polyfit(x,y,1);
for i=1:89
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
```

C- IBM Performance and its Autocorrelation

See Figures C-1 and C-2

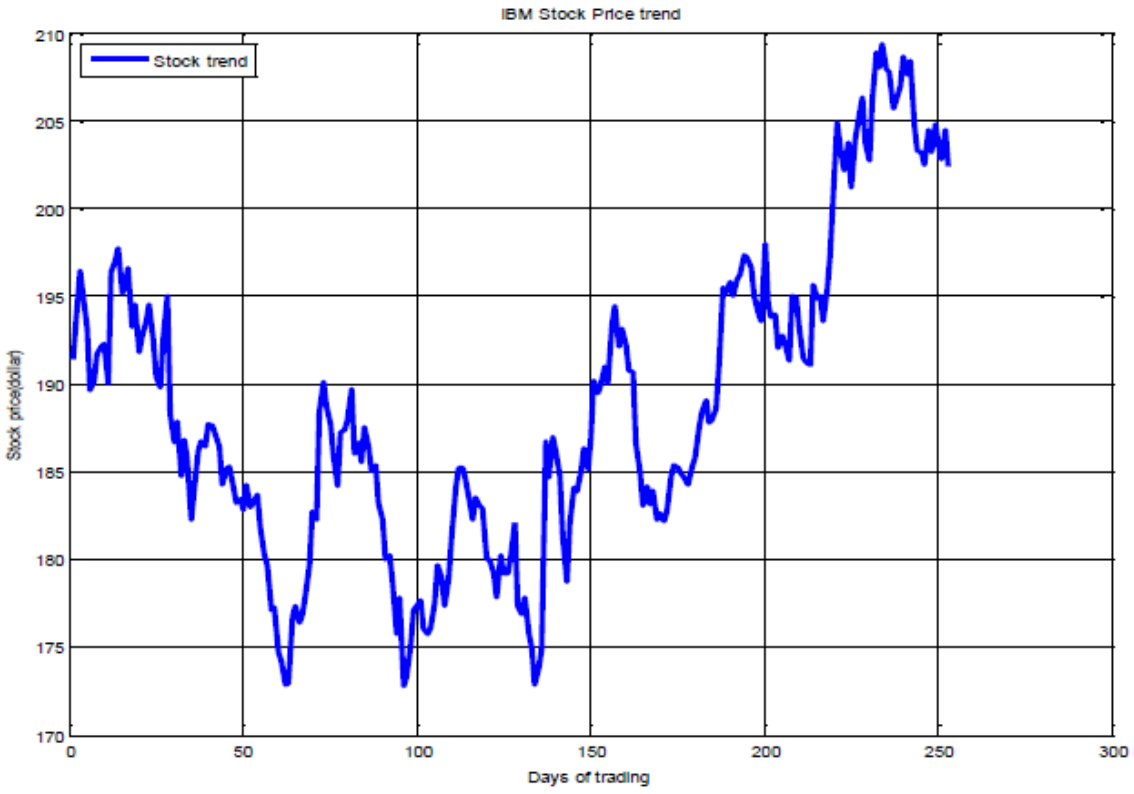


Figure C-1

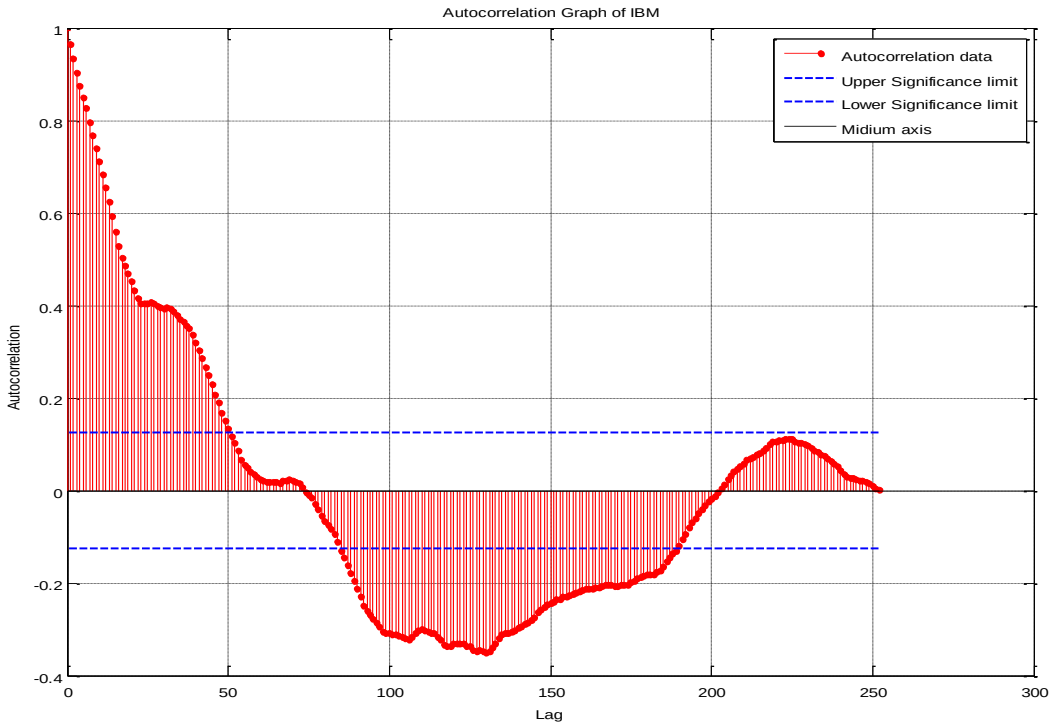


Figure C-2

The blue graph of IBM Corporation is the performance of its stock for a period of 252 days. Before attempting to predict the price of the stock, we need to know the autocorrelation of the company stock price. This is represented by the second graph. There is a particular point of this autocorrelation graph that will help us to the range of data that are relevant to use for our prediction by finding the best fitting line using Polyfit commend in Matlab.

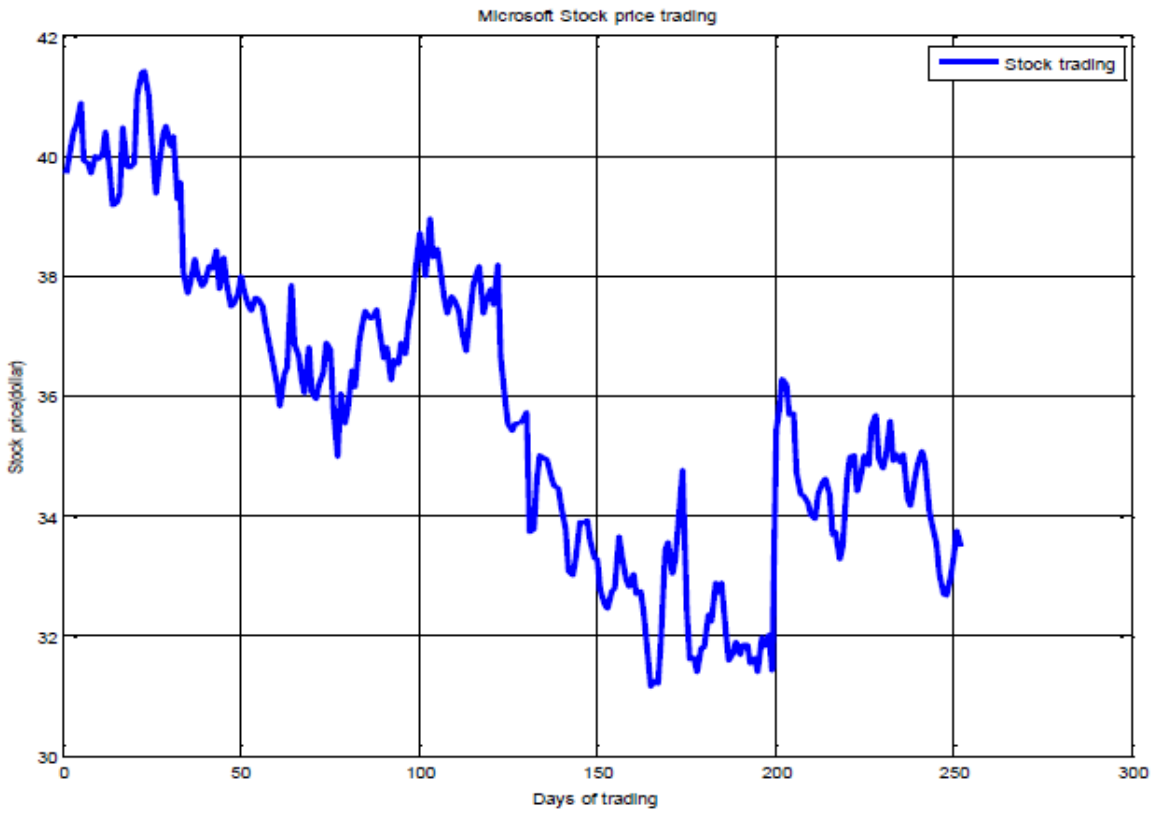
The most important point is where the Autocorrelation Graph intersect or cross the **axe X = 0**. For this company, this point which is the date when the line cross X = 0 is the **point 72**. The difference between the last day (252) and the point where the Auto

Correlation line crossed X = 0 is valid or relevant data to use for our prediction. Here, we have a total of (252-89) relevant data. In another word, we **have 180 relevant data points.** The above graphs are obtained with the following code:

```
load 'IBM.mat';
p1=Closem(:,1);
[m,n]=size(p1);
autocorr(p1,252);
p2=p1(1:72);
[m,n]=size(p2);
for i=1:72
    x(i)=i;
    y(i)=p2(73-i);
end
p=polyfit(x,y,1);
for i=1:88
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
```

D- Microsoft Performance and its Autocorrelation

See Figures D-1 and D-2



See Figures D-1

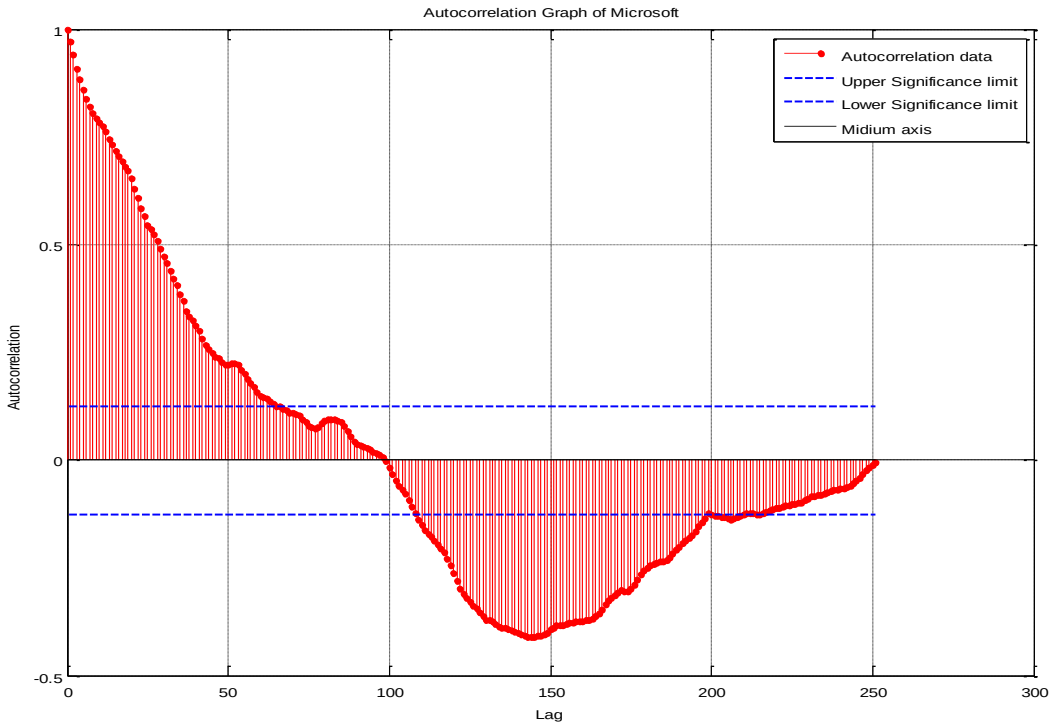


Figure D-2

The blue graph of Microsoft Corporation is the performance of its stock for a period of 252 days. Before attempting to predict the price of the stock, we need to know the autocorrelation of the company stock price. This is represented by the second graph. There is a particular point of this autocorrelation graph that will help us to the range of data that are relevant to use for our prediction by finding the best fitting line using Polyfit commend in Matlab.

The most important point is where the Autocorrelation Graph intersect or cross the **axe X = 0**. For this company, this point which is the date when the line cross X = 0 is the

point 96. The difference between the last day (252) and the point where the Auto Correlation line crossed X = 0 is valid or relevant data to use for our prediction

Here we have a total of (252-89) relevant data. In another word, we **have 156 relevant data points.** The code written to get these figures above is the following:

```
load 'microsoft.mat';
p1=Closem(:,1);
[m,n]=size(p1);
autocorr(p1,252);
p2=p1(1:96);
[m,n]=size(p2);
for i=1:96
    x(i)=i;
    y(i)=p2(97-i);
end
p=polyfit(x,y,1);
for i=1:96
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
```

E- Facebook Performance and its Autocorrelation

See Figures E-1 and E-2

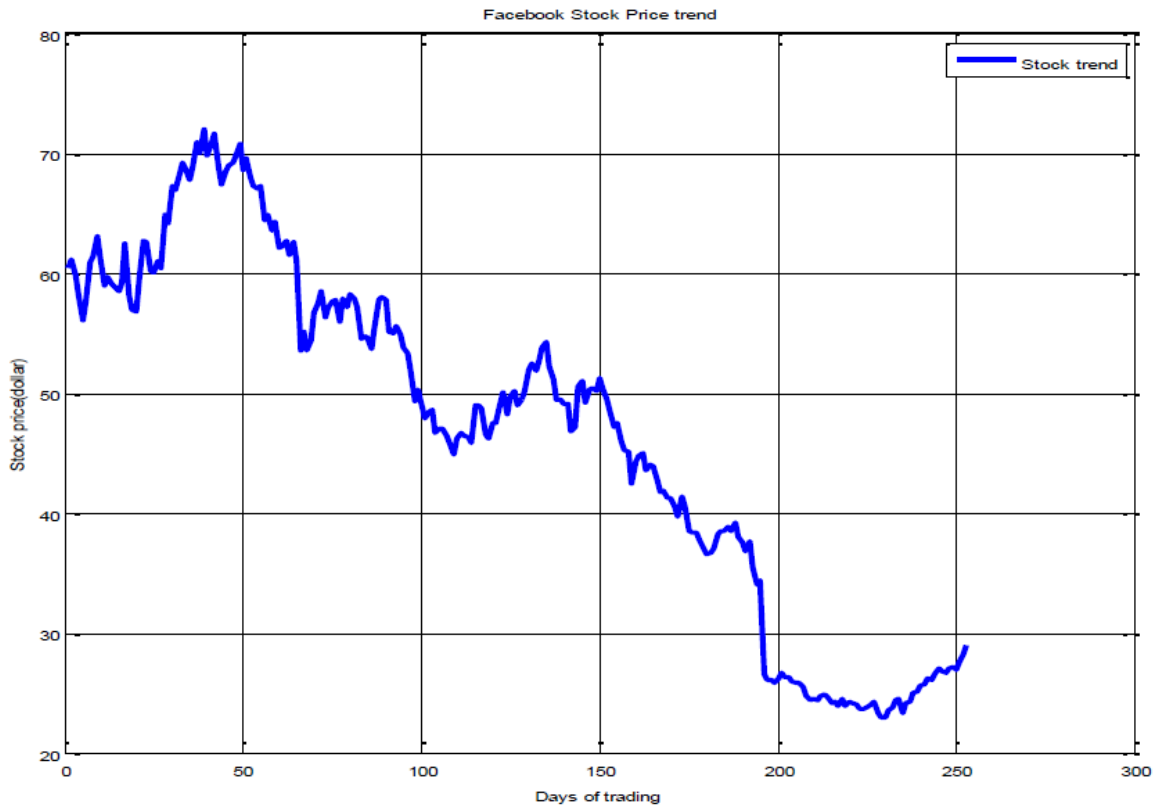


Figure E-1

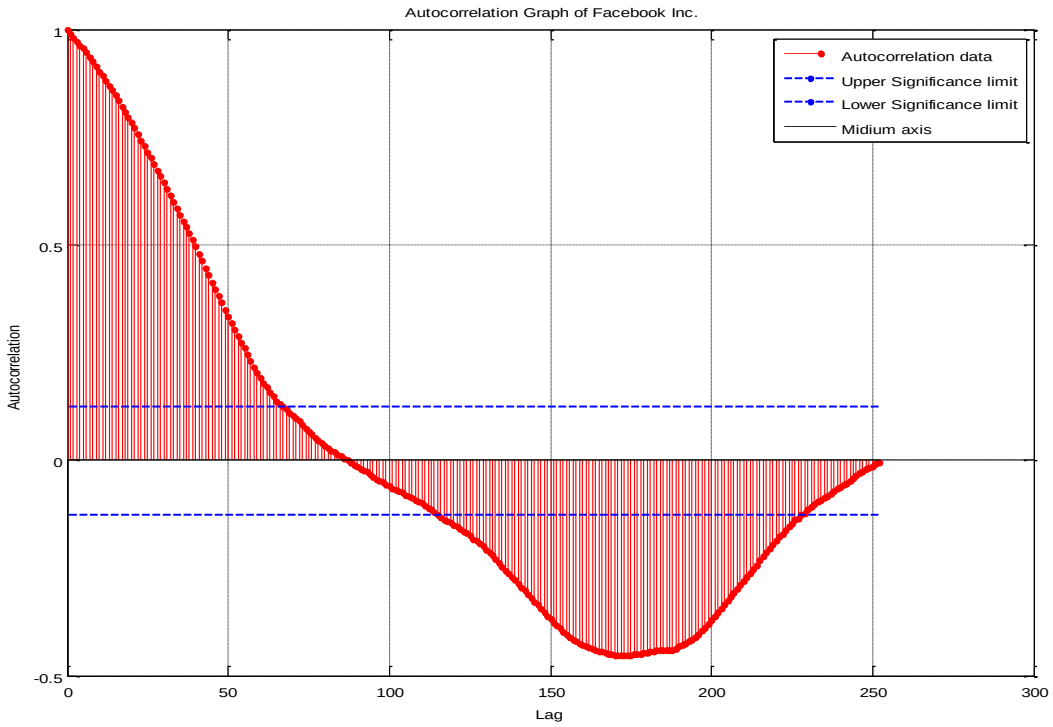


Figure E-2

The blue graph of Facebook Inc. is the performance of its stock for a period of 252 days. Before attempting to predict the price of the stock, we need to know the autocorrelation of the company stock price. This is represented by the second graph. There is a particular point of this autocorrelation graph that will help us to the range of data that are relevant to use for our prediction by finding the best fitting line using Polyfit commend in Matlab.

The most important point is where the Autocorrelation Graph intersect or cross the **axe X = 0**. For this company, this point which is the date when the line cross X = 0 is the **point 89**. The difference between the last day (252) and the point where the Auto Correlation line crossed X = 0 is valid or relevant data to use for our prediction.

This means that we have a total of (252-89) relevant data. In another word, we **have 163 relevant data points.** The above figures are obtained with the following code:

```
load 'Facebook.mat';
p1=Closef(:,1);
[m,n]=size(p1);
autocorr(p1,252);
p2=p1(1:89);
[m,n]=size(p2);
for i=1:89
    x(i)=i;
    y(i)=p2(90-i);
end
p=polyfit(x,y,1);
for i=1:89
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
```

F - Intel Corp. Performance and its Autocorrelation

See Figures F-1 and F-2

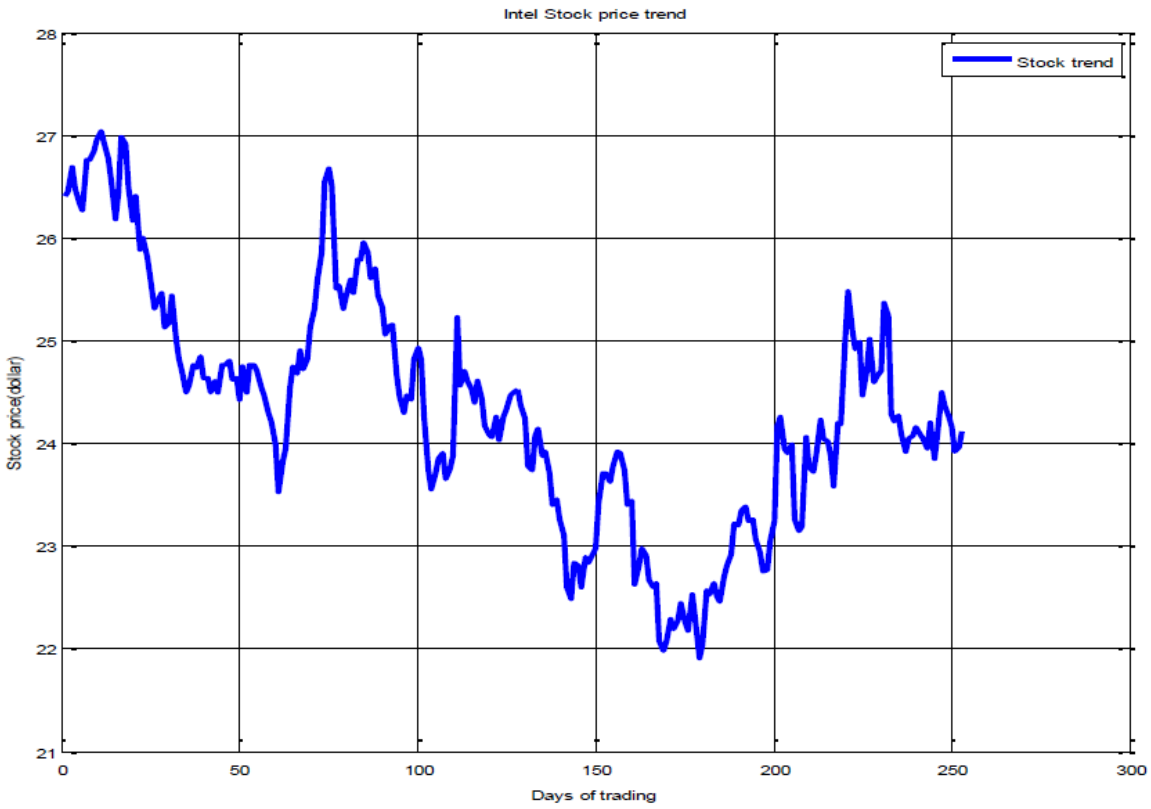


Figure F-1

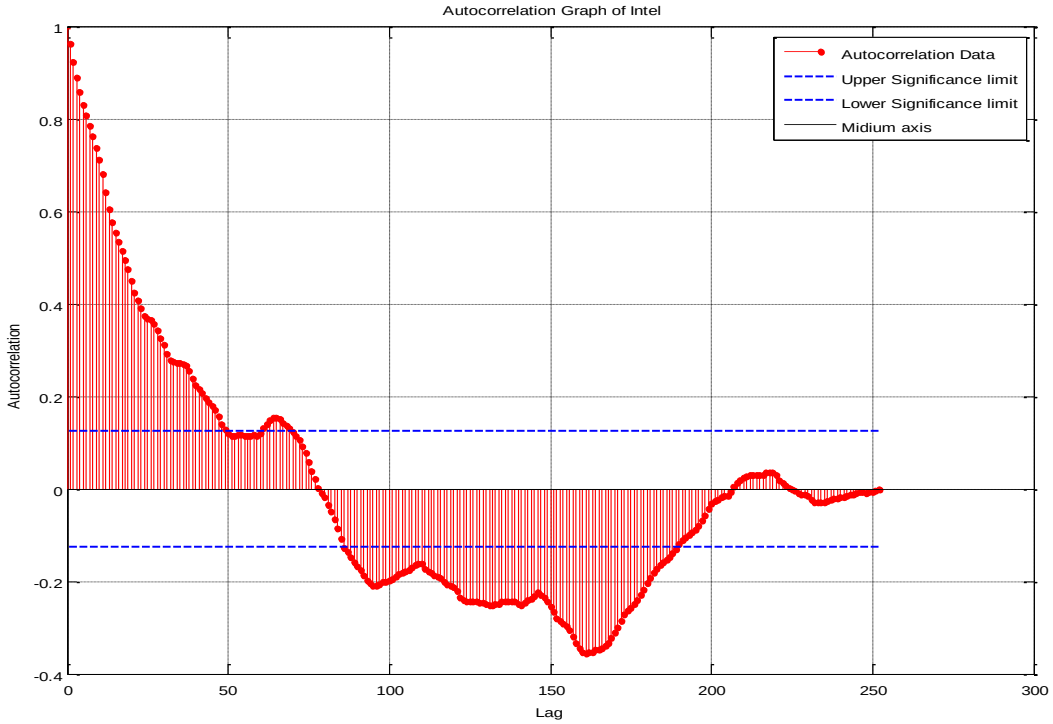


Figure F-2

The Blue graph of the Blue Chips Company, Intel, indicates the performance of its stock for a period of 252 days. Before attempting to predict the price of the stock, we need to know the autocorrelation of the company stock price. This is represented by the second graph. There is a particular point of this autocorrelation graph that will help us to the range of data that are relevant to use for our prediction by finding the best fitting line using Polyfit commend in Matlab.

The two horizontal lines constituted the significant limits also known as Confidence bounds.

The most important point is where the Autocorrelation Graph intersect or cross the **axe X = 0**. For this company, this point which is the date when the line cross X = 0 is the **point 77**. The difference between the last day (252) and the point where the Auto Correlation line crossed X = 0 is valid or relevant data to use for our prediction

This means that we have a total of (252-89) relevant data. In another word, we **have 175 relevant data points. Intel Stock trend and autocorrelation graphs are obtained with the following code:**

```
load 'Intel.mat';
p1=Close2(:,1);
[m,n]=size(p1);
autocorr(p1,252);
p2=p1(1:89);
[m,n]=size(p2);
for i=1:89
    x(i)=i;
    y(i)=p2(90-i);
end
p=polyfit(x,y,1);
for i=1:89
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
```

G – MRV Telecommunication Inc.

See Figures G-1 and G-2

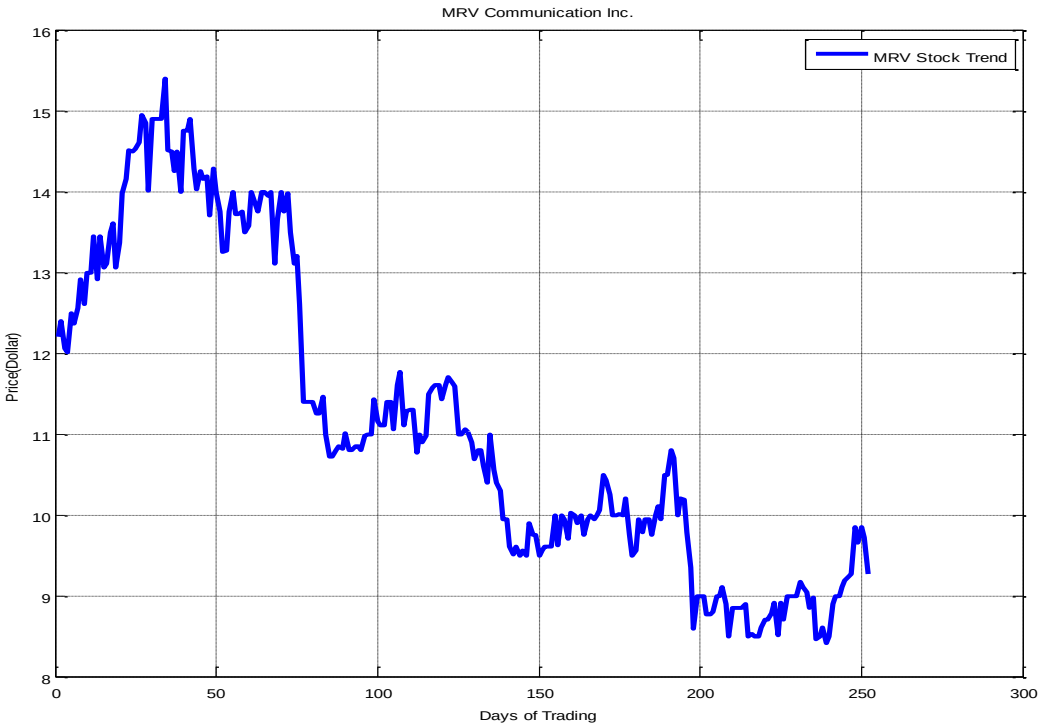
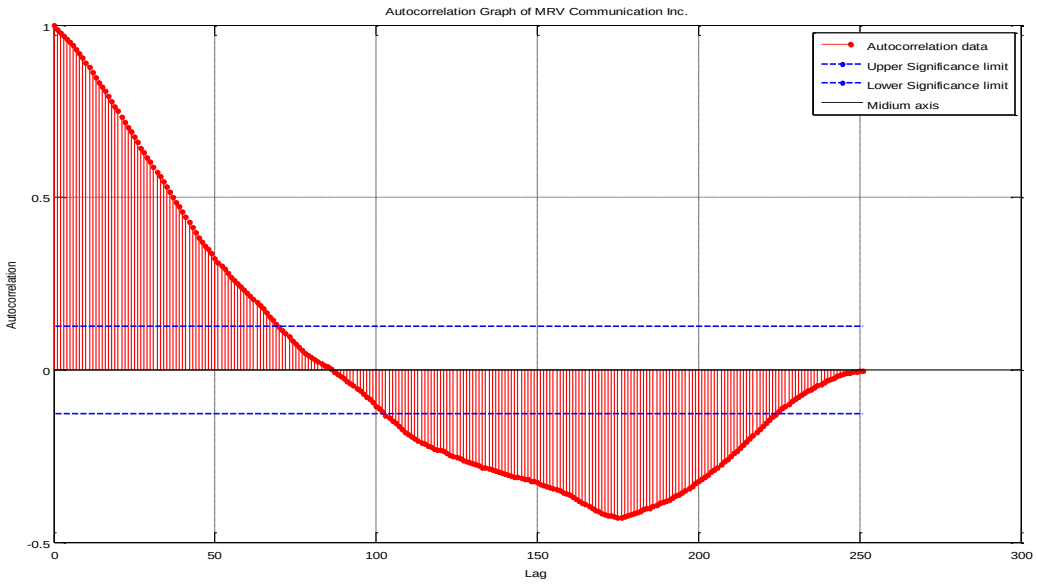


Figure G-1




```
load('MRV.mat');
p1=Closemrv(:,1);
[m,n]=size(p1)
autocorr(p1,251);
plot(Closemrv);
```

H – Model Inc. Performance and its Autocorrelation

See Figures H-1 and H-2

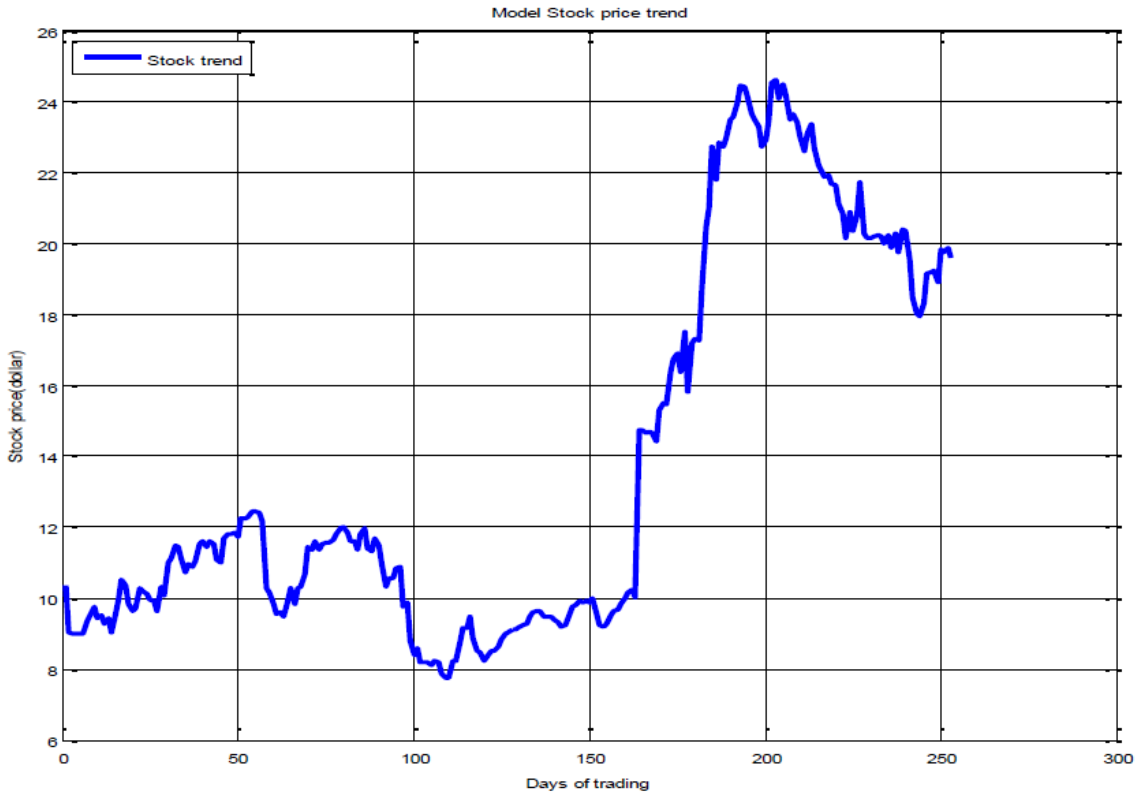


Figure H-1

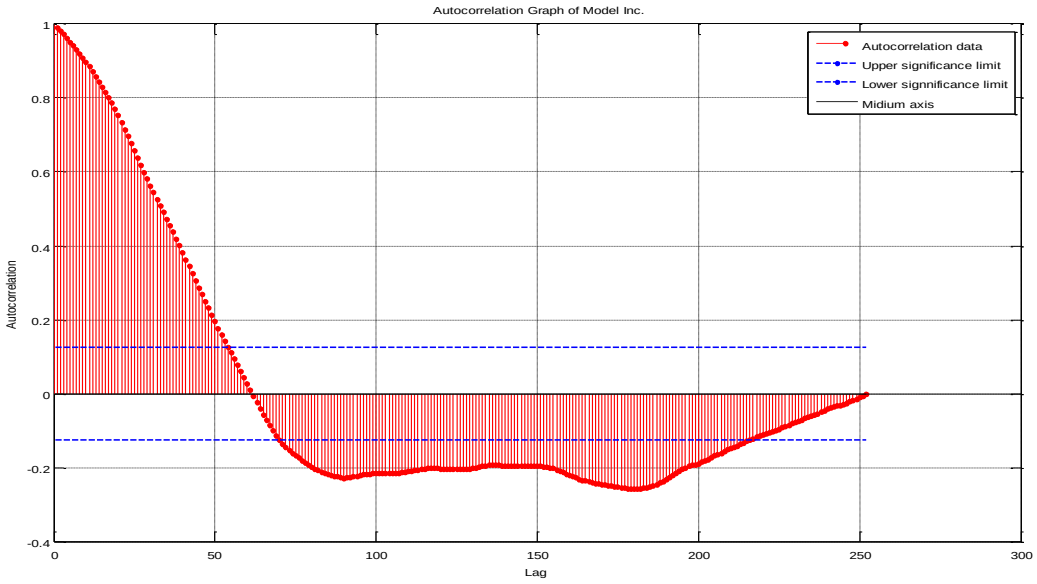


Figure H-2

The blue graph of Model N, Inc. indicates the performance of its stock for a period of 252 days. Before attempting to predict the price of the stock, we need to know the autocorrelation of the company stock price. This is represented by the second graph. There is a particular point of this autocorrelation graph that will help us to the range of data that are relevant to use for our prediction by finding the best fitting line using Polyfit commend in Matlab.

The most important point is where the Autocorrelation Graph intersect or cross the **axe X = 0**. For this company, this point which is the date when the line cross X = 0 is the **point 61**. The difference between the last day (252) and the point where the Auto Correlation line crossed X = 0 is valid or relevant data to use for our prediction

Model N Inc**. has a total of 191** relevant days (data points) to use for the prediction of its stock price**.**

```
load 'MODN.mat';
p1=Closemo(:,1);
[m,n]=size(p1);
autocorr(p1,252);
p2=p1(1:61);
[m,n]=size(p2);
for i=1:61
    x(i)=i;
    y(i)=p2(62-i);
end
p=polyfit(x,y,1);
for i=1:61
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
```

I – Micrel Inc. Performance and its Autocorrelation

See Figures I-1 and I-2

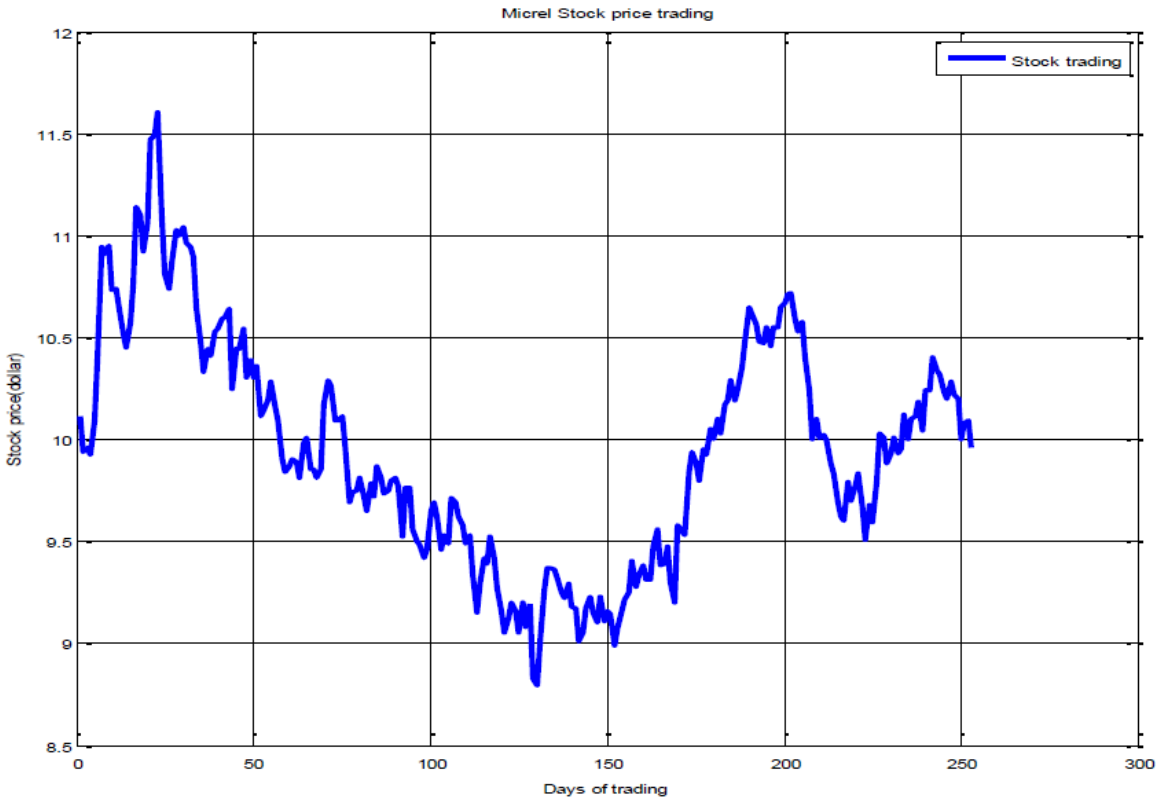


Figure I-1

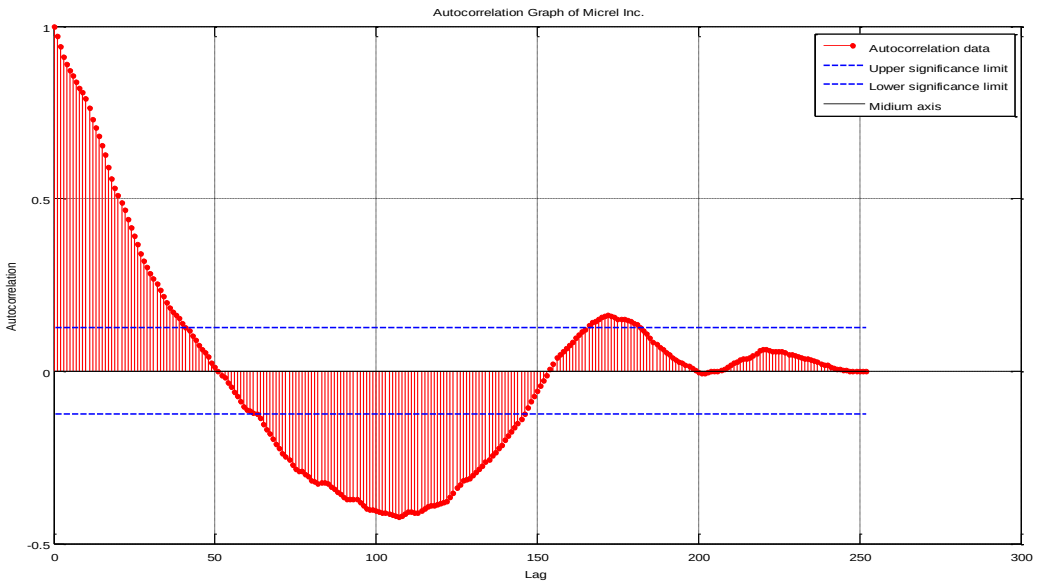


Figure I-2

The blue graph of Micrel Inc indicates the performance of its stock for a period of 252 days. Before attempting to predict the price of the stock, we need to know the autocorrelation of the company stock price. This is represented by the second graph. There is a particular point of this autocorrelation graph that will help us to the range of data that are relevant to use for our prediction by finding the best fitting line using Polyfit commend in Matlab. The most important point is where the Autocorrelation Graph intersect or cross the **axe X = 0**. For this company, this point which is the date when the line cross X = 0 is the **point 50**. The difference between the last day (252) and the point

where the Auto Correlation line crossed X = 0 is valid or relevant data to use for our prediction. The difference of **202 data points** constitutes the relevant data to use for the prediction.

```
load 'Micrel.mat';
p1=Closem(:,1);
[m,n]=size(p1);
autocorr(p1,251);
p2=p1(1:50);
[m,n]=size(p2);
for i=1:50
    x(i)=i;
    y(i)=p2(51-i);
end
p=polyfit(x,y,1);
for i=1:50
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
```

J – Inteliquent Performance and its Autocorrelation

See Figures J-1 and J-2

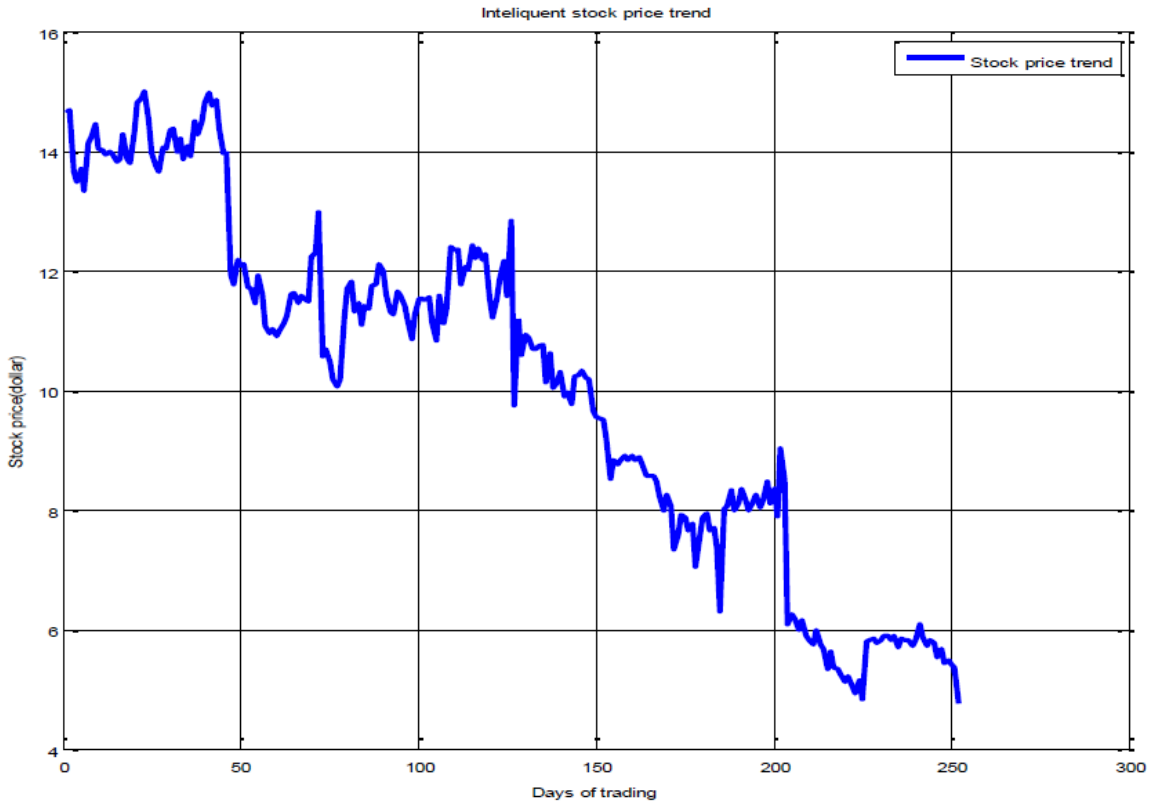


Figure J-1

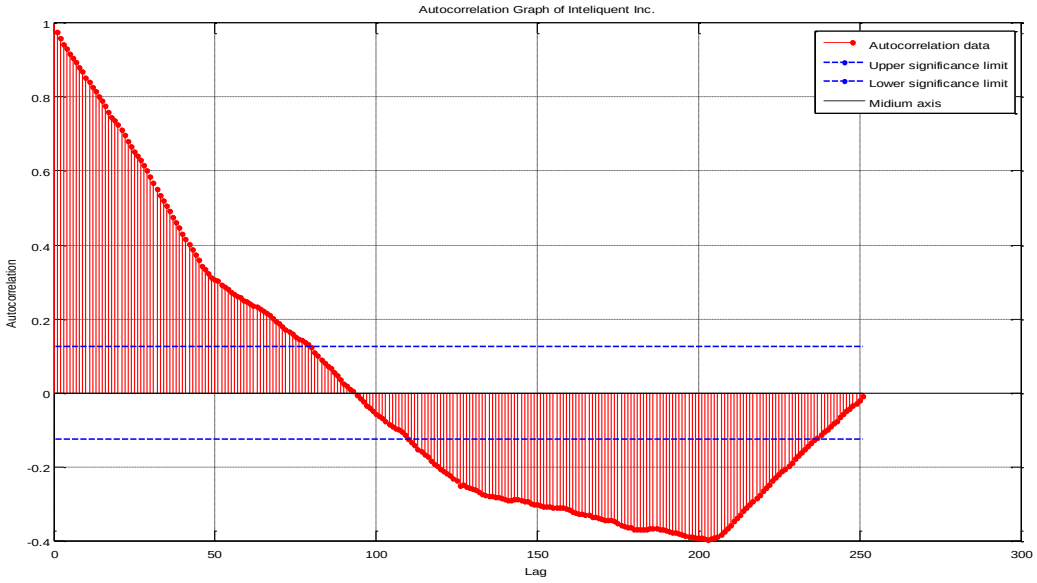


Figure J-2

The blue graph of Ineloquent Inc indicates the performance of its stock for a period of 252 days. Before attempting to predict the price of the stock, we need to know the autocorrelation of the company stock price. This is represented by the second graph. There is a particular point of this autocorrelation graph that will help us to the range of data that are relevant to use for our prediction by finding the best fitting line using Polyfit commend in Matlab. The most important point is where the Autocorrelation Graph intersect or cross the **axe X = 0**. For this company, this point which is the date when the line cross X = 0 is the **point 98**. The difference between the last day (252) and the point 98 constitutes a total relevant **data points of 154** to be used for the prediction which is the difference between the best fit line and the graph obtain with the relevant data.

```
load 'IQNT.mat';
p1=Close2(:,1);
[m,n]=size(p1);
autocorr(p1,252);
p2=p1(1:98);
[m,n]=size(p2);
for i=1:98
    x(i)=i;
    y(i)=p2(99-i);
end
p=polyfit(x,y,1);
for i=1:98
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
```

5-3 Best Fitting Line

What is the Best Fitting Line also called Regression Line?

Also called ‘Line of Best Fit’ by some authors, it is a straight line plotted or drawn through the center of a group of data points plotted on a scatter plot. The trend constructed by stock prices over a certain period of time is a realization of multiple discrete data points scattered on a plot. The line of the Best Fit determines whether or not two variables are correlated. This line of the Best Fit is used in regression analysis that help to predict the variable called the “***criterion variable***” recorded on the Y-axis (Price of stock), based on the other variable called “***predictor variable***” or independent variable (days) on the X-axis. In order to determine the Best Fitting Line, mathematical method called “the Least Squares to make close approximations or estimation of data. The closer the data to the Line of Regression, the better result the prediction will be.

It is important to note that there are other modeling methods used to fit function to curve. Other than straight line, there are polynomial method(function with degree more than 1), logarithmic method and Gaussian method.

For our purpose, we will used the straight line approach with the mathematical equation in the form of $\boldsymbol{Y = ax + b}$.

The following figures are the one we obtained with the combine stocks trends and the Line of Best fit. After obtaining each of these figures, we will plot the difference between

the trend of the stock and the Line of regression. The curve obtain from that difference is the sum of all the points that are closed to the regression line.

APPLE Inc.

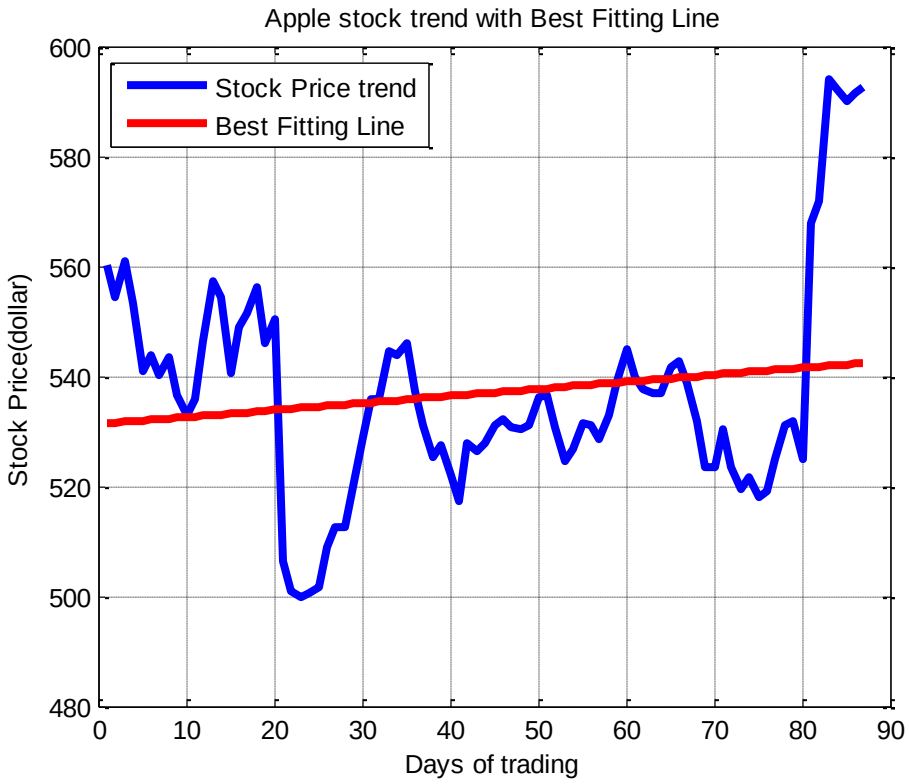


Figure A-3

The following graph is the difference between the stock price trend and the Best Fitting line for Apple Inc.

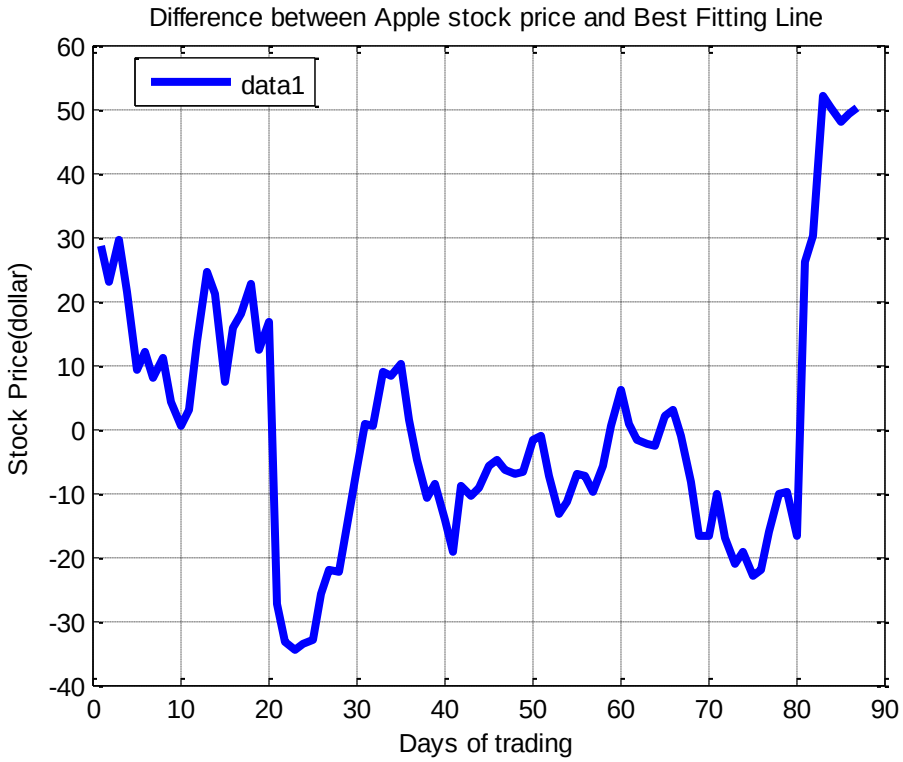

Difference between Apple stock price and Best Fitting Line
data1
Stock Price(dollar)
Days of trading
60
50
40
30
20
10
0
-10
-20
-30
-40
0
10
20
30
40
50
60
70
80
90

Figure A-4

MRV Communications Inc.

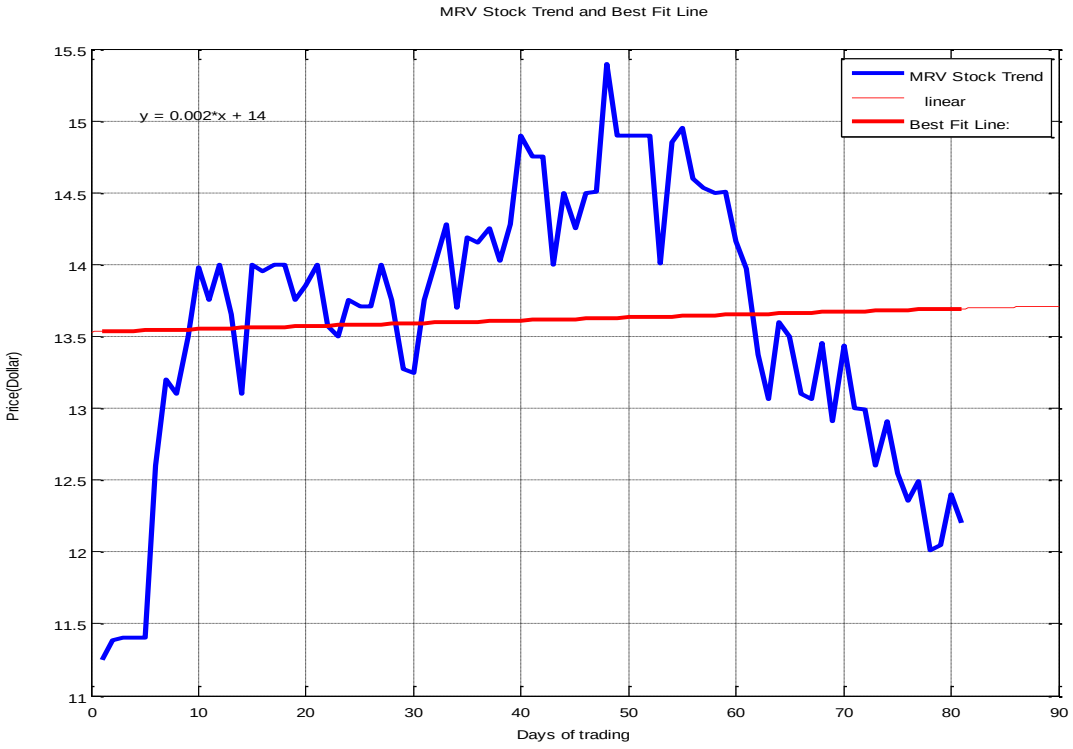


Figure M-1

The better trend approximation is then giving by the following graph of MRV Communications Inc.

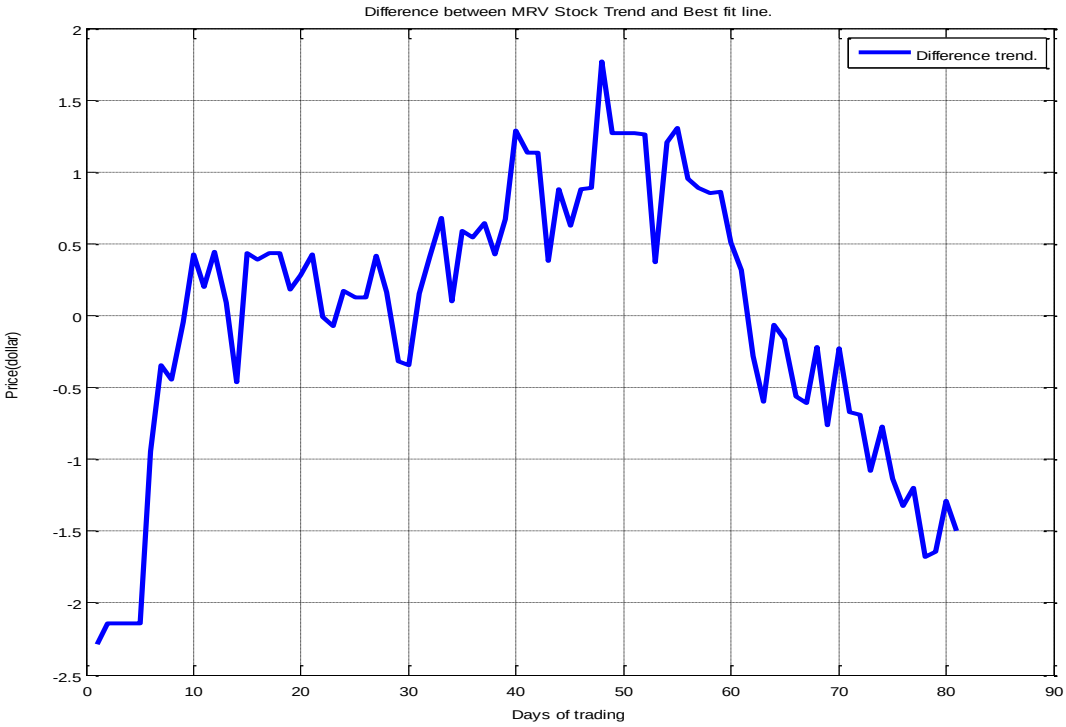


Figure M-2

```
load('MRV.mat');
p1=Closemrv(:,1);
[m,n]=size(p1)
autocorr(p1,251);
p2=p1(1:81);
for i=1:81
    x(i)=i;
    y(i)=p2(82-i);
end
p=polyfit(x,y,1);
for i=1:81
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
hold on
plot(x,lst,'r');
figure;

plot(x,(y-lst),'b');
```

FACEBOOK Inc.

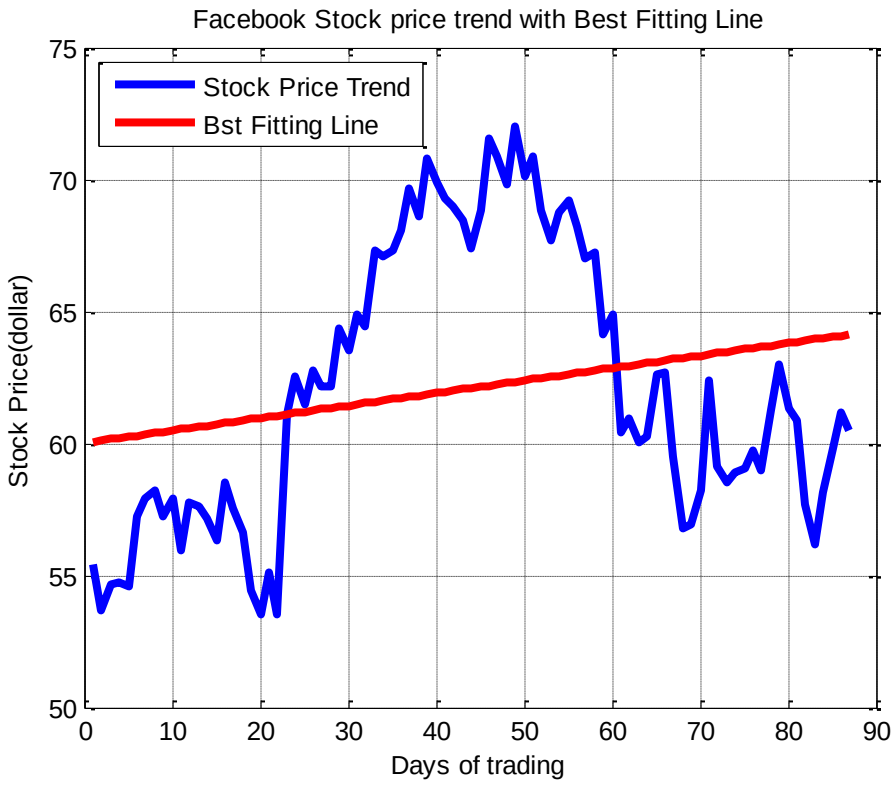


Figure F-1

Figure: Facebook Trend and it difference with the regression line.

The approximated best curve obtained is the following:

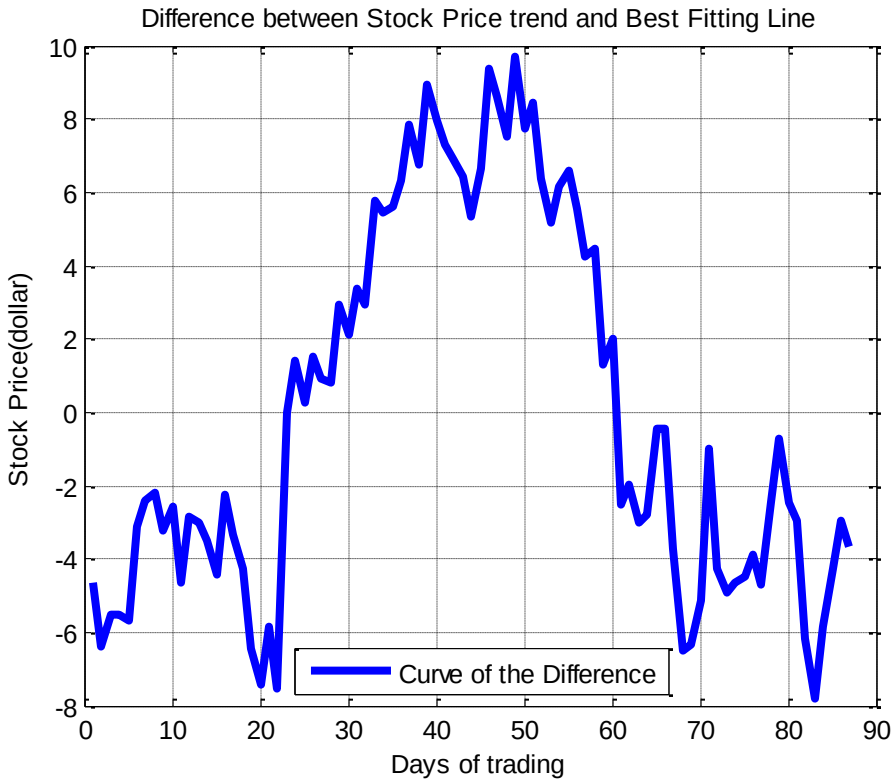

Difference between Stock Price trend and Best Fitting Line
Stock Price(dollar)
Days of trading
Curve of the Difference
10
8
6
4
2
0
-2
-4
-6
-8
0
10
20
30
40
50
60
70
80
90

Figure F-2

GOOGLE Inc.

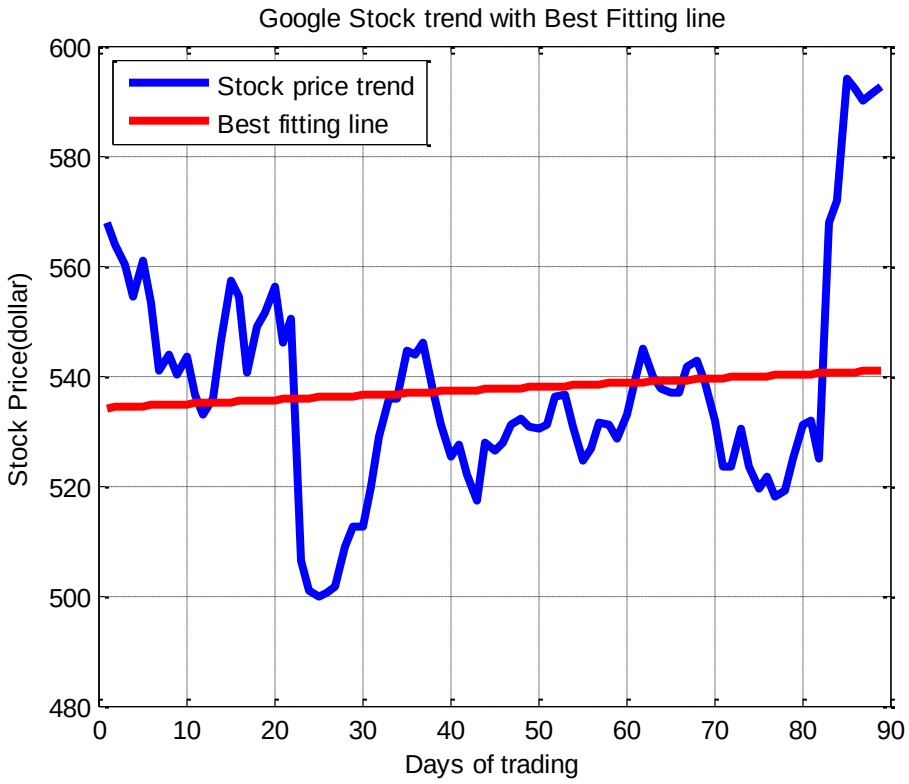


Figure G-1

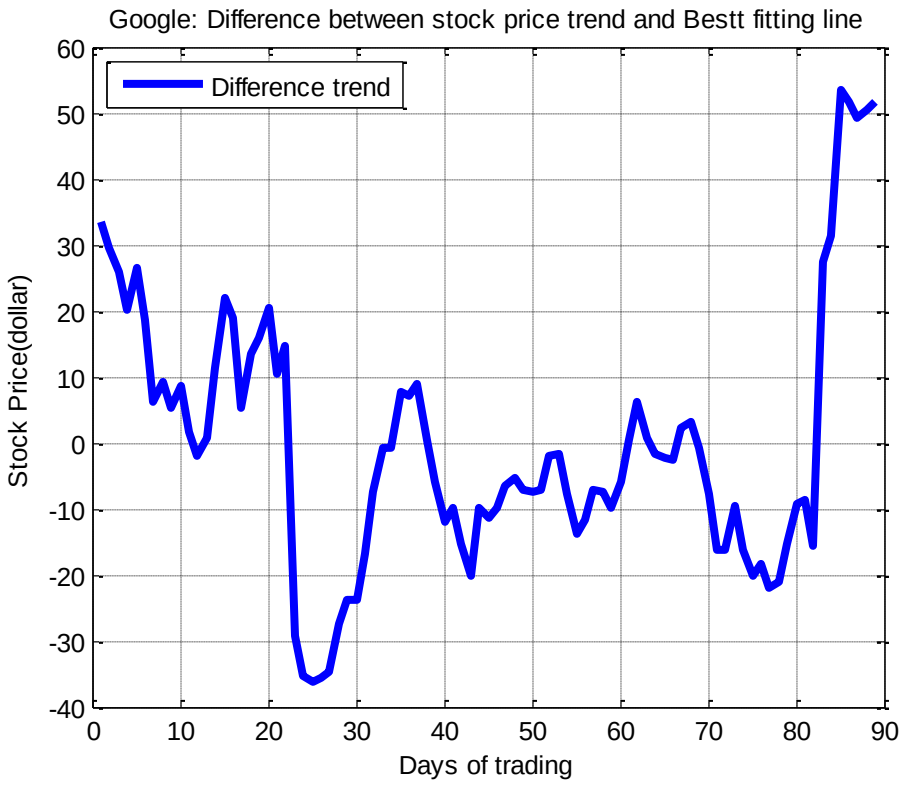


Figure G-2

When we look at the curve obtained with the trend and the Best Fit, there is no big difference.

Let continue with the other graphs.

IBM CORPORATION

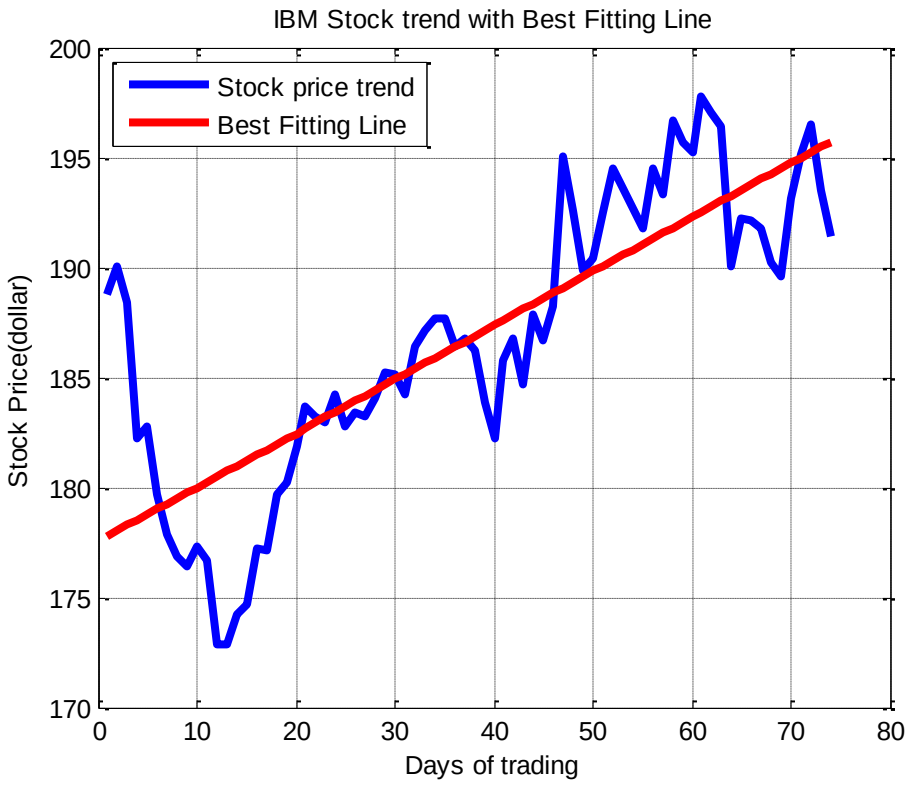


Figure I-1

Difference between the stock price and the Best fitting line is the following graph below.

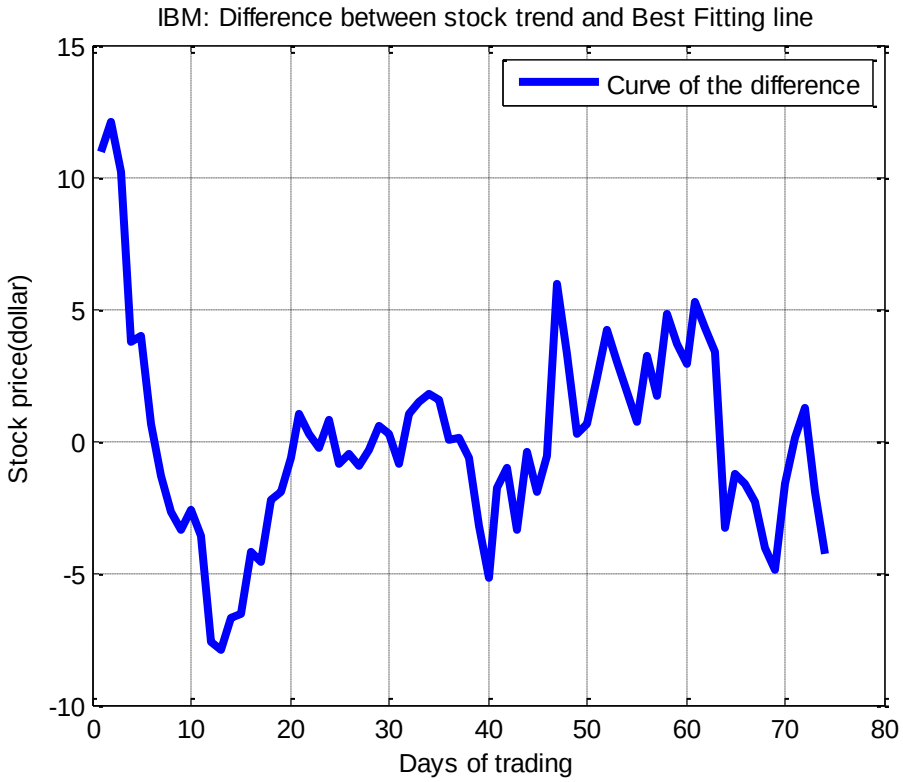

IBM: Difference between stock trend and Best Fitting line
Curve of the difference
Stock price(dollar)
Days of trading
15
10
5
0
-5
-10
0
10
20
30
40
50
60
70
80

Figure I-2

INTEL CORPORATION

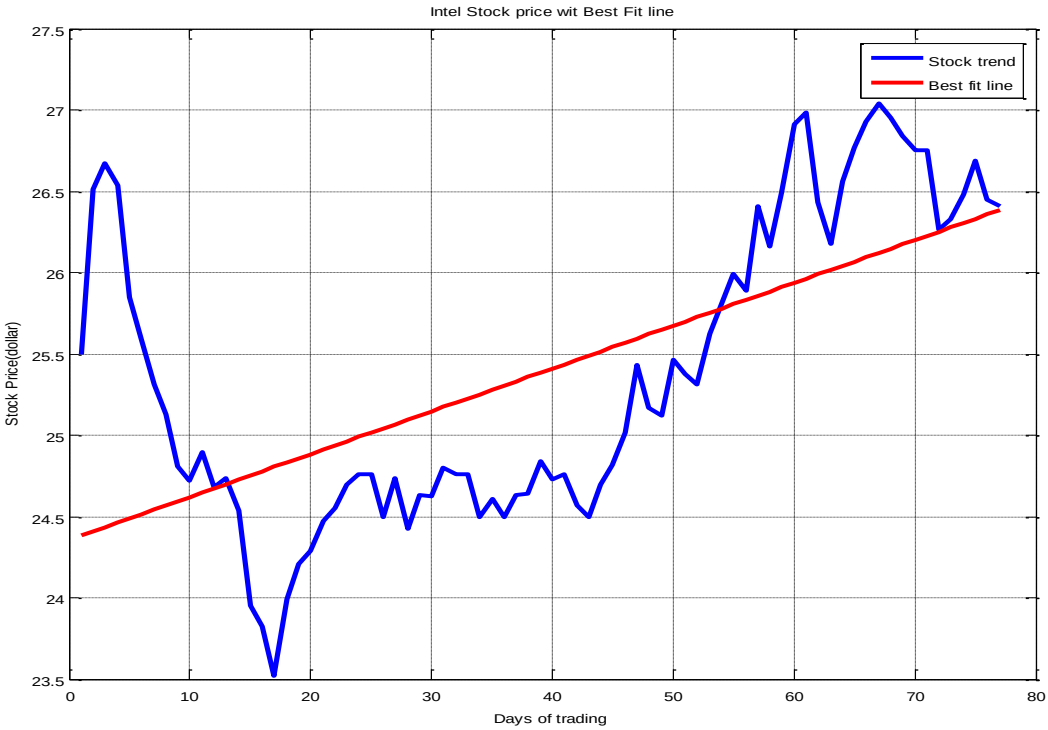


Figure I-3

This figure shows the Best Fitting line with the stock trend.

Intel Difference Trend

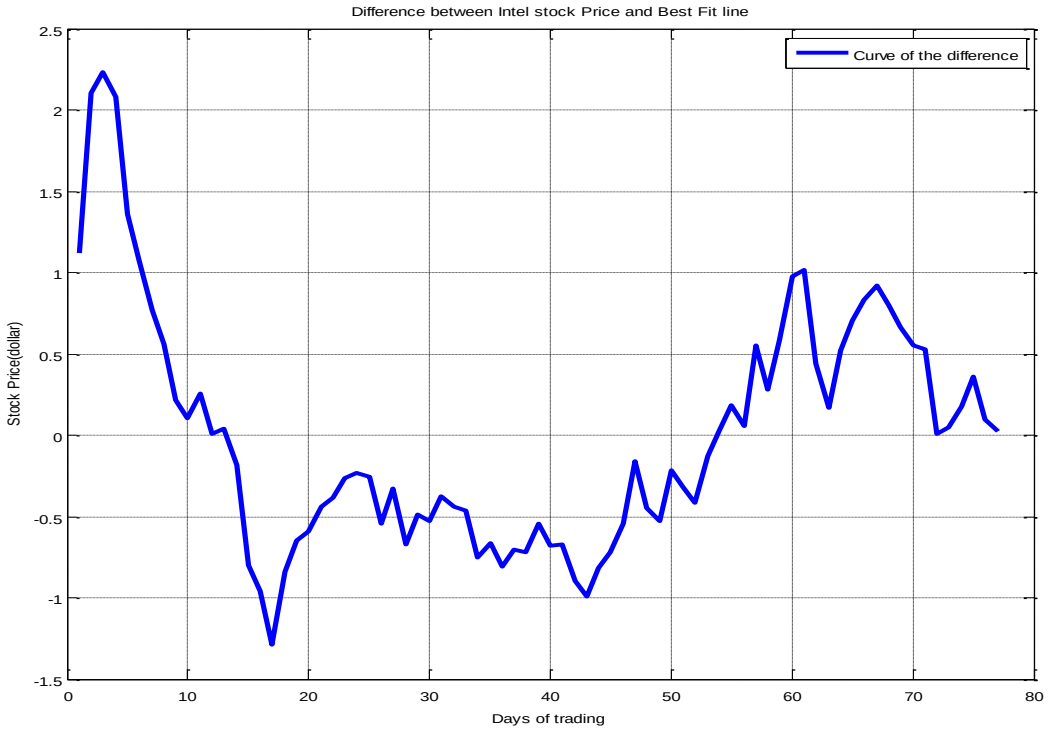


Figure I-4

This figure shows the difference between the regression line and the stock price trend.

INTELIQUENT Inc.

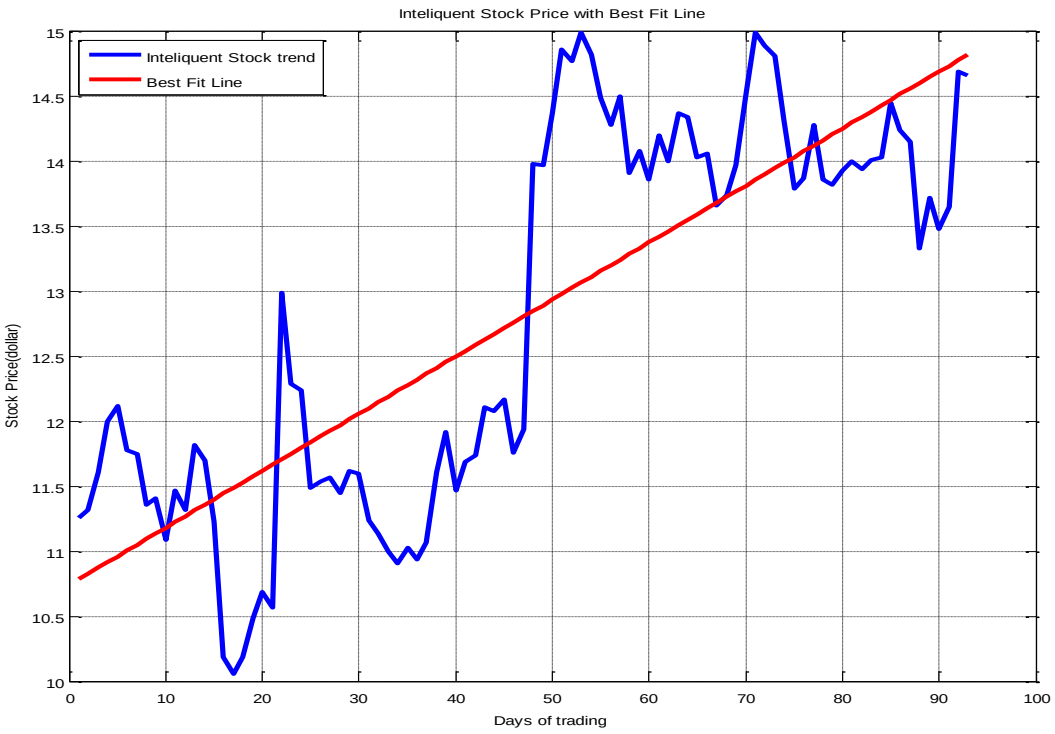


Figure I-5

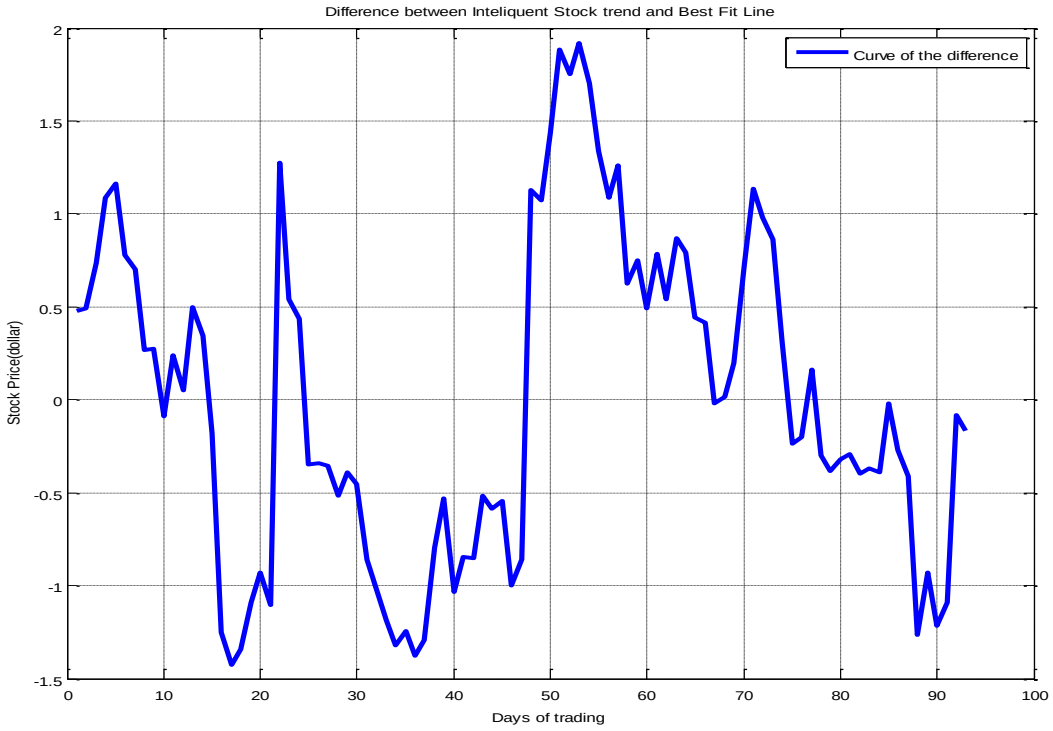


Figure I-6

This figure I-5 determines the best approximation of the stock trend when the Best Fit Line is subtracted from the real and original stock price trend.

MICREL Inc.

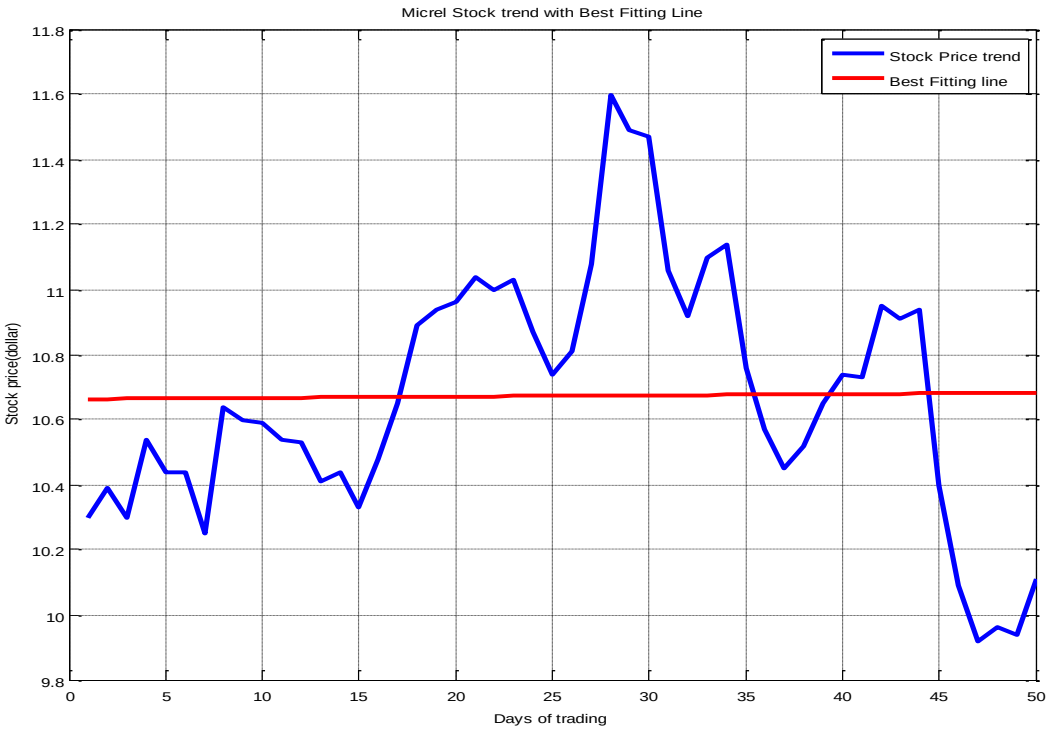


Figure M-3

This figure M-3 is the trend of the stock with the best fitting line

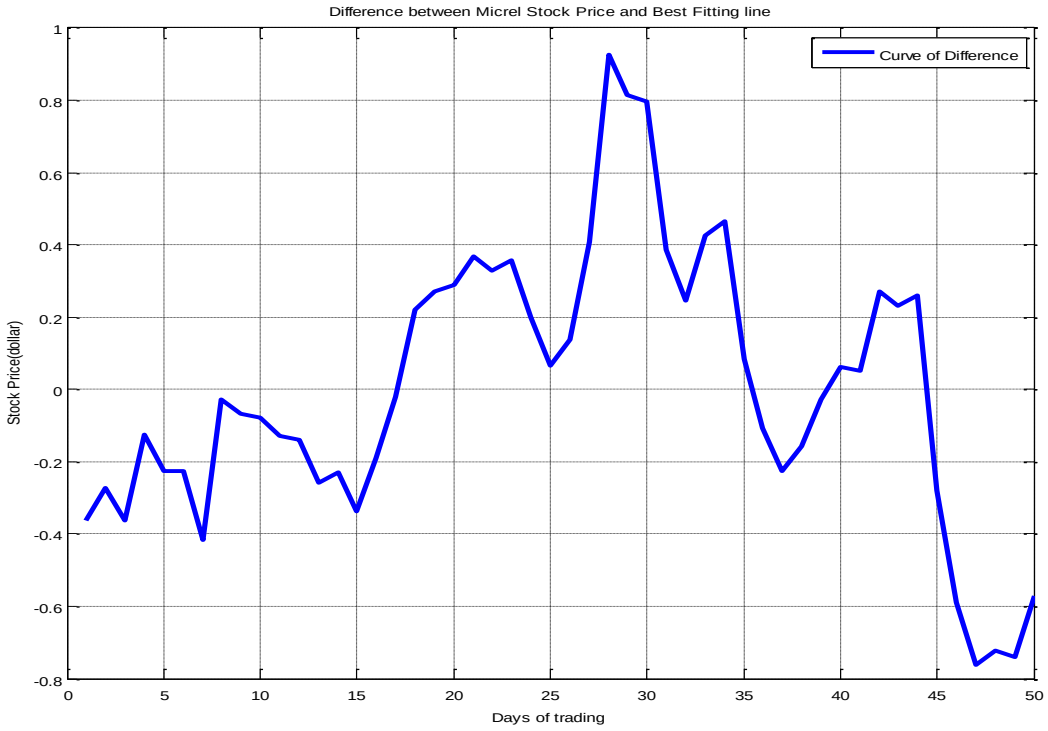


Figure M-4

This figure M-4 determines the best approximation of the stock trend when the Best Fit Line is subtracted from the real and original stock price trend.

MICROSOFT CORPORATION

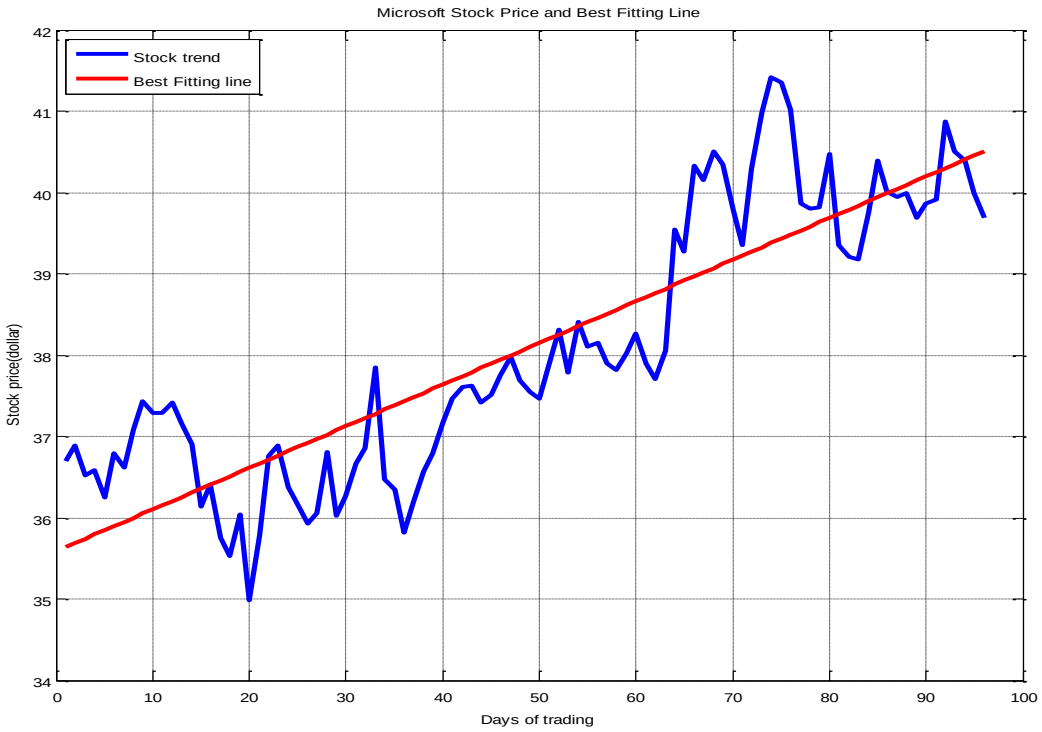


Figure M-5

Microsoft Stock price trend indicates that the highest trading price is around $41.50 while the lowest is at $35.00. The first degree Best Fit Line subtracted from this trend will determine the best approximation showing below.

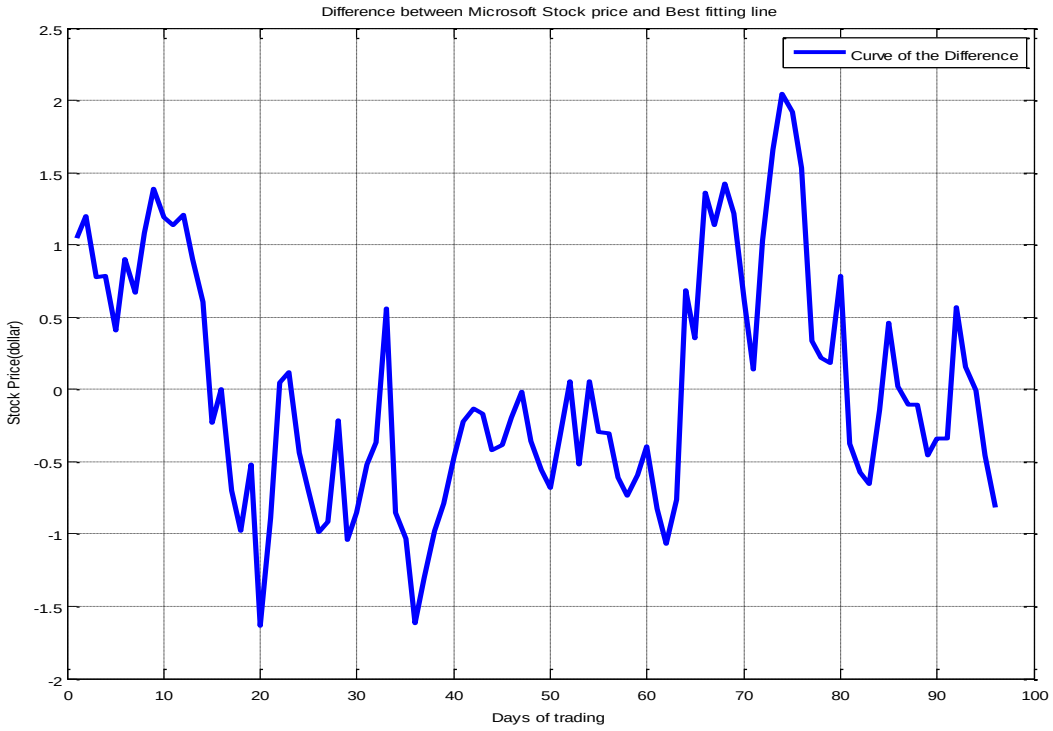


Figure M-6

This figure M-6 determines the best approximation of the stock trend when the Best Fit Line is subtracted from the real and original stock price trend.

MODEL Inc.

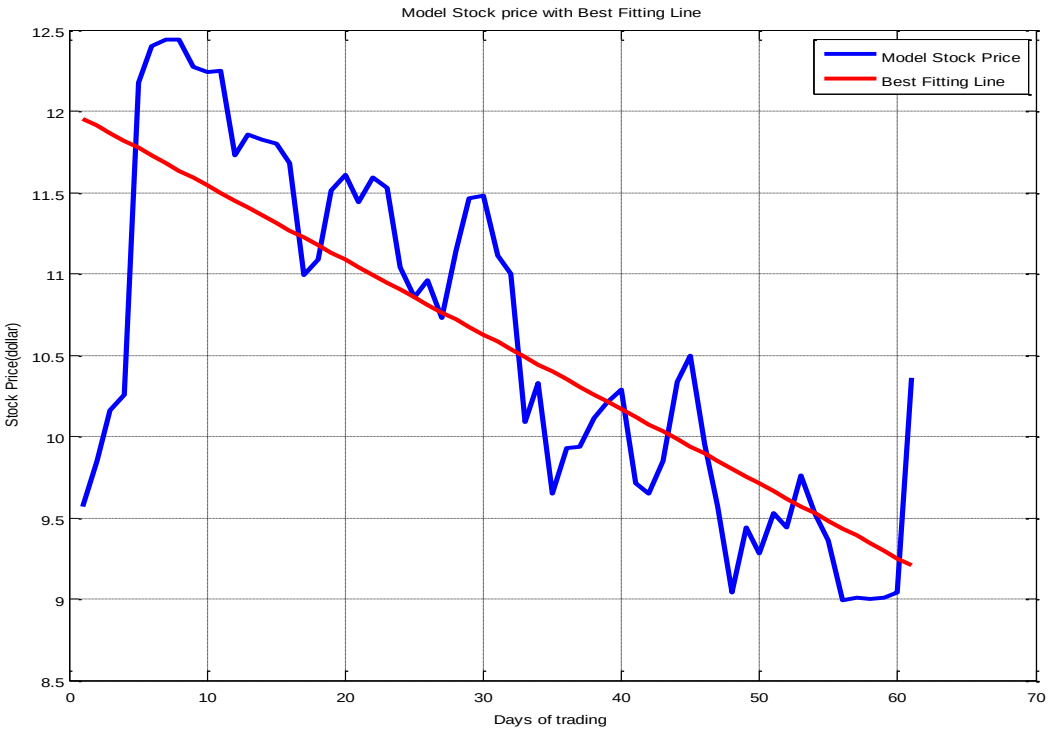


Figure M-7

The regression line in red subtracted from Model Inc. Stock price give us the best trend approximation below.

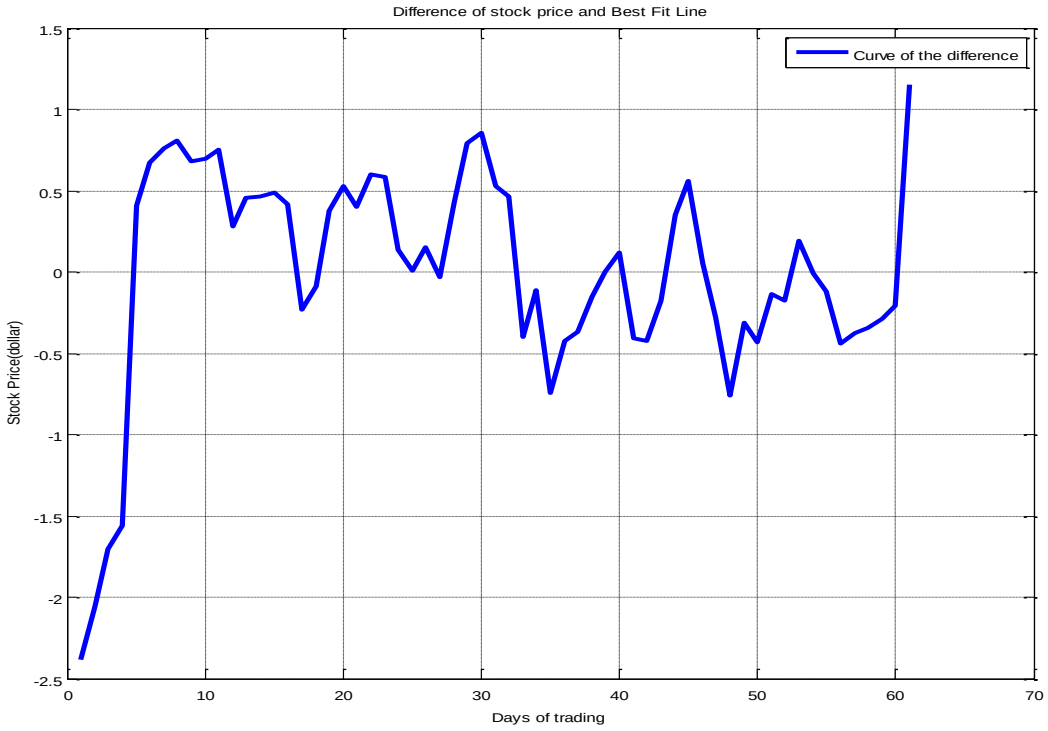


Figure M-8

This figure M-8 determines the best approximation of the stock trend when the Best Fit Line is subtracted from the real and original stock price trend.

Now that we have used the Least Square method to find the best approximation of our entire stocks trend, we will combine this trend with Fourier Series Expansion to find another stock trend that is the noise. But before we do that, it is important to know the definition of Fourier Series Expansion, how useful it is in general and in particularly in our stock price prediction.

5-4 FOURIER SERIES EXPANSION

Before using this great idea of Baron Jean Baptiste Fourier, we want to show this historic portrait of the man whose 62 years of existence keeps changing the world. This portrait was taking from Mah24.net or could be accessed at http://www.math24.net/definition-of-fourier-series.html

Baron Jean Baptiste Joseph Fourier (1768 – 1830) introduced the idea that any periodic function can be represented by a series of sines and cosines which are harmonically related.

To consider this idea in more detail, we should introduce some definitions and common terms.

Source: http://www.math24.net/definition-of-fourier-series.html

Indeed, the definition of the Fourier Series Expansion is worded differently depending of the author, but all saying the same thing and converted to the same result and formula. Indeed, the following definitions are from Wikipedia and mathworld.wolfram.com/FourierSeries.htlm

"A **Fourier series** is an **expansion** of a periodic function in terms of an infinite sum of sines and cosines. **Fourier series** make use of the orthogonally relationships of the sine and cosine functions."

”In mathematics, a Fourier series is a way to represent a wave-like function as a combination of simple sine waves. More formally, it decomposes any periodic function or periodic signal into the sum of a (possibly infinite) set of simple oscillating functions, namely sines and cosines (or complex exponentials). The Discrete-time Fourier transform is a periodic function, often defined in terms of a Fourier series. And the Z-transform reduces to a Fourier series for the important case |z|=1”

The Fourier Series of a periodic function f(x) is giving by:

$$f(t) \sim \frac{a_0}{2} + \sum_{n=1}^{\infty} a_n \cos(n\omega t) + \sum_{n=1}^{\infty} b_n \sin(n\omega t)$$

where

$$\omega = \frac{2\pi}{T}$$

$$a_0 = \frac{2}{T} \int_{-T/2}^{T/2} f(t)dt$$

$$a_n = \frac{2}{T} \int_{-T/2}^{T/2} f(t) \cos(n\omega t)dt$$

$$b_n = \frac{2}{T} \int_{-T/2}^{T/2} f(t) \sin(n\omega t)dt$$

Now, that we know we could use the Fourier Series Expansion equation to first find the noise in our stocks trends, the confidence interval which is the range of values between the maximum and minimum where our prediction could fall. We are going to use Matlab program to plot both the stock trend and the Fourier Series Expansion and take the difference of both. This will give us the noise as result.

Knowing the best fit line and Fourier Series Expansion, we could extrapolate the signal (trend of the stock) from the past known trend to the future. This is will be our prediction of the stock price of individual company's stock.

The following graphs show the trend giving by the difference between the trend of the stock's price and the Fourier Series Expansion associated with them follow by the noise created by their difference: Difference – Fourier series expansion.

APPLE Inc.

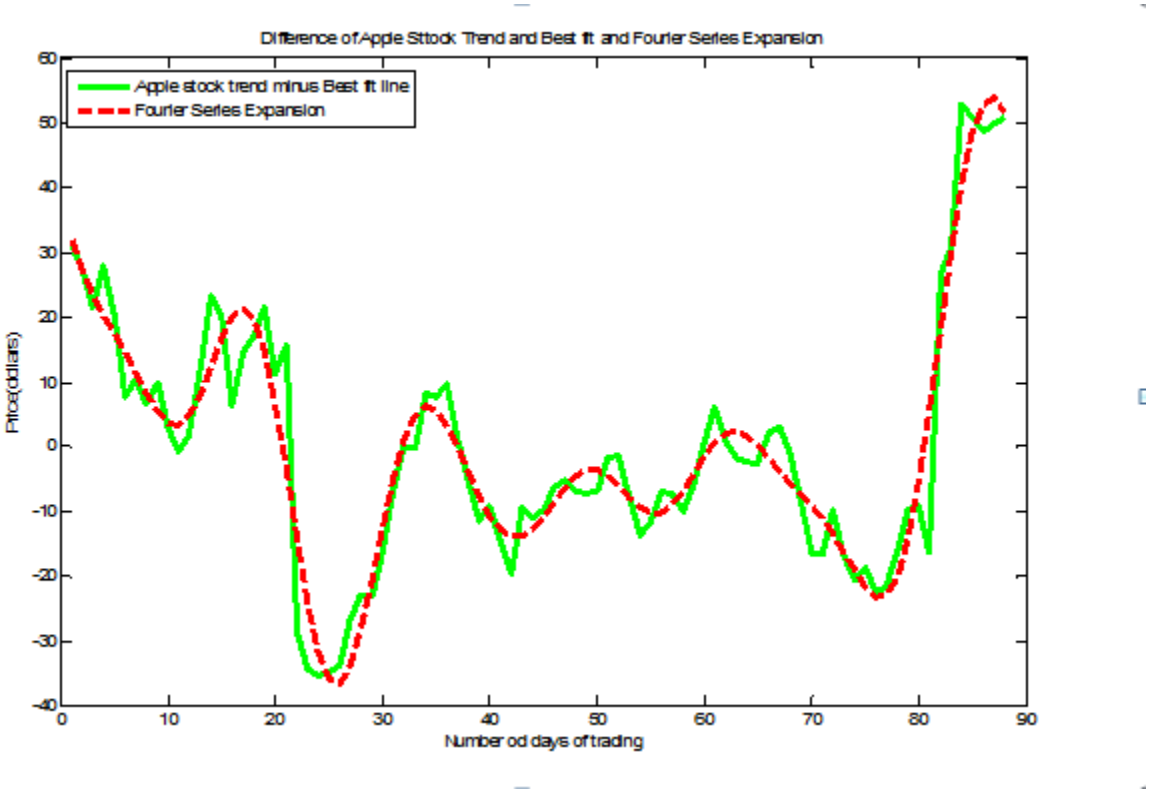


Figure A-3

The green curve represents the actual Apple Inc. stock trend. The red curve is Fourier series expansion over the relevant data from 1 to 89.

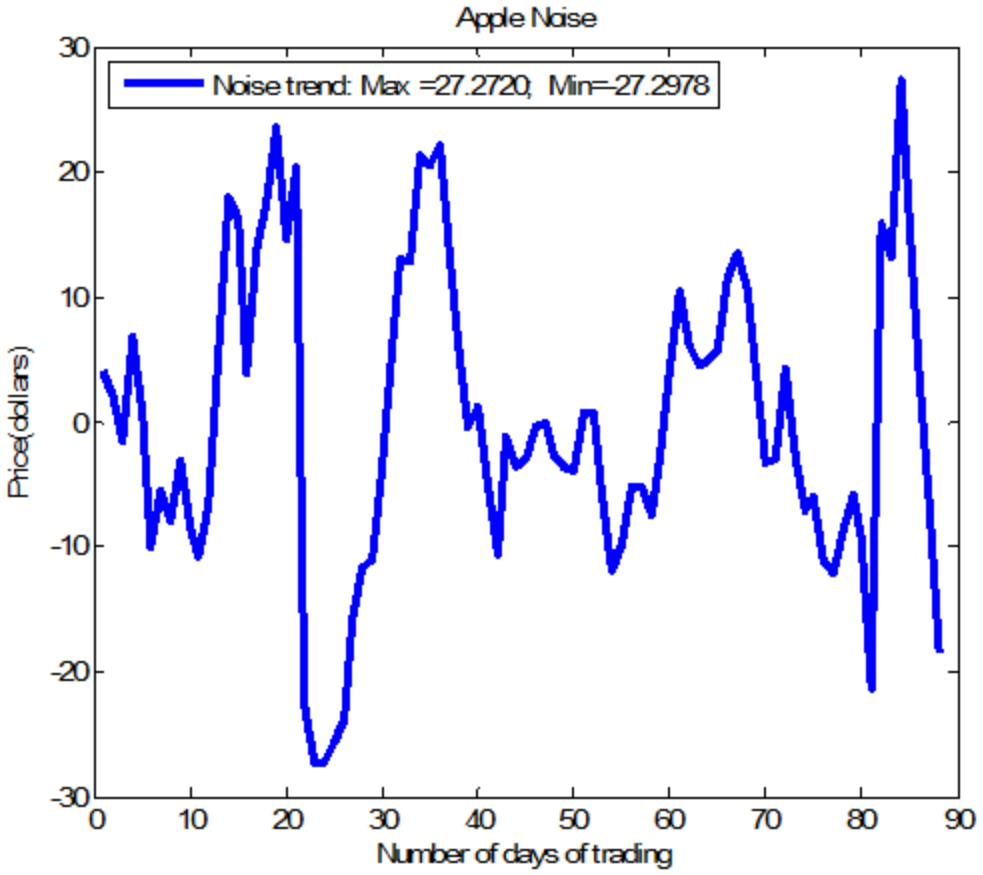


Figure A-4

The Figure A-4 is the difference between the actual trend of the stock and Fourier series expansion.

The part of the code that permits the graphing of the above figures is as follow:

```
f=fit(x',(y-lst)','fourier8');
hold on
plot(x',f(x'),'--r');
Diff=y-lst,
figure;
plot(x',(Diff'-f(x)),'b'); % This is the noise of the trend(signal). It is
the difference between the trend and the Fourier series Expansion
```

FACEBOOK Inc.

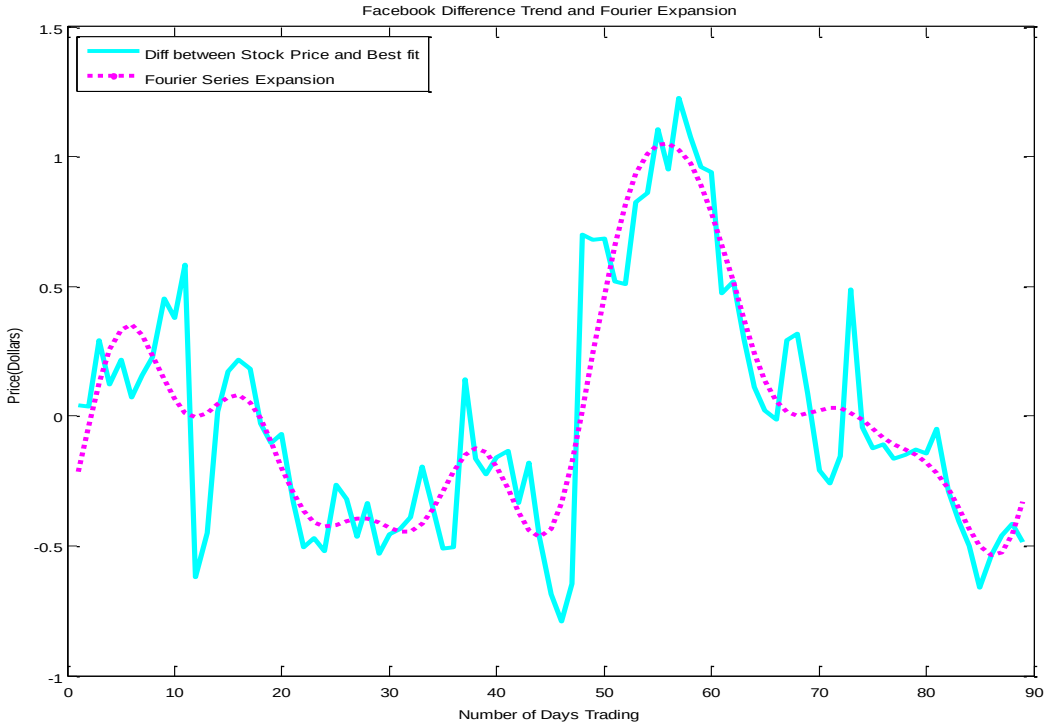


Figure F-3

The Figure F-3 represents the actual Facebook Inc. stock trend and the Fourier series expansion over the relevant data.

FACEBOOK NOISE

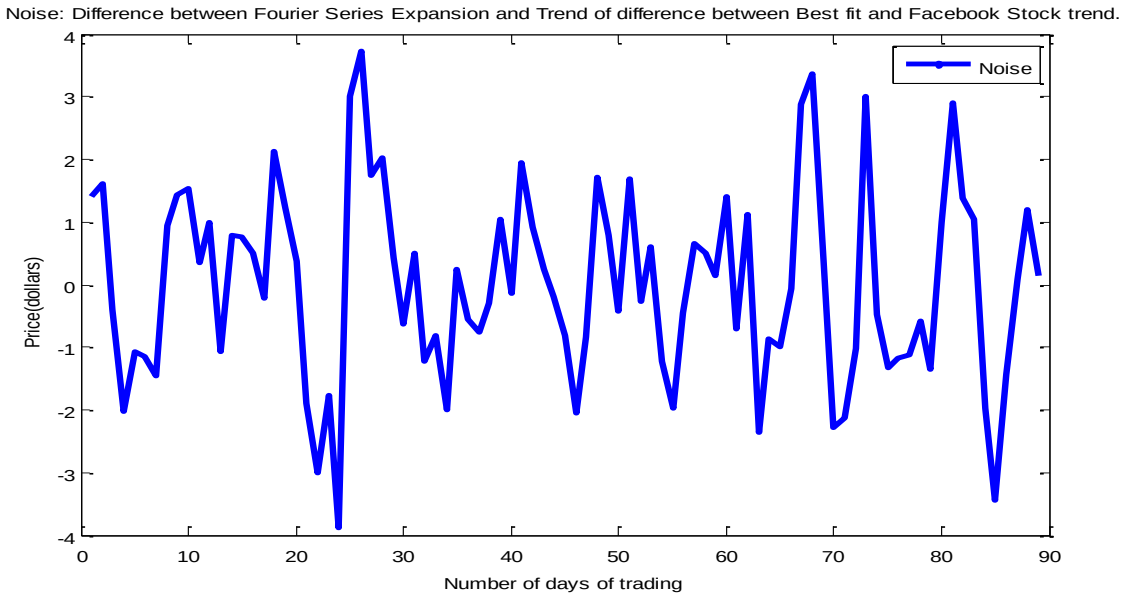


Figure F-4

This is the noise of Facebook Stock Price model with Fourier3.

The maximum noise is 3.8826 and the minimum noise is -3.7223.

```
plot(x,(y-lst),'c');
f=fit(x',(y-lst)','fourier8');
hold on
plot(x',f(x'),'--m');
Diff=y-lst,
figure;
plot(x',(Diff'-f(x)),'b'); % This is the noise of the trend(signal). It is

the difference between the trend and the Fourier series Expansion
```

INTEL CORPORATION

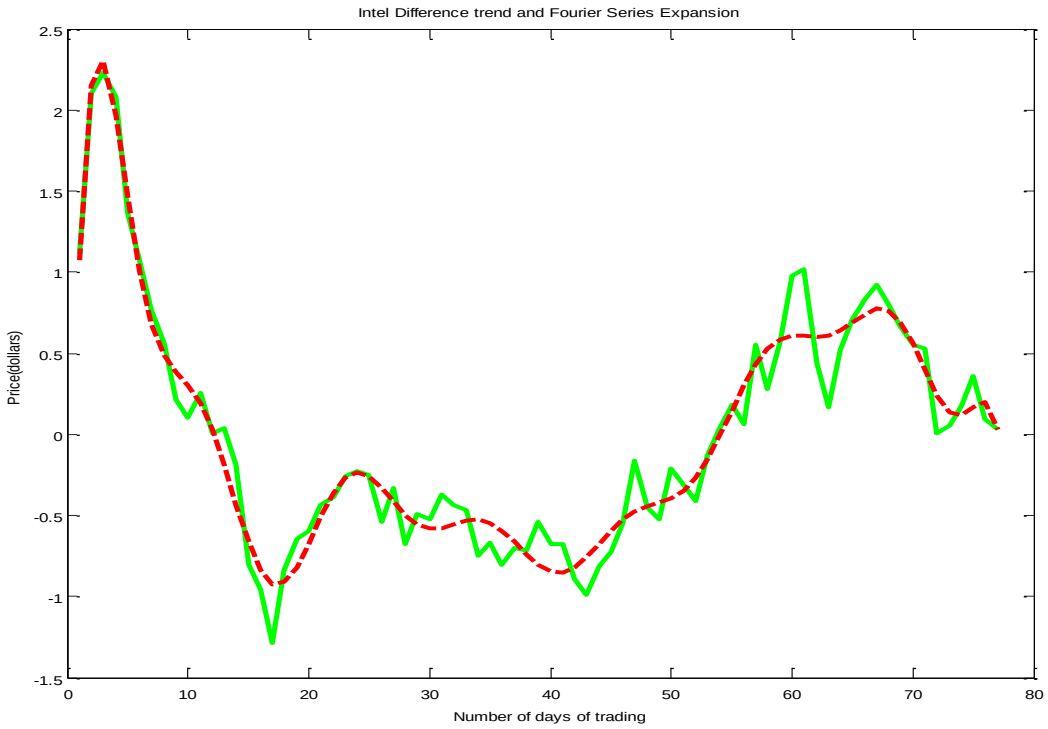


Figure I-7

The Figure I-7 represents the actual Intel Corporation stock trend and the Fourier series expansion over the relevant data: 1 to 77

INTEL NOISE

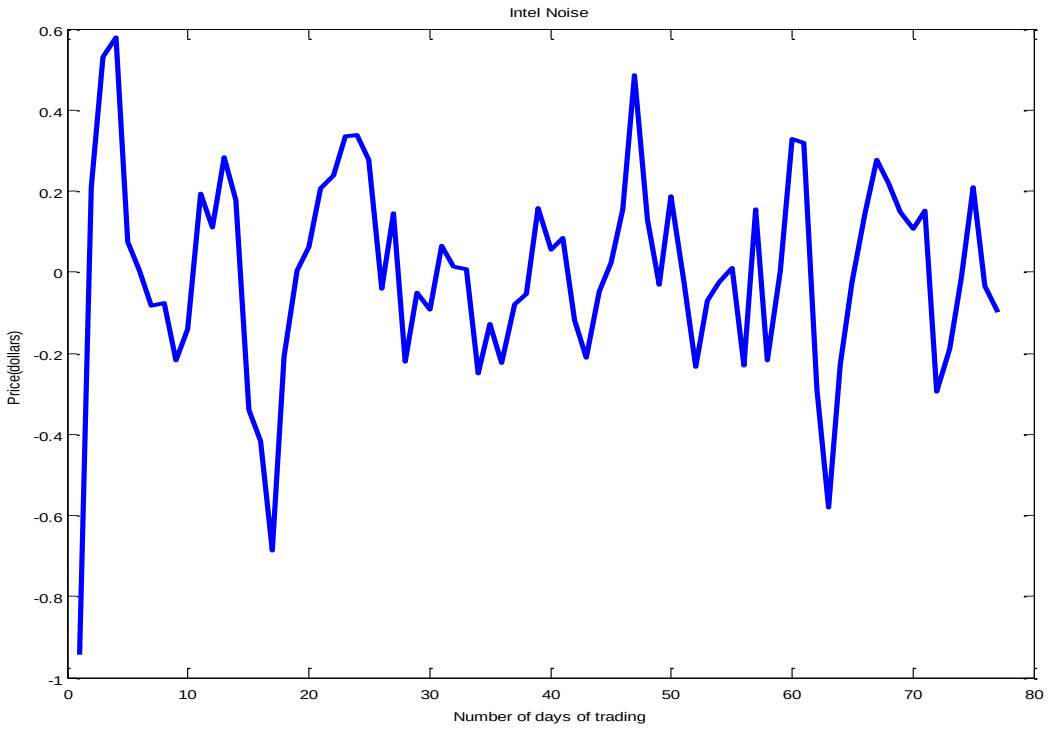


Figure I-8

Max_noise =0.9430

Min_noise = -0.5784

Fourier3

```
plot(x,(y-lst),'g');
f=fit(x',(y-lst)','fourier8');
hold on
plot(x',f(x'),'--r');
Diff=y-lst,
figure;
plot(x',(Diff'-f(x)),'b'); % This is the noise of the trend(signal). It is

the difference between the trend and the Fourier series Expansion
```

IBM CORPORATION

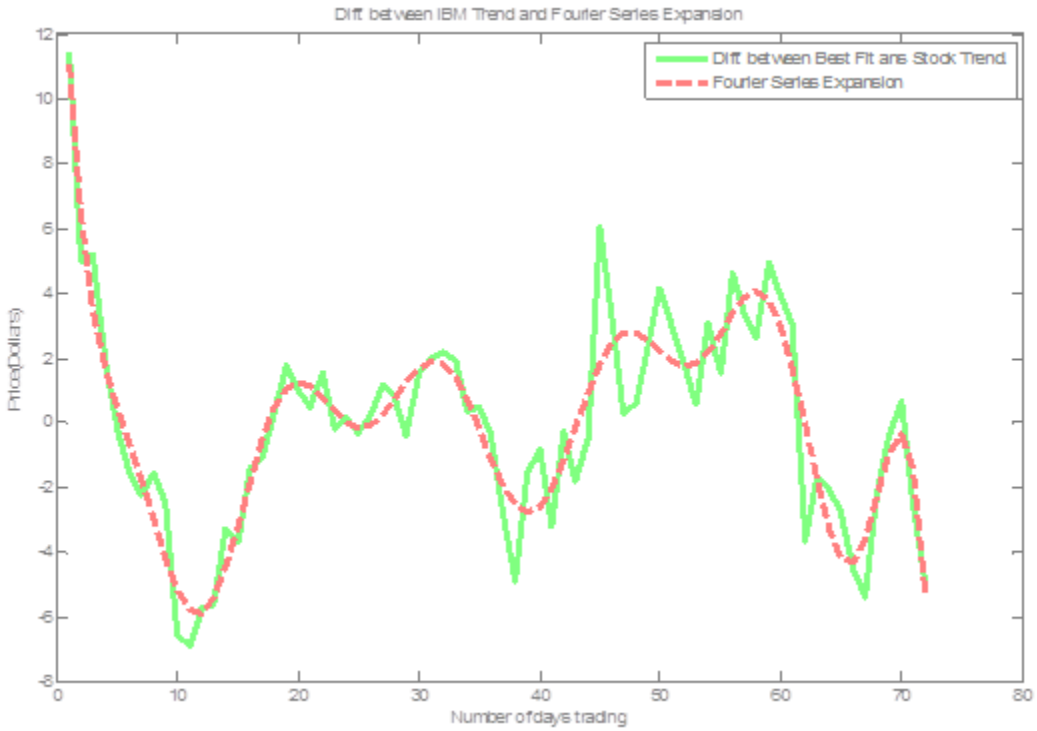


Figure I-9

The Figure I-9 represents the actual IBM Corporation stock trend and the Fourier series expansion over the relevant data.

IBM Noise below

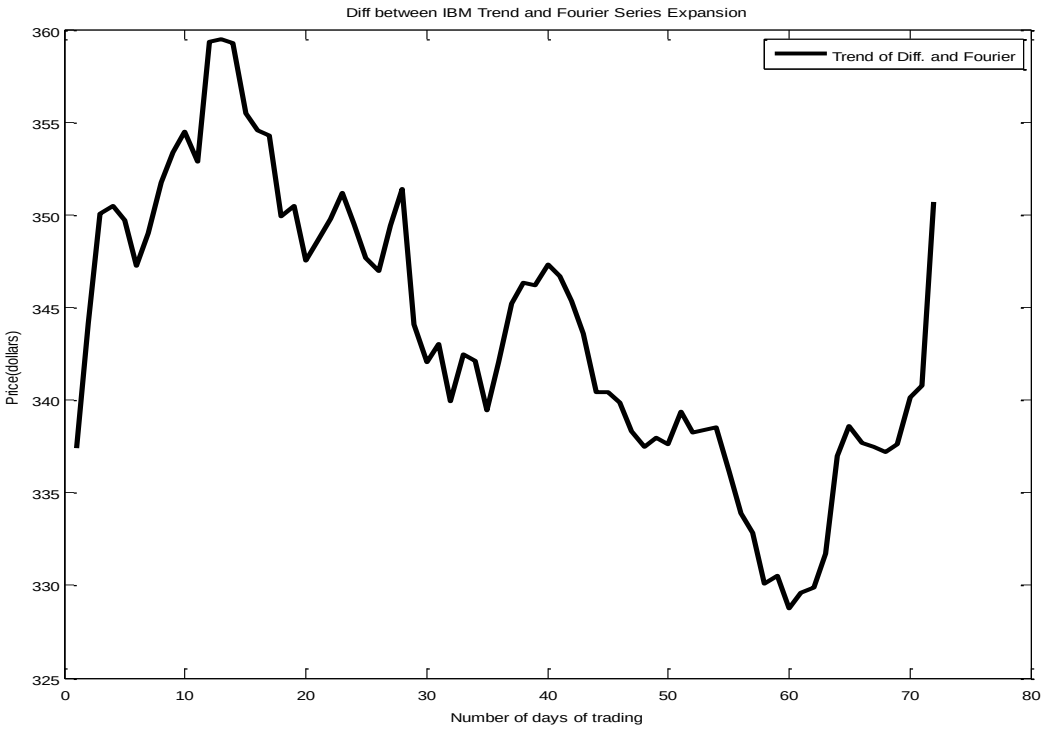


Figure I-10

```
plot(x,(y-lst),'g');
f=fit(x',(y-lst)','fourier8');
hold on
plot(x',f(x'),'--r');
Diff=y-lst,
figure;
plot(x',(Diff'-f(x)),'k'); % This is the noise of the trend(signal). It is

the difference between the trend and the Fourier series Expansion
```

INTELIQUENT Inc. Difference and Fourier series Expansion

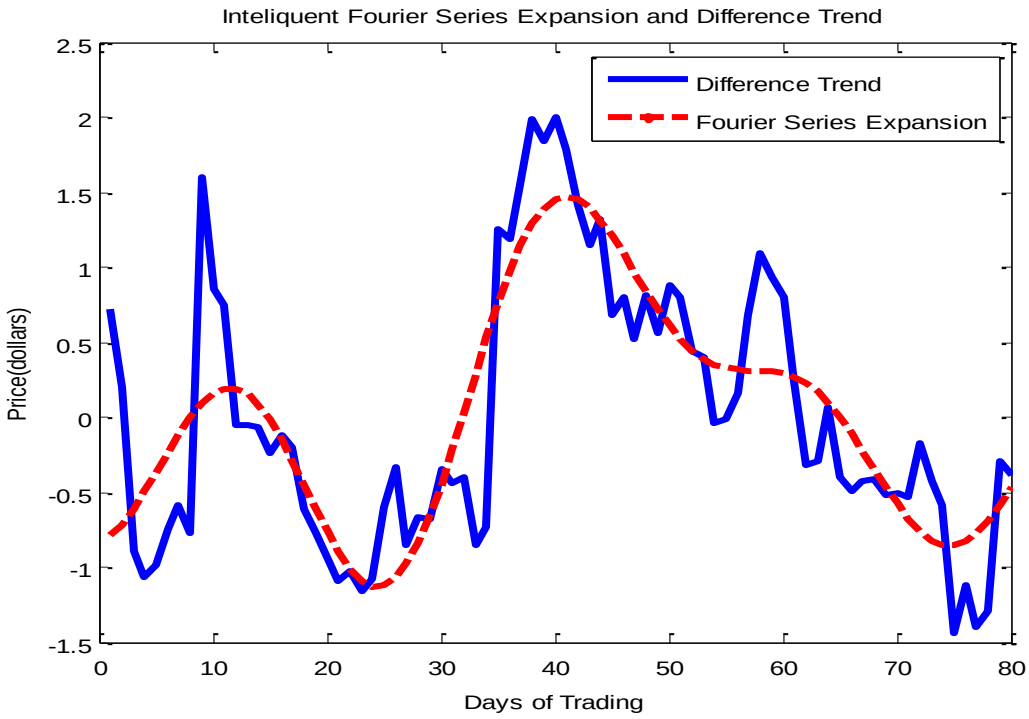


Figure I-11

```
plot(x,(y-lst),'b');
f=fit(x',(y-lst)','fourier8');
hold on
plot(x',f(x'),'--r');
Diff=y-lst,
figure;
plot(x',(Diff'-f(x)),'b'); % This is the noise of the trend(signal). It is

the difference between the trend and the Fourier series Expansion
```

INTELIQUENT NOISE (below)

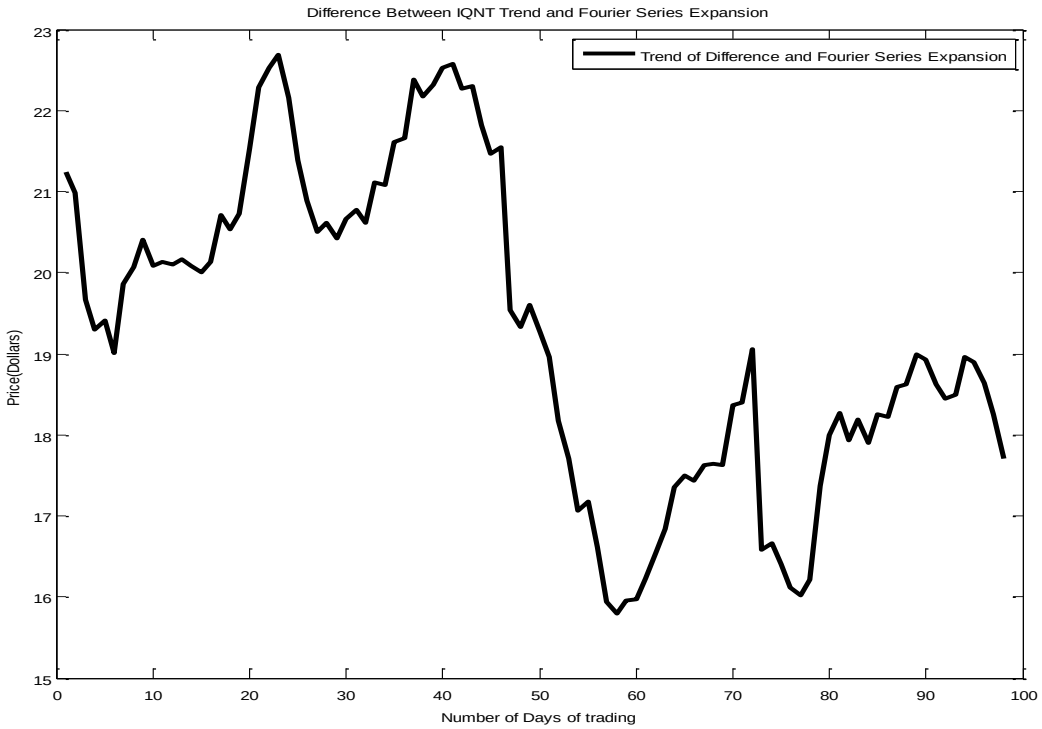


Figure I-12

```
plot(x',(Diff'-f(x)),'k'); % This is the noise of the trend(signal). It is
the difference between the trend and the Fourier series Expansion
```

GOOGLE Inc.

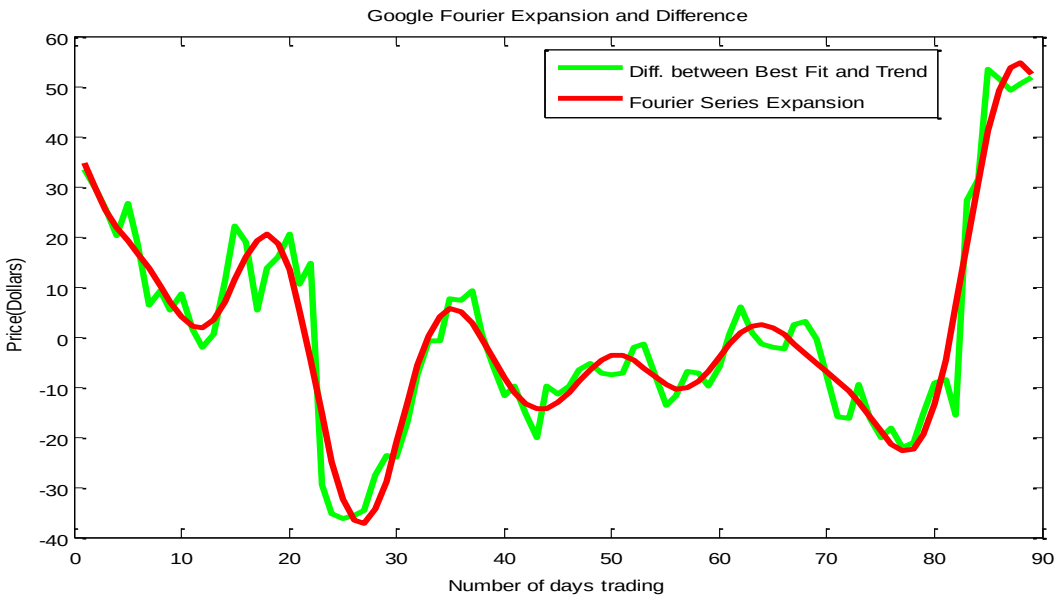


Figure G-3

The **red** curve is Fourier Series Expansion Level8: f=fit (x', (y-lst)','fourier8');

The **green** curve is the difference between the best fit and the trend:
Diff=y (i)-lst(i)

** With Level8 of Fourier Series Expansion, we get better fit

GOOGLE NOISE

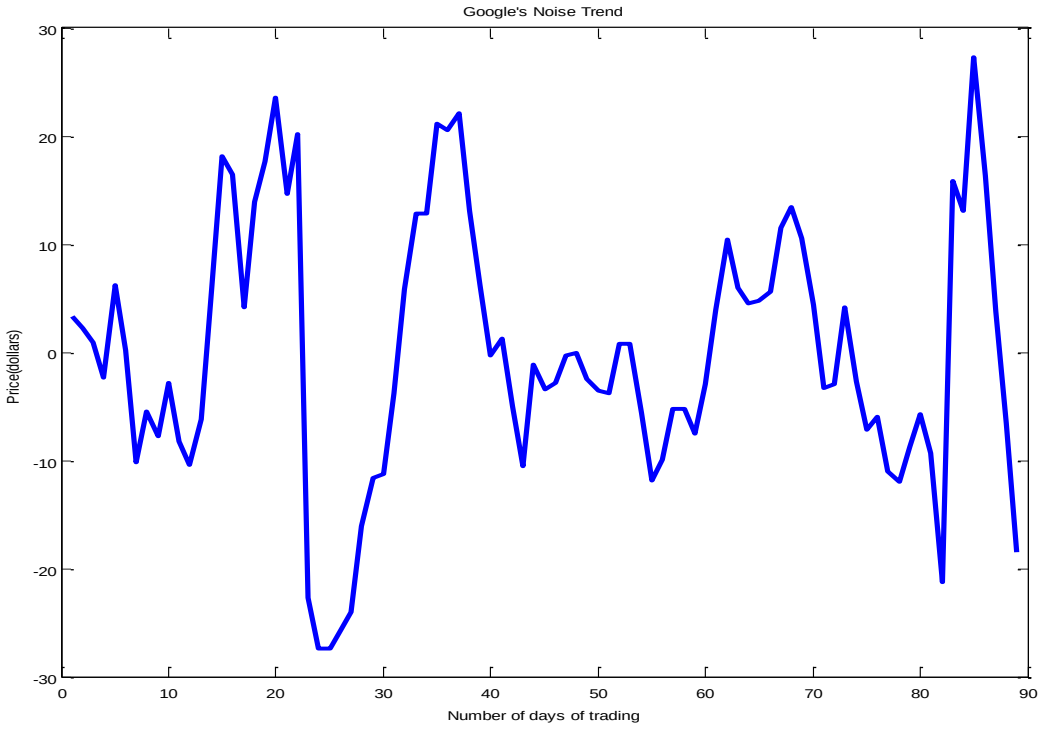


Figure G-4

max_noise = 27.3998;

min_noise = -27.2876

Fourier3

```
plot(x,(y-lst),'g',’linewidth’,3);
f=fit(x',(y-lst)','fourier8');
hold on
plot(x',f(x'),'r',’linewidwith’, 3);
Diff=y-lst,
figure;
plot(x',(Diff'-f(x)),'b'); % This is the noise of the trend(signal). It is

the difference between the trend and the Fourier series Expansion
```

MICROSOFT FOURIER EXPANSION AND DIFFERENCE

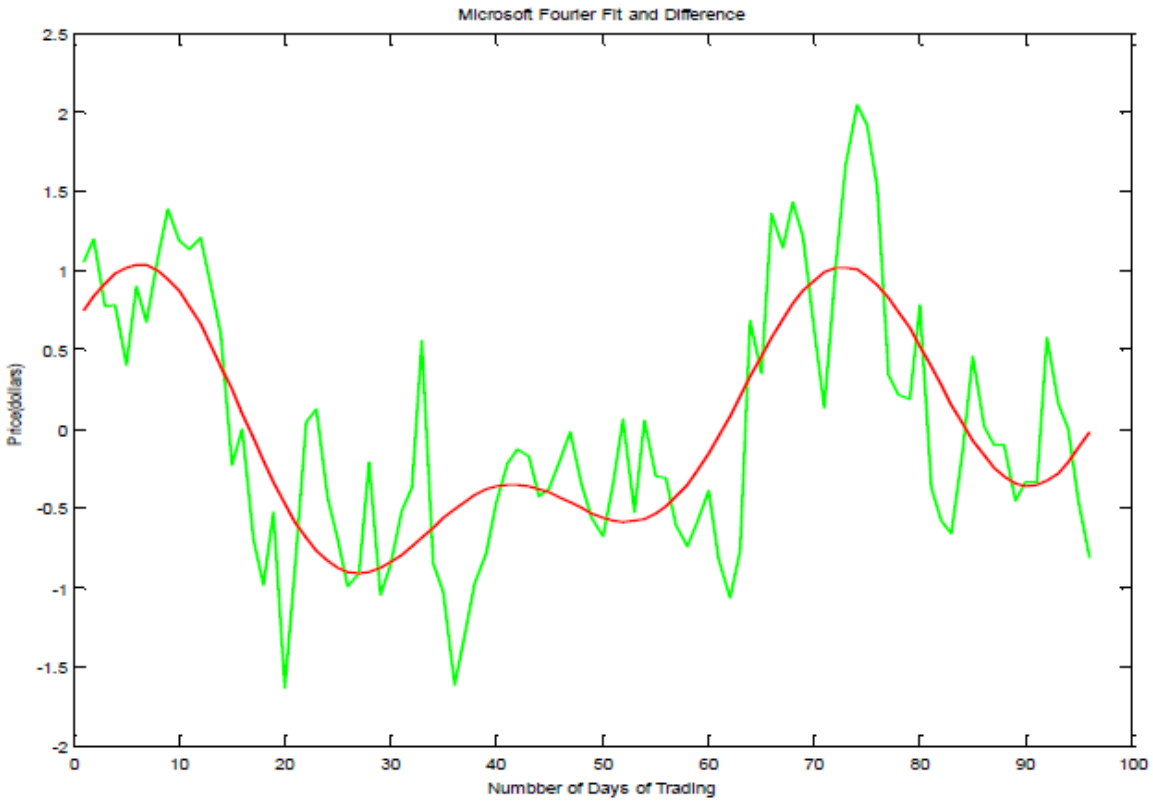
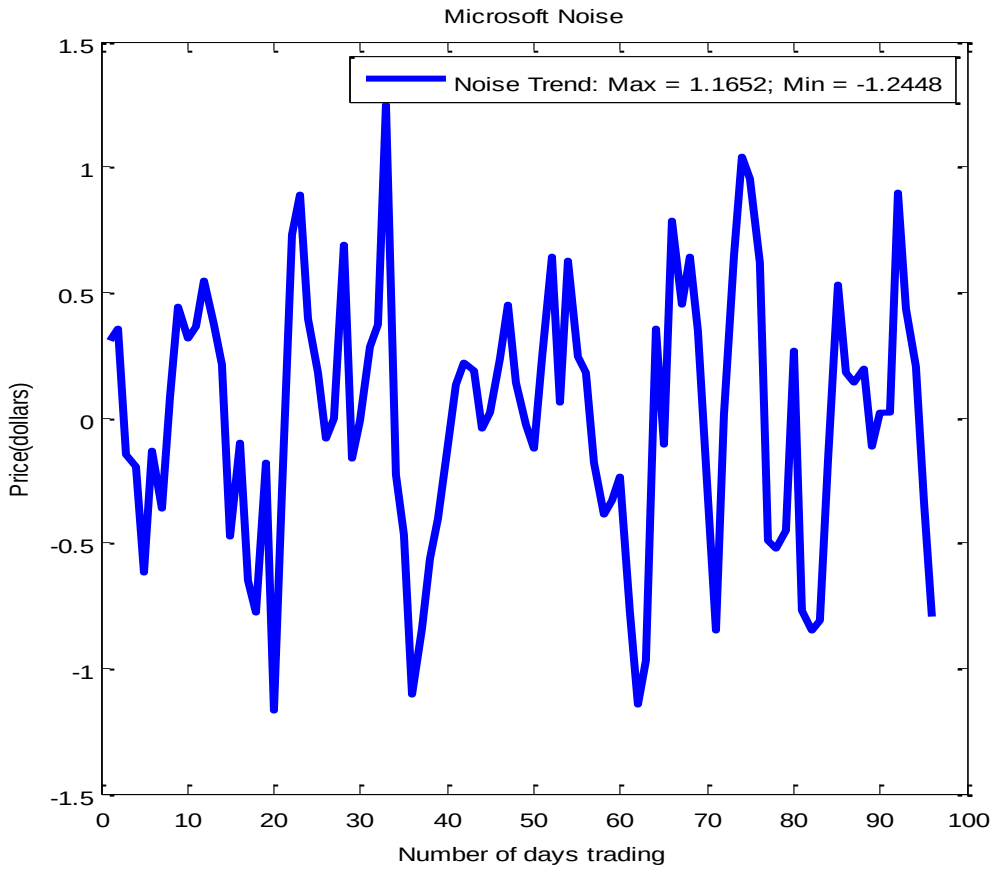


Figure M-9

The green curve is the difference between the real actual Microsoft stock trend and the best fitting line. The red curve is the Fourier series expansion.

```
plot(x,(y-lst),'g');
f=fit(x',(y-lst)','fourier8');
hold on
plot(x',f(x'),'r');
```

MICROSOFT NOISE



Max_noise= 1.1652

Min_noise= - 1.2448

Fourier3

```
Diff=y-lst,


figure;
plot(x',(Diff'-f(x)),'b'); % This is the noise of the trend(signal). It is

the difference between the trend and the Fourier series Expansion
```

MICREL DIFFERENCE AND FOURIER EXPANSION

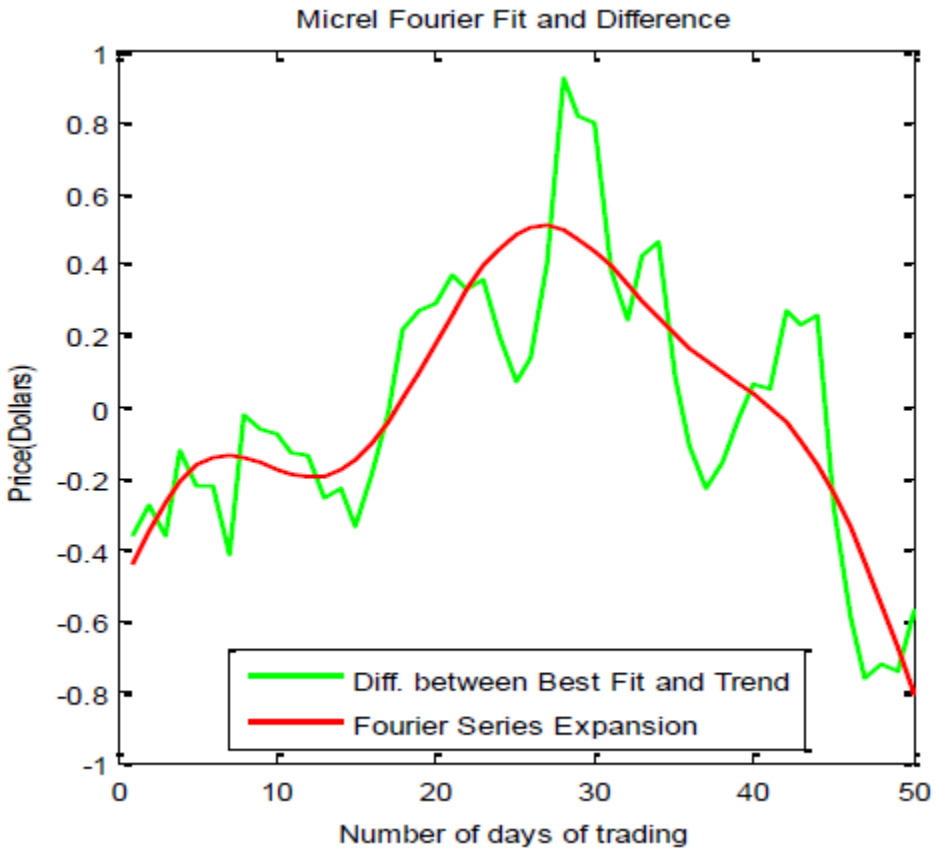


Figure M-10

The green curve is the difference between the real actual Microsoft stock trend and the best fitting line. The red curve is the Fourier series expansion.

```
plot(x,(y-lst),'g');
f=fit(x',(y-lst)','fourier8');
hold on
plot(x',f(x'),'r');
```

MICREL NOISE

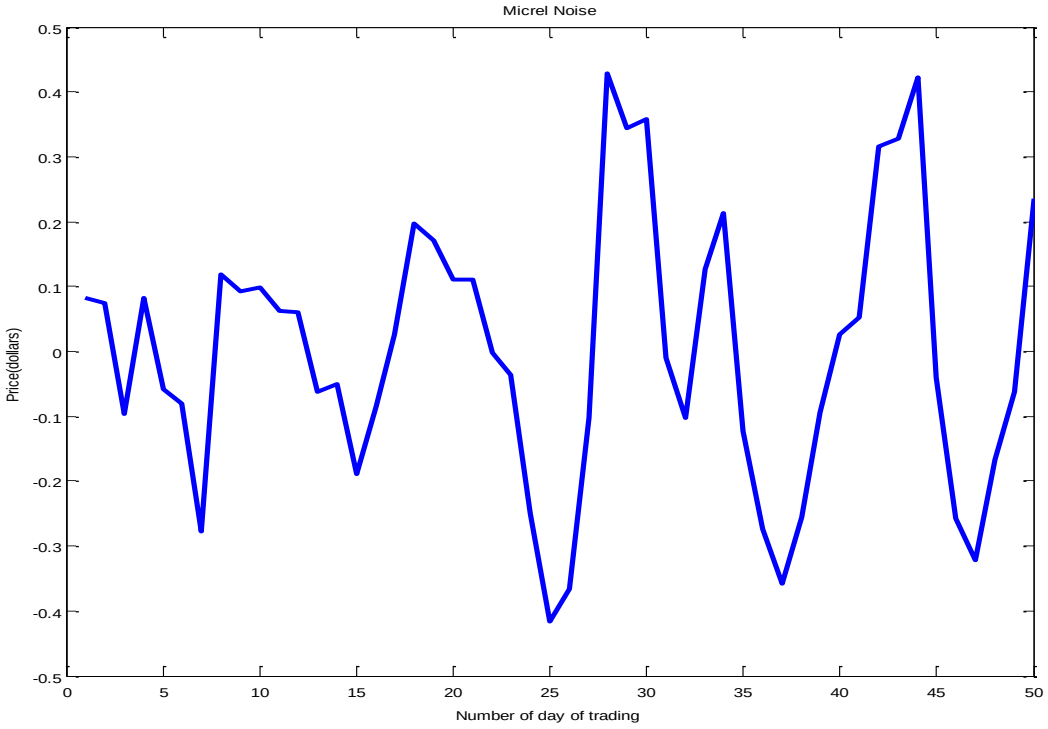


Figure M-11

```
Diff=y-lst,
figure;
plot(x',(Diff'-f(x)),'b'); % This is the noise of the trend(signal). It is

the difference between the trend and the Fourier series Expansion
```

Model Inc. Difference and Fourier Expansion

Model Noise

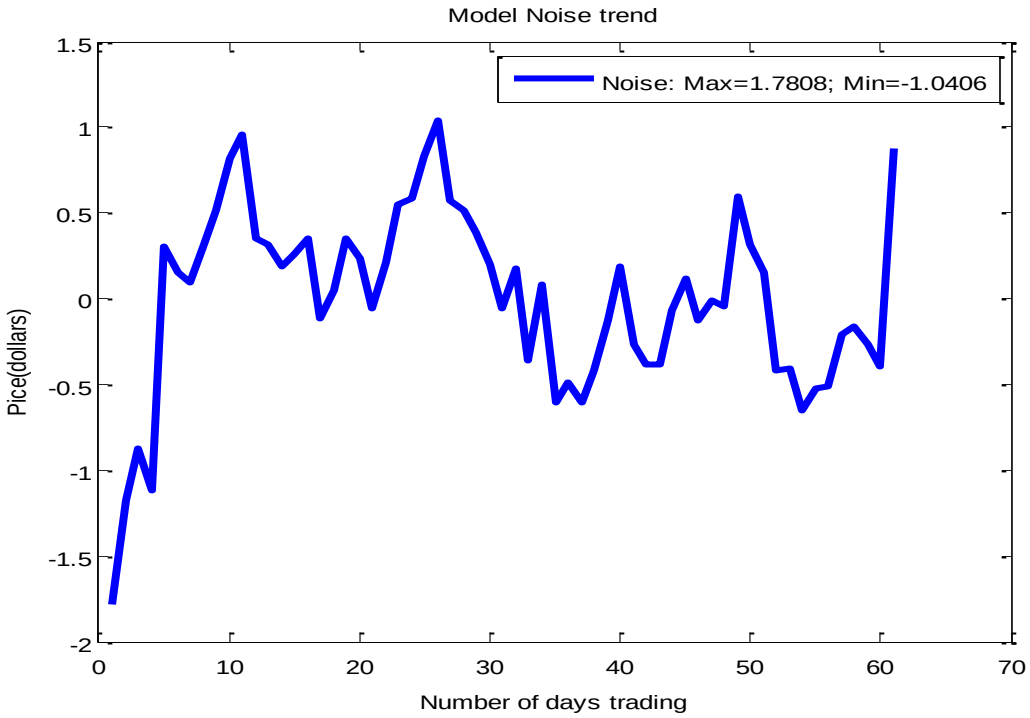


Figure M-12

Max_noise= 1.7808

Min_noise=-1.0406

Fourier3

```
Diff=y-lst,
figure;
plot(x',(Diff'-f(x)),'b'); % This is the noise of the trend(signal). It is

the difference between the trend and the Fourier series Expansion
```

Fourier Model Fitting

Knowing the trend of each stock that we are using for our project, we can use Fourier Model Fitting to first determine how close our model to the actual price trend of the stock.

The closer the fitting to the stock trend, the smaller the difference between the stock trend and the model; and the farther the model fitting, the larger the difference. Now, because we know that our Fourier Model Fitting fit well with some stocks, not so well with others, we can do 30 days prediction on all stocks and do our analysis to see which stock's price prediction works well with our model and which ones do not.

Using Matlab programming to plot ours graphs, we obtain the following figures for the ten technology stocks that we have chosen.

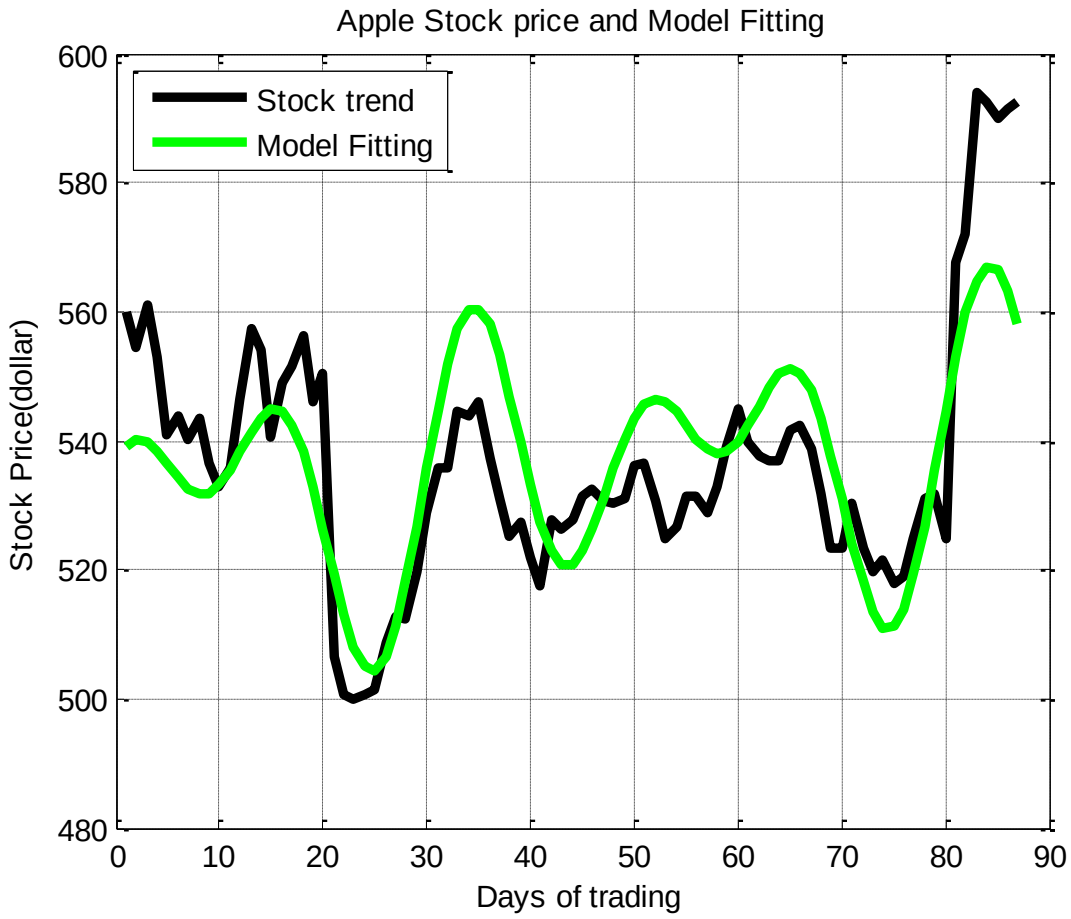


Figure A-5

Figure A-5 shows Apple Inc. stock price and Fourier series Modelling. This is done from day 1 to Day 87. We use this Fourier model and extrapolation; we find the 30 days prediction of the stock.

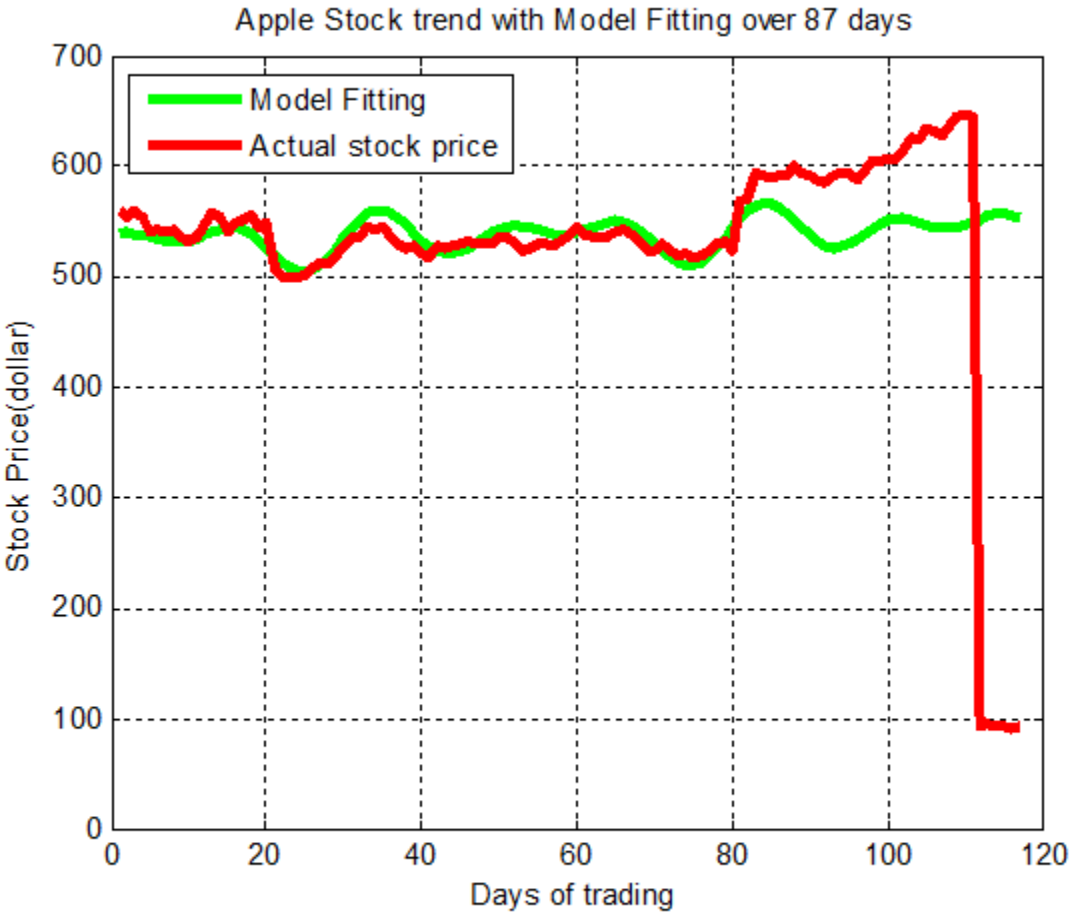


Figure 2: Historical Price and Model Fitting

The Fourier Series Model fits almost perfectly the real trend of Apple Inc. Stock. This model which is the sum of the Best Fitting Line (Regression Line) and Fourier series expansion is used to extrapolate (predict) the stock price for 30 more days which graph is showing below.

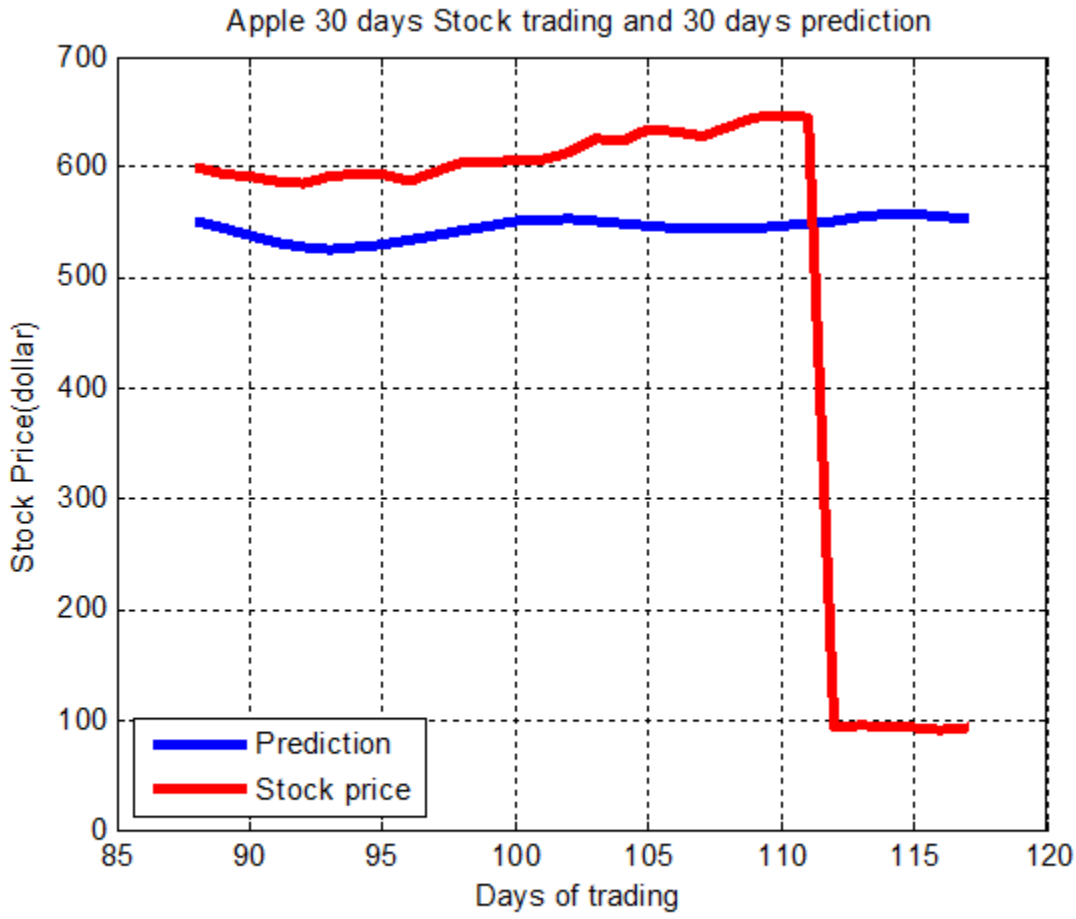


Figure 3: Stock Price and 30 days prediction

Prediction Analysis: The prediction curve matches with the stock trend in some periods of the graph and is out with big gap in other range. As we could see, from day 87 to day 105, the prediction is fairly accurate. When the trend of the stock goes down or up, the prediction also follow the trend. The prediction is way out from around days 112 and 117 where the actual stock drops sharply while the prediction still trading high.

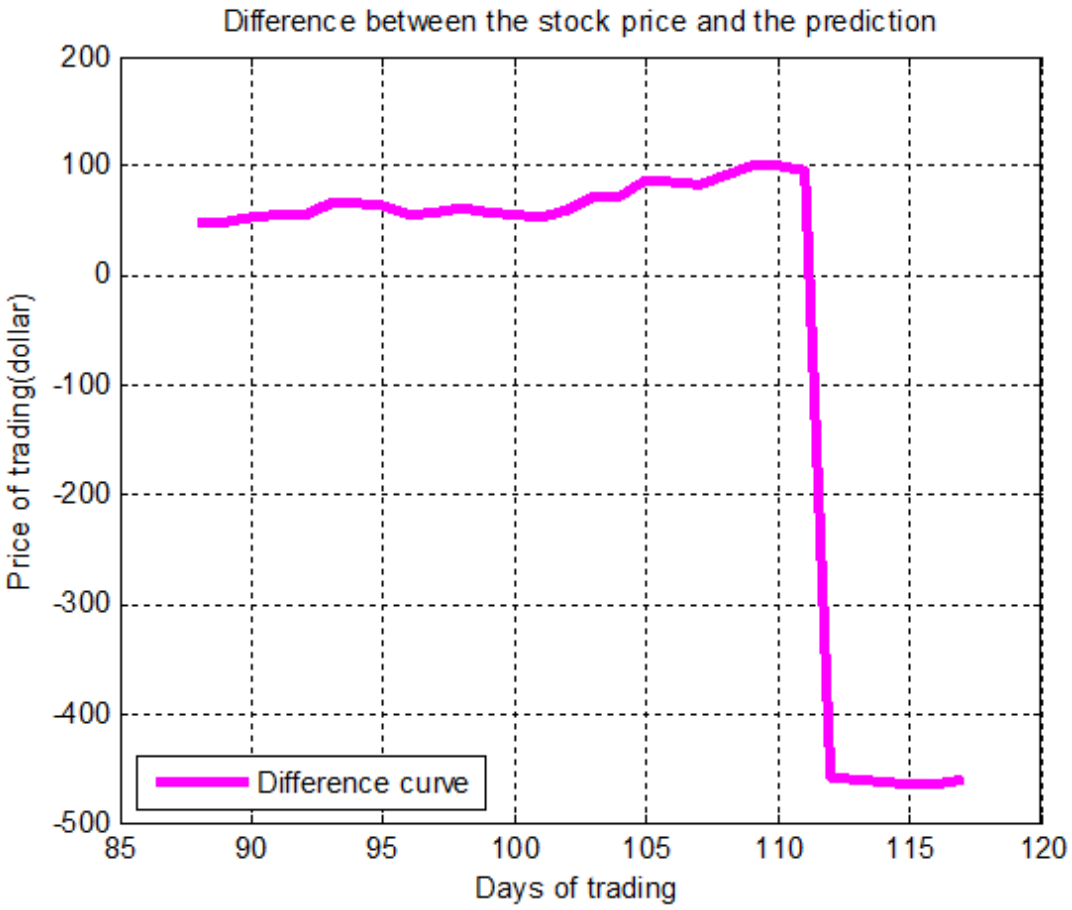


Figure 4: Difference between the curves.

Google Inc.

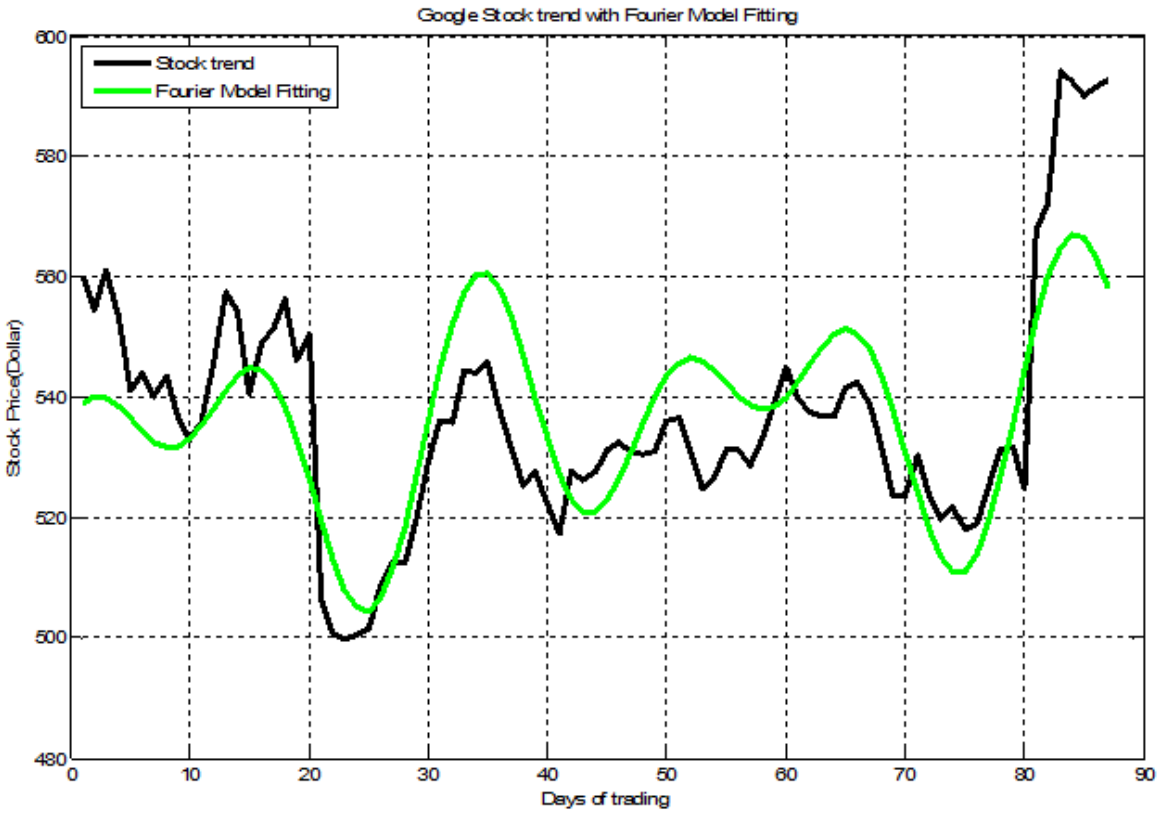


Figure 1: Stock Trend with Fourier model fitting plot in relevant data

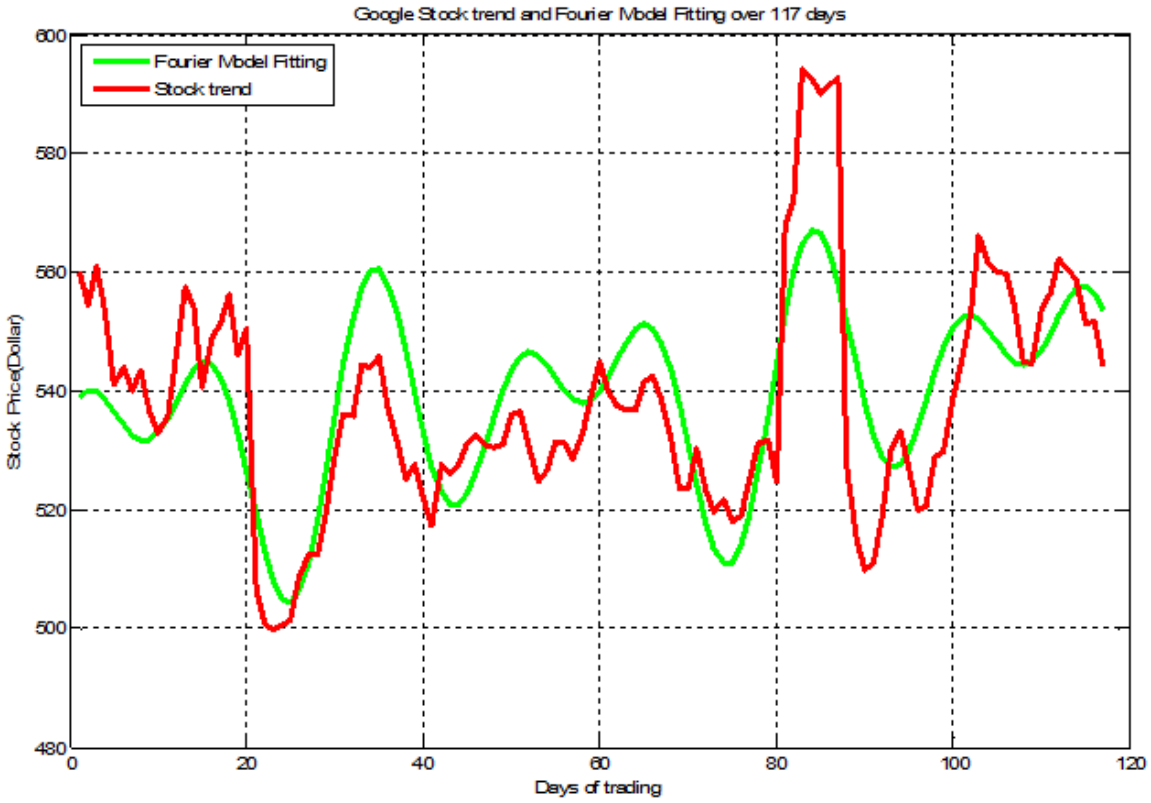


Figure 2: Stock Trend with Fourier model fitting over 117 days

The Fourier Series Model fits almost perfectly the real trend of Google Inc. Stock. This model which is the sum of the Best Fitting Line (Regression Line) and Fourier series expansion is used to extrapolate (predict) the stock price for 30 more days which graph is showing below.

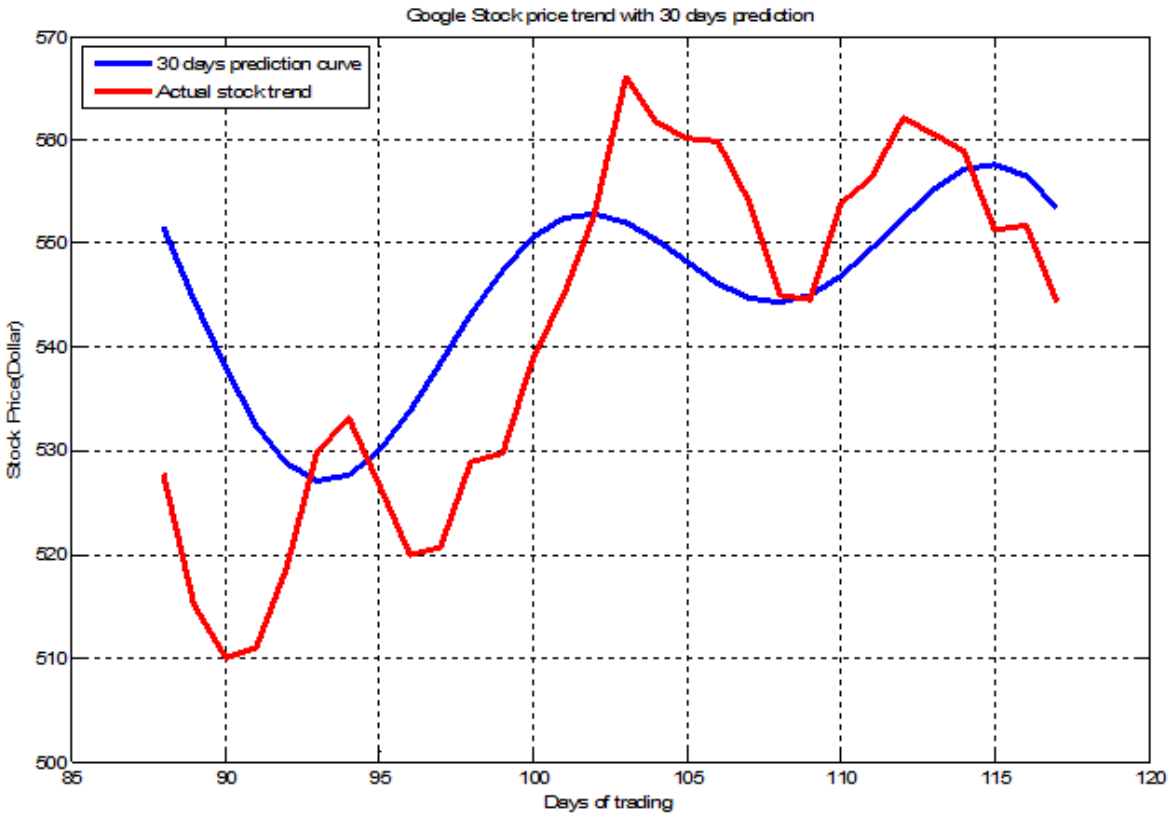


Figure 3: Google Actual stock price and 30 days prediction curve

Prediction Analysis: At the beginning of the 30 days prediction on day 87, the actual trend of the price of the stock (red curve) and the prediction curve match well. Both curves are trading down until approximately day 93 where the stock is trading up while the prediction is going down. Around day 97 the trend are accurate with both curves trading up. From 105 to 117, the prediction is fairly accurate with both curves trading up and down.

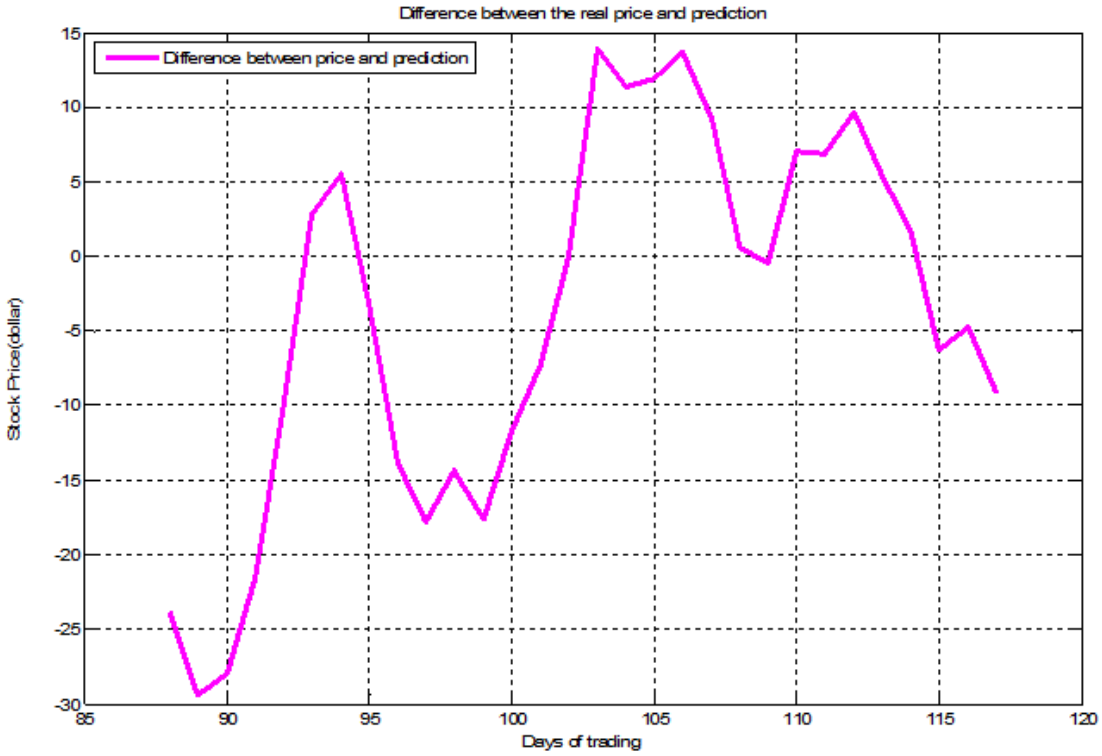


Figure 4: Difference between Google actual stock price and prediction.

Microsoft Corporation

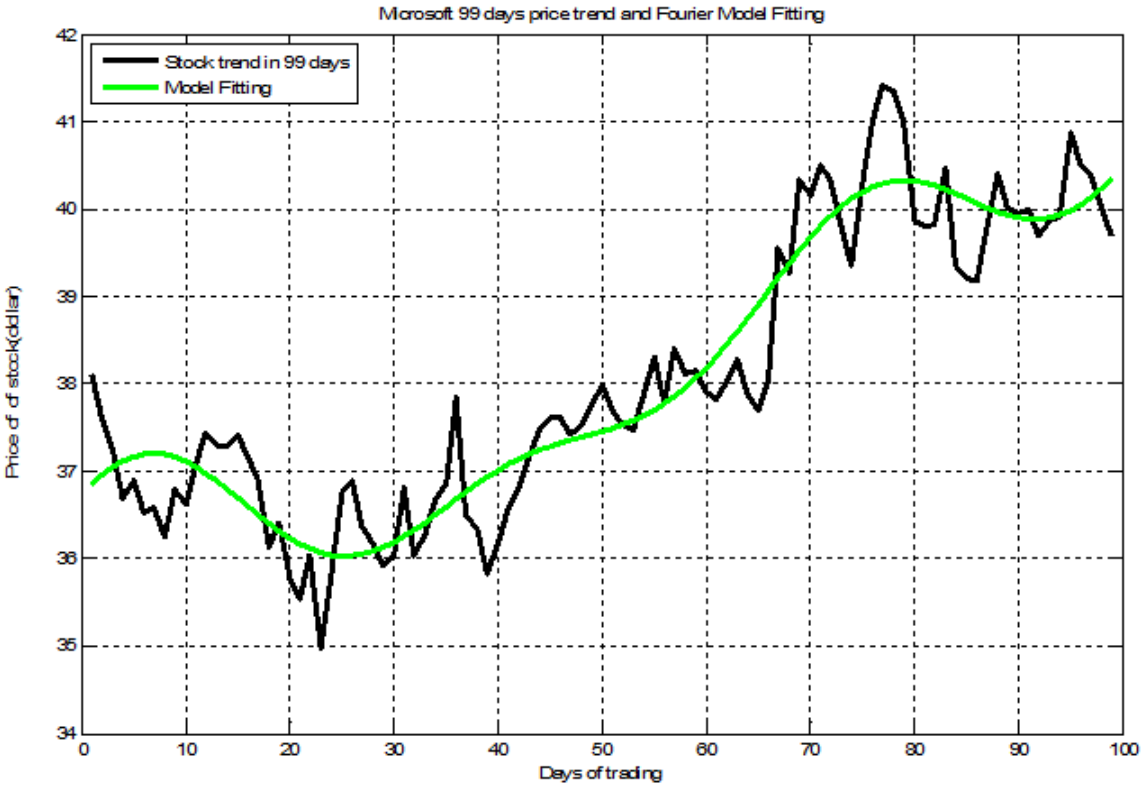


Figure 1: Microsoft actual historical price and Model fitting

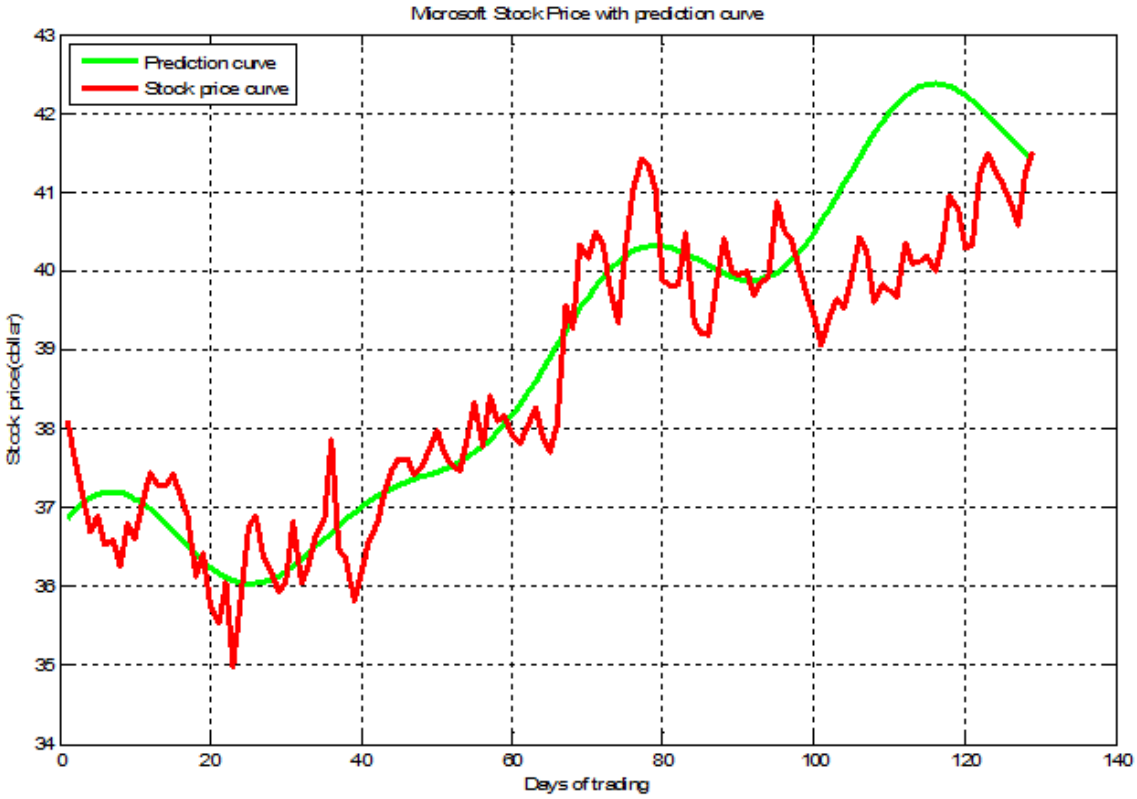


Figure 2: Actual Stock price and prediction

The Fourier Series Model fits almost perfectly the real trend of Microsoft Corporation Stock. This model which is the sum of the Best Fitting Line (Regression Line) and Fourier series expansion is used to extrapolate (predict) the stock price for 30 more days

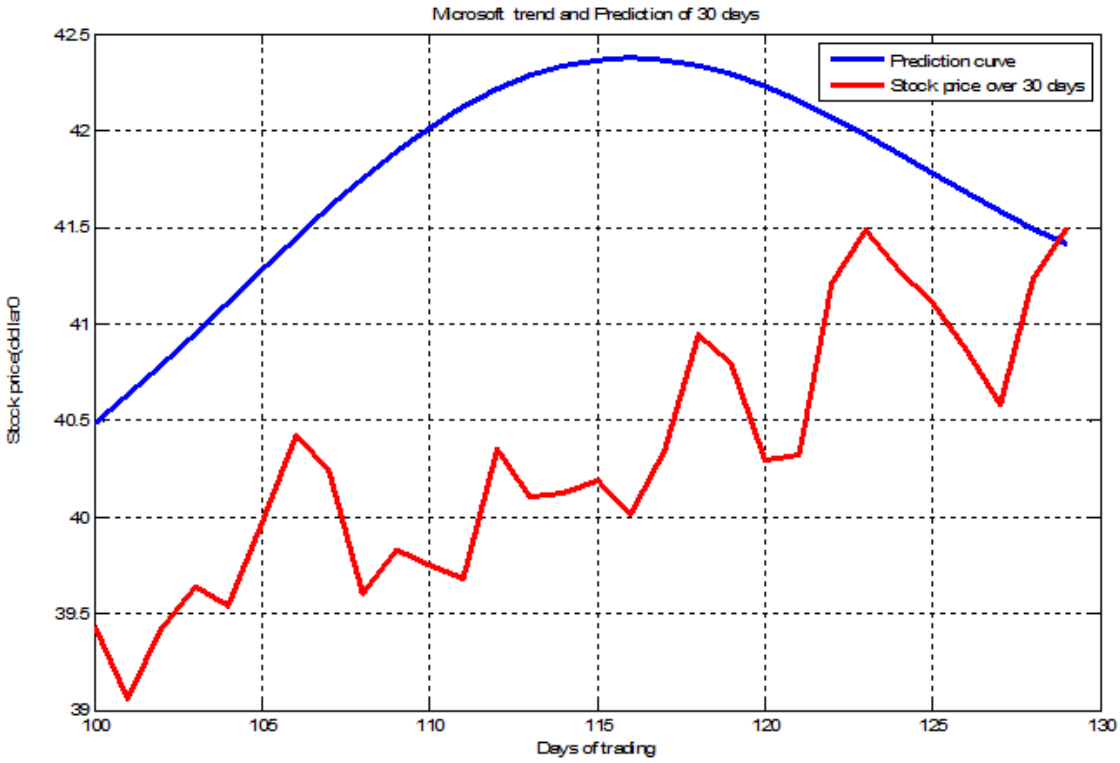


Figure 3: Prediction of 30 days along with Stock trend

Prediction Analysis: Considering the prediction line starting from $40.5 and end approximately $41.00, we can see that the prediction is upward from day 100 to day 115. During the same period of time, the actual stock price fluctuated up and down. While the forecast continues to go up, the stock itself goes down from the beginning(day 100) and started going up from about Day 102 for two days before going down around day 104. From there, it went up until day 107 before going down. This up and down trend of the actual stock continue until the end of the 30 days prediction where both curves meet with the prediction going down while the actual stock is going up. It is important to note that the difference between the stock trend and the prediction is approximately $2.00 which means that the prediction is not way off the chart.

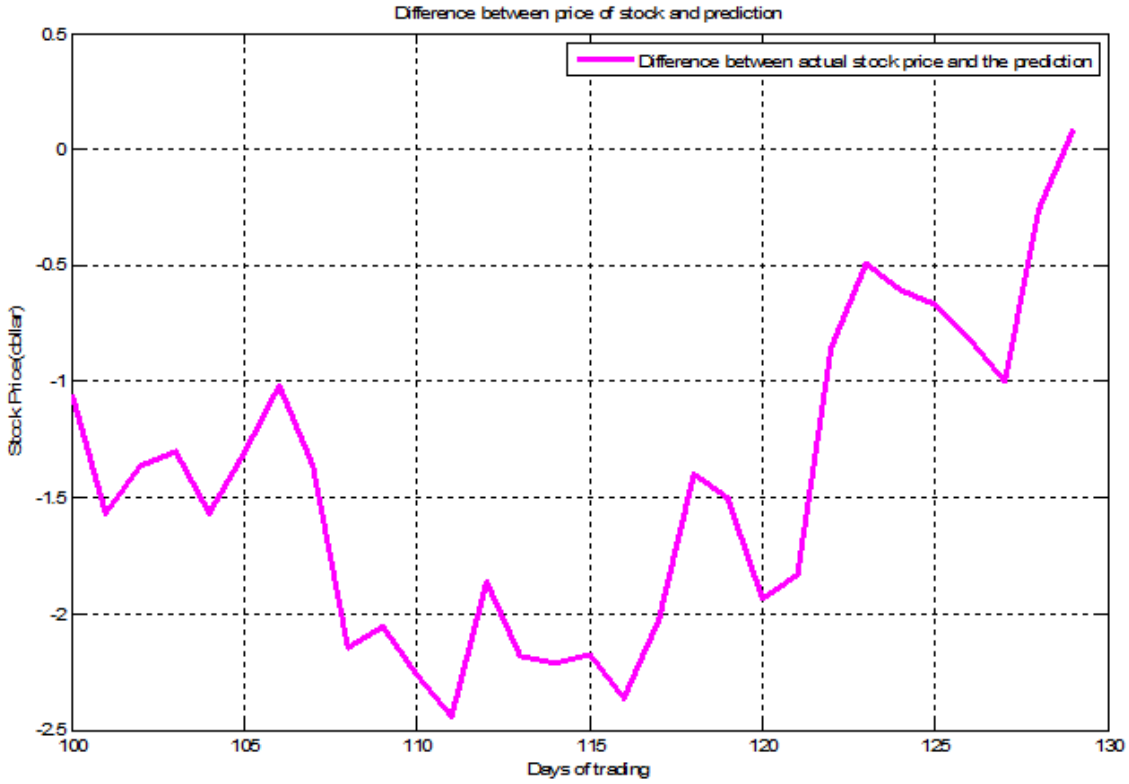


Figure 4: Curves difference

IBM Corporation

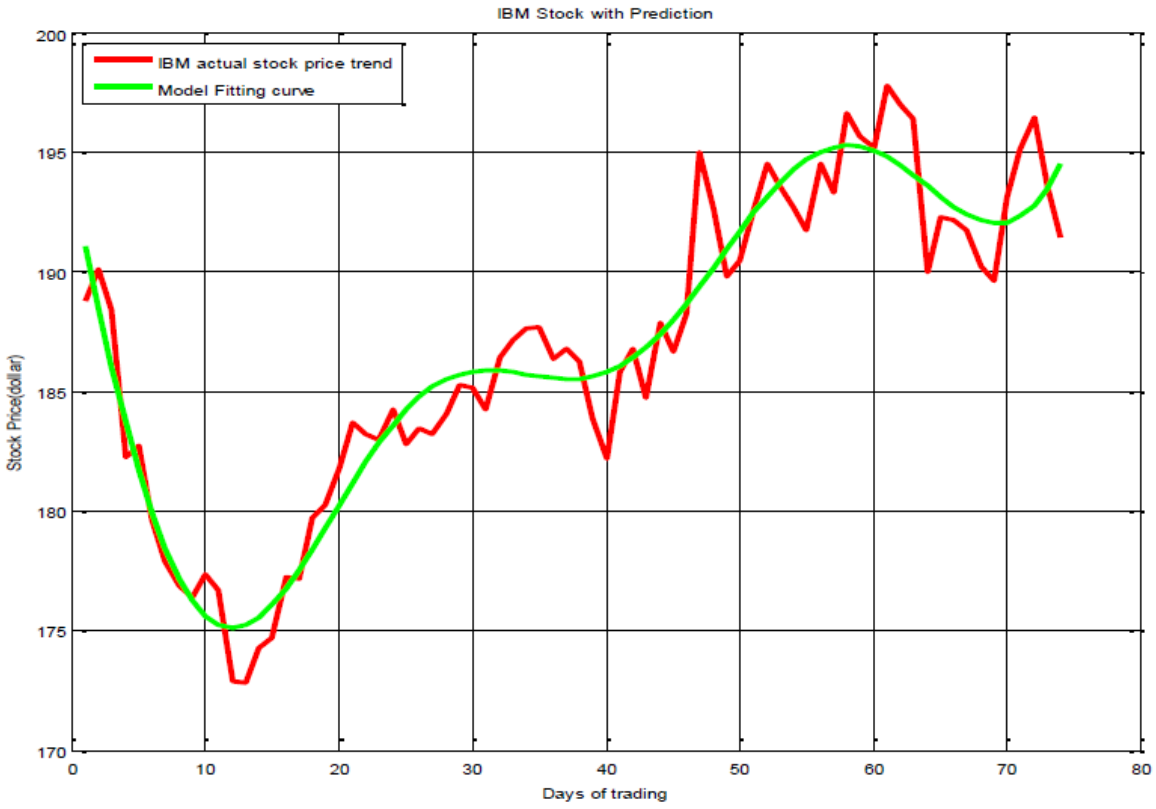


Figure 1: IBM actual historical price and Model fitting

Figure 1: IBM actual historical price and Model fitting

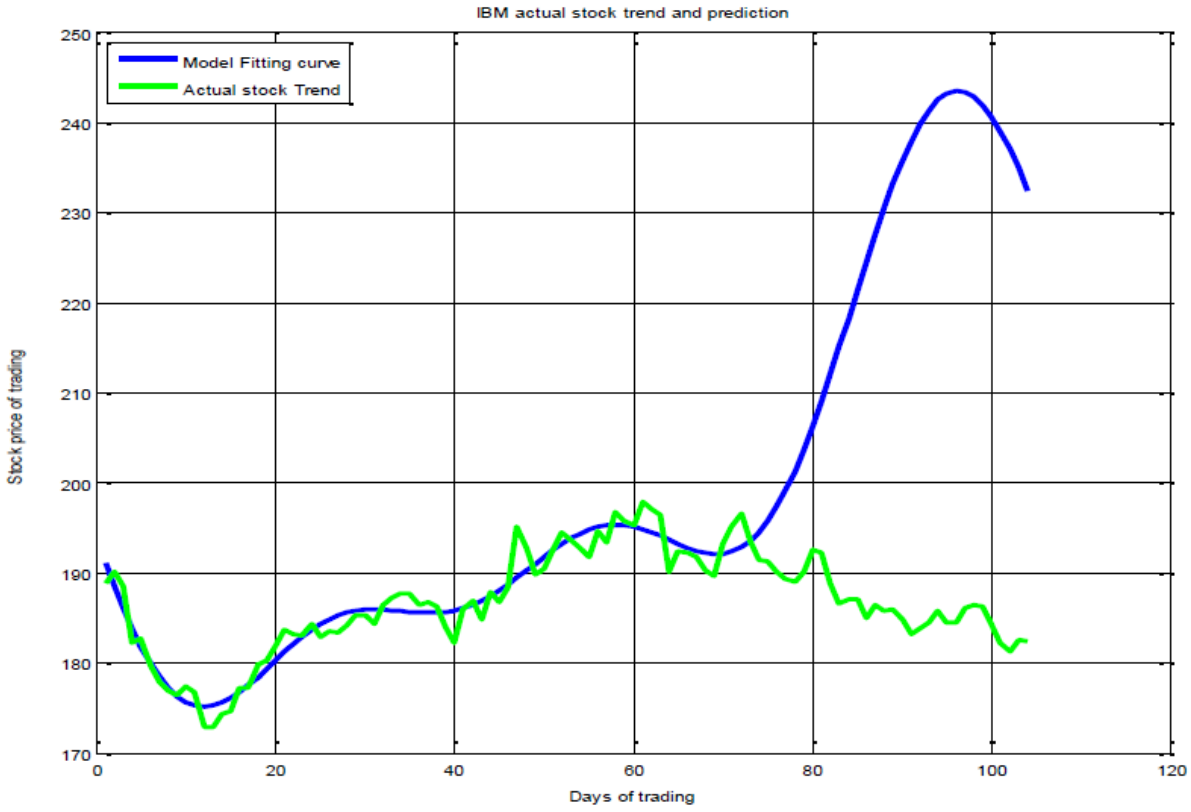


Figure 2: Stock trend and prediction

The Fourier Series Model fits almost perfectly the real trend of IBM Corporation Stock. This model which is the sum of the Best Fitting Line (Regression Line) and Fourier series expansion is used to extrapolate (predict) the stock price for 30 more days

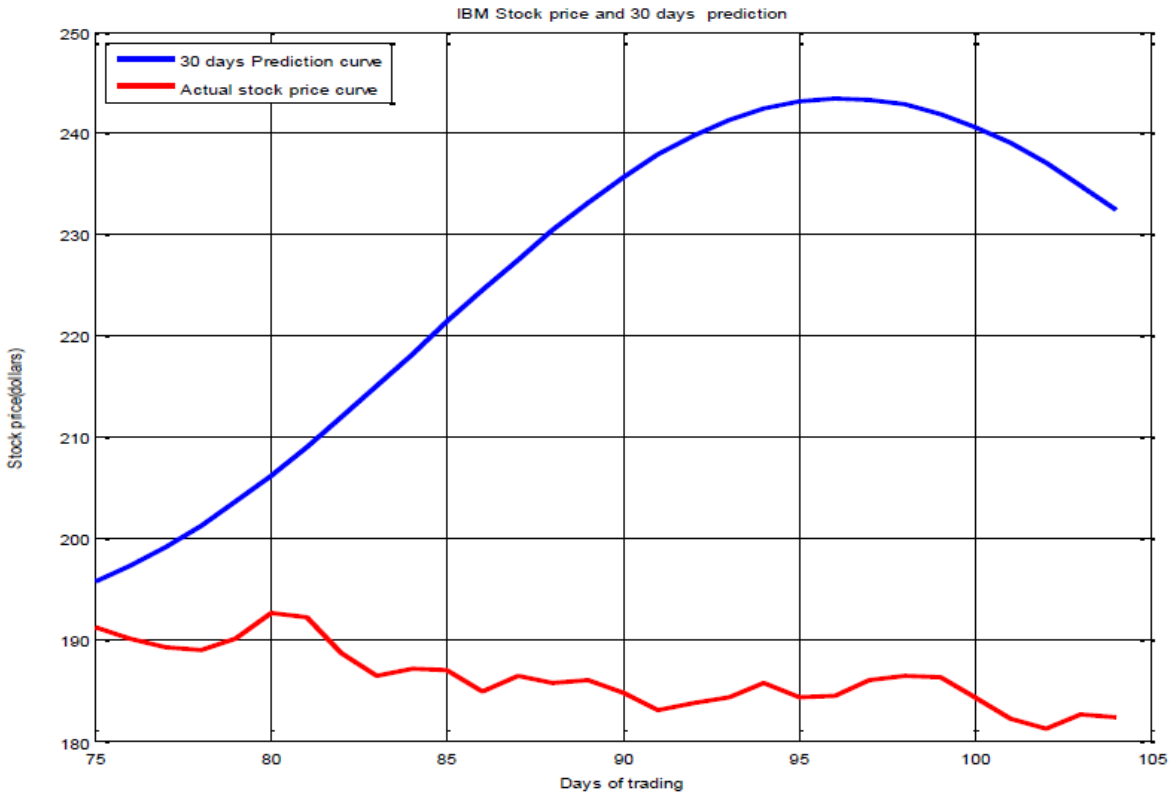


Figure 3: Stock Price and 30 days prediction

Prediction Analysis: The IBM prediction is way with the difference between the actual stock trend (red) and the prediction, difference which graph is below. It shows that the difference is about $55 which is way too much. Following this prediction by IBM stock buyers will result in a loss of money during the 30 days. Only very small days show that the prediction is correct. Example: Days 78 to 80; Days 84 to 85; days 91 to 95 and day 96 to 99, all show both the prediction and the stock trend go up. It is also correct from Day 98 to 103 where both curves go

down. So, out of 30 days, only 11 days prediction is correct. The 19 other days are wrong which mean that investors will lose money if following this prediction.

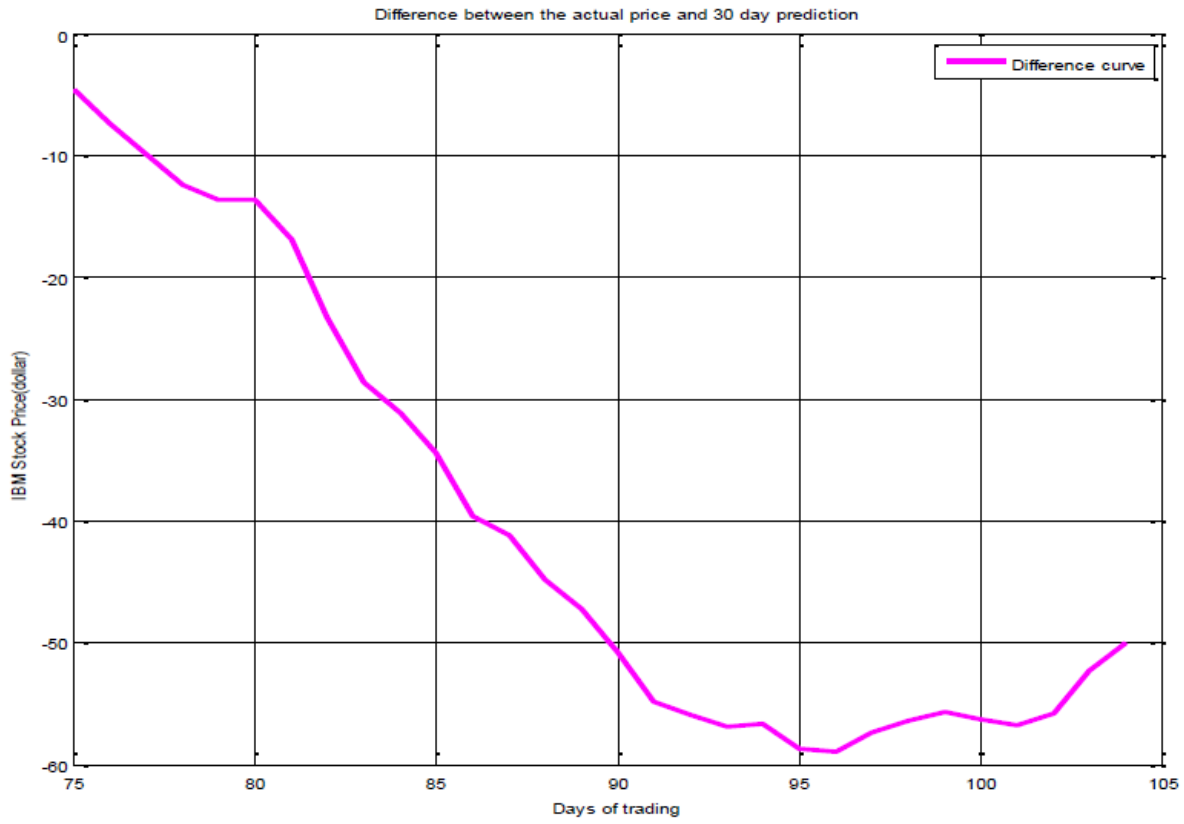


Figure 3: Difference between actual price and prediction

Facebook Inc.

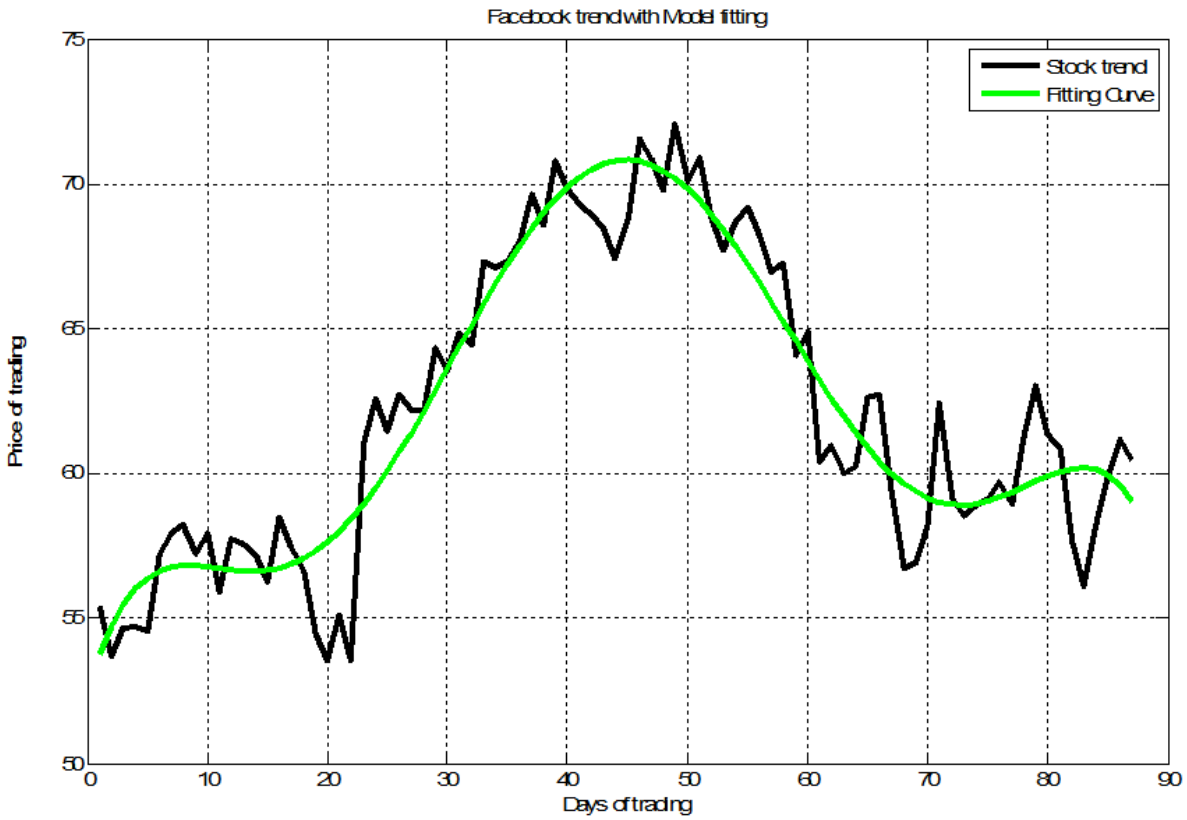


Figure 1: Facebook actual historic price and model fitting

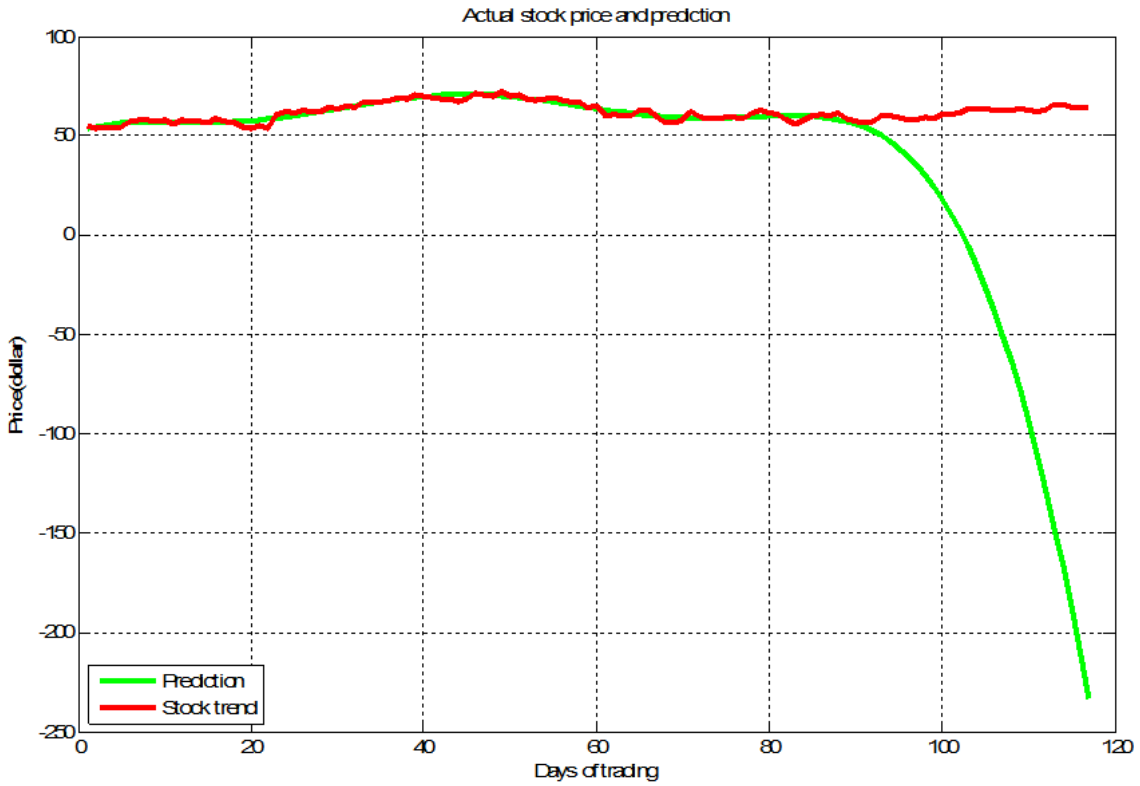


Figure 2: Actual stock price trend with Model Fitting up to 117 days.

In order to clearly see and analyze the actual trend of the stock and the Model fitting, we adjust the axis of the days of trading from (-250 to 120), to (0 to 120) as the figure 3 is showing below.

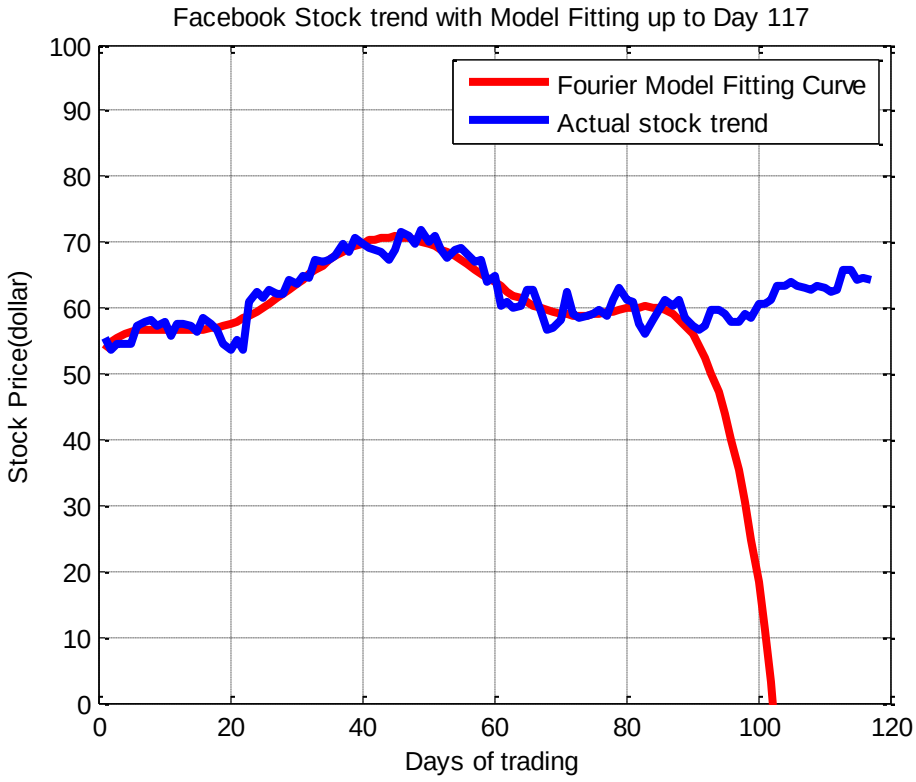


Figure 3: Actual stock price trend with Model fitting with adjusted axis.

The Fourier Series Model fits almost perfectly the real trend of Facebook Inc. Stock. This model which is the sum of the Best Fitting Line (Regression Line) and Fourier series expansion is used to extrapolate (predict) the stock price for 30 more days

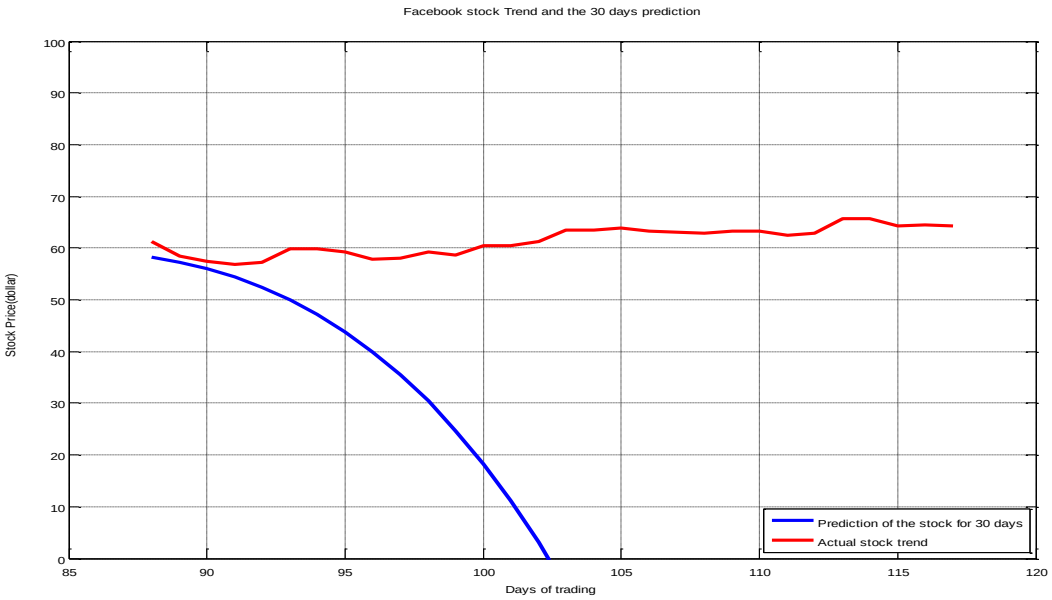


Figure 3: Actual stock trend with prediction

Prediction Analysis: In order to see correctly the trend to the stock along with the prediction, we must adjust the stock price axis(y axis) origin. Instead of -250 as origin, we take it from 0. Doing so, limit the prediction curve to 103 instead of 117 which give us the total 30 days prediction.

We notice that both the stock price trend and the prediction started both around $60.00. From that price, the prediction shows a constant decreasing up to 30 days. The stock itself goes slightly up and down but is around the starting price of $60.00.

Believing in this prediction can be a waste of an opportunity because, believing that the stock will continuously go down, investors will not buy it. But in reality, the stock goes up more than it goes down during these 30 days. From day 100 up to 117, the stock is consistently up and above $60.00. The only time that the prediction is correct is from the beginning (Day 89) up to day 93 and from day 96 to Day 99 where the both the prediction and the stock price go down. So the prediction is correct only for 9 days out of 30.

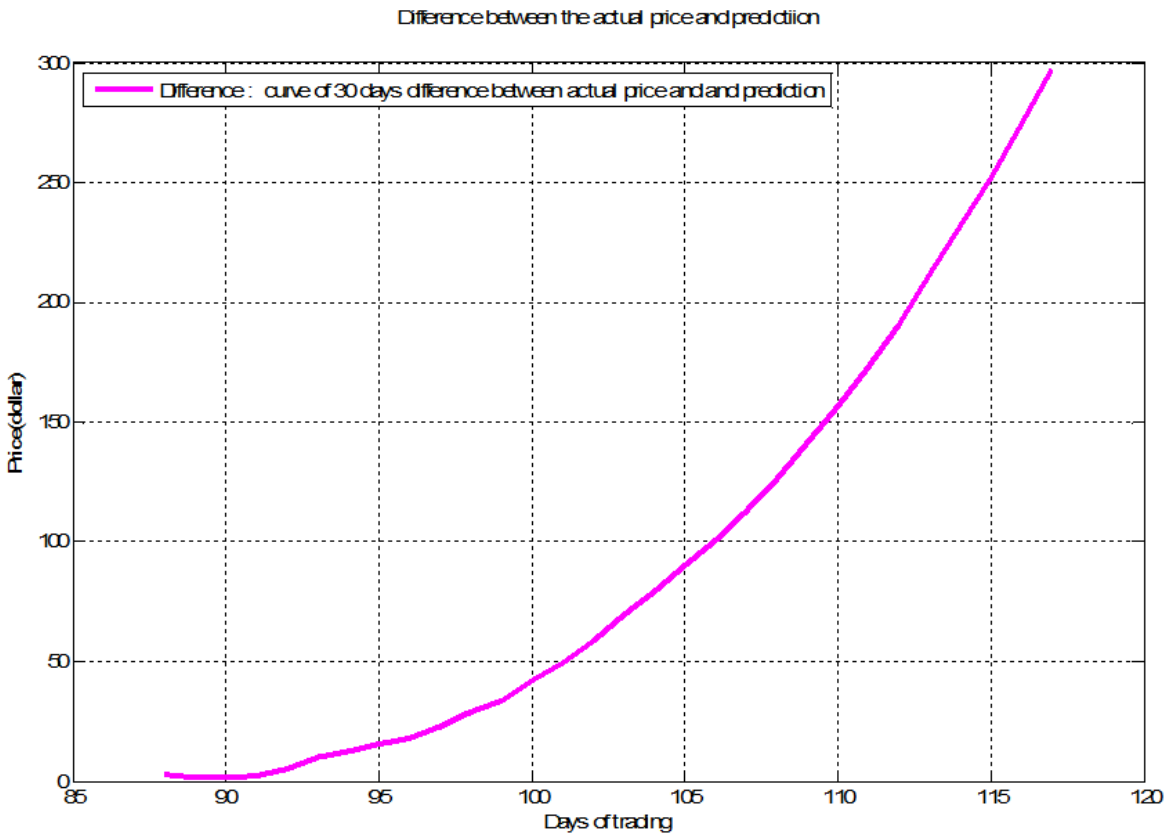


Figure 3: Curve of the difference

Intel Corporation

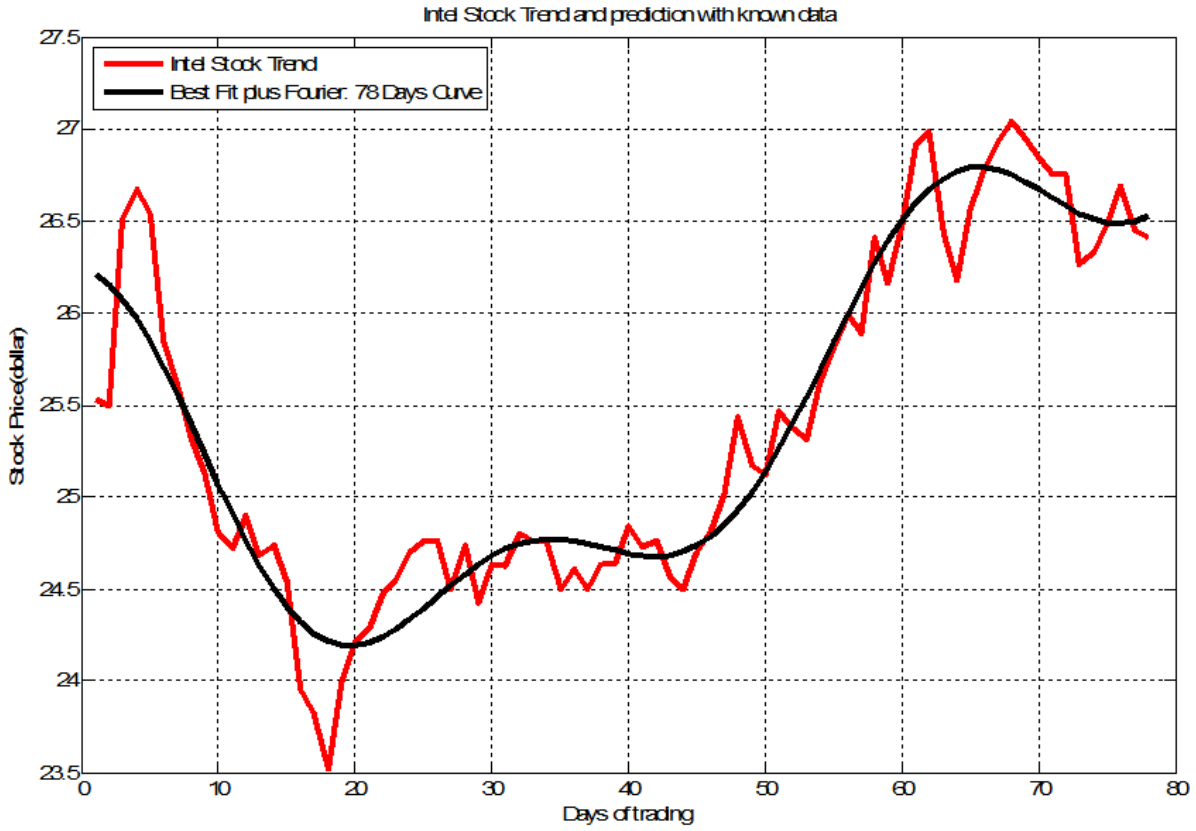


Figure 1: Actual Intel stock price and Model fitting

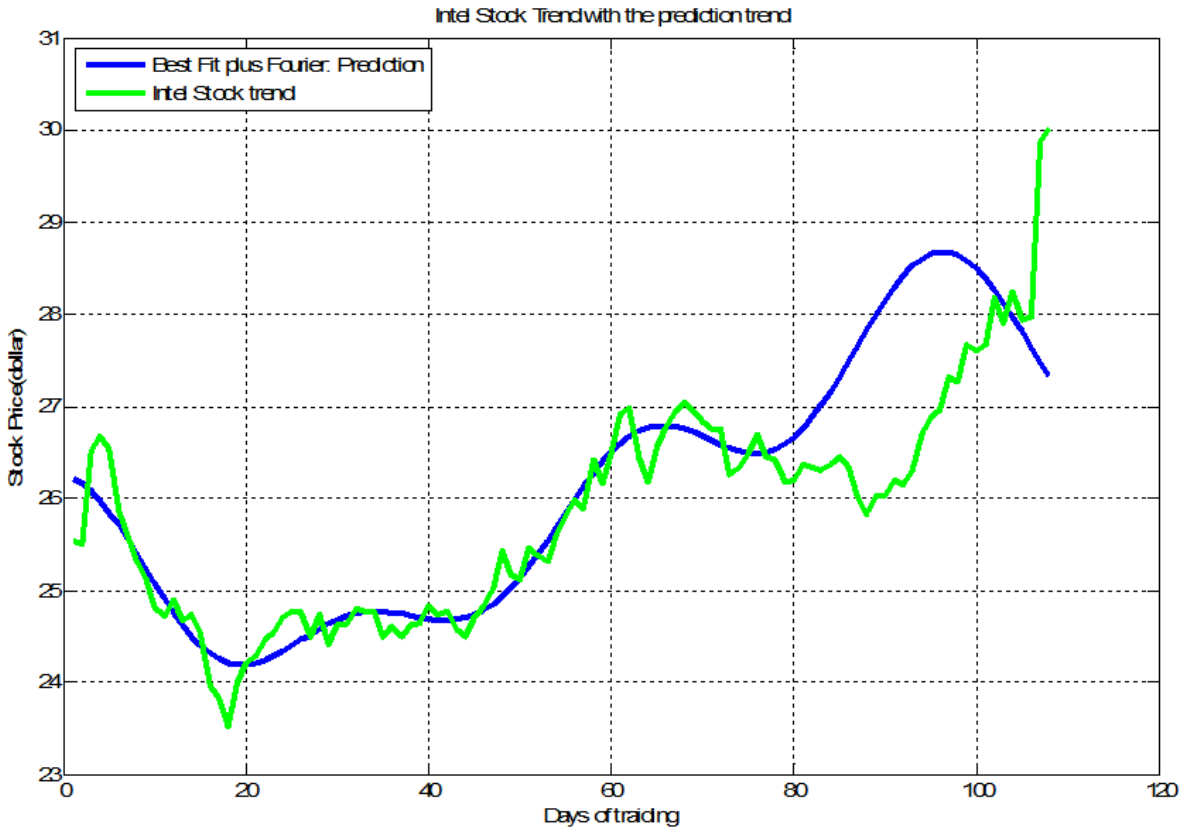


Figure 2: Intel Stock trend with Model Fitting up to 108 days

The Fourier Series Model fits almost perfectly the real trend of Intel Corporation Stock. This model which is the sum of the Best Fitting Line (Regression Line) and Fourier series expansion is used to extrapolate (predict) the stock price for 30 more days

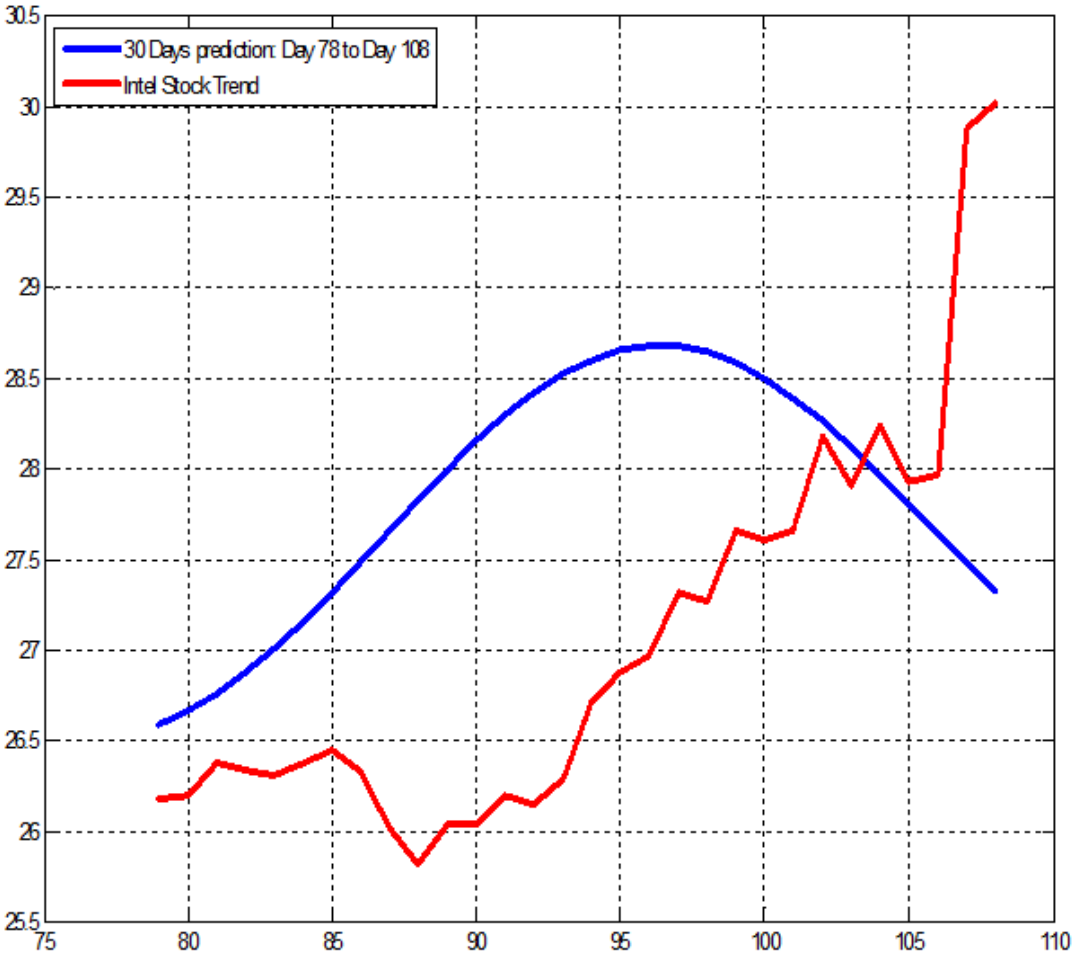


Figure 3: Prediction of 30 days along with Intel stock trend

Prediction Analysis: From Day 80 to Day 95, the prediction is correct with slightly small difference. From Day 95 to Day 117, the prediction is mixed. The trend of both curves will be opposite as the prediction days increases. This shows that our model will perfectly work with short period of time.

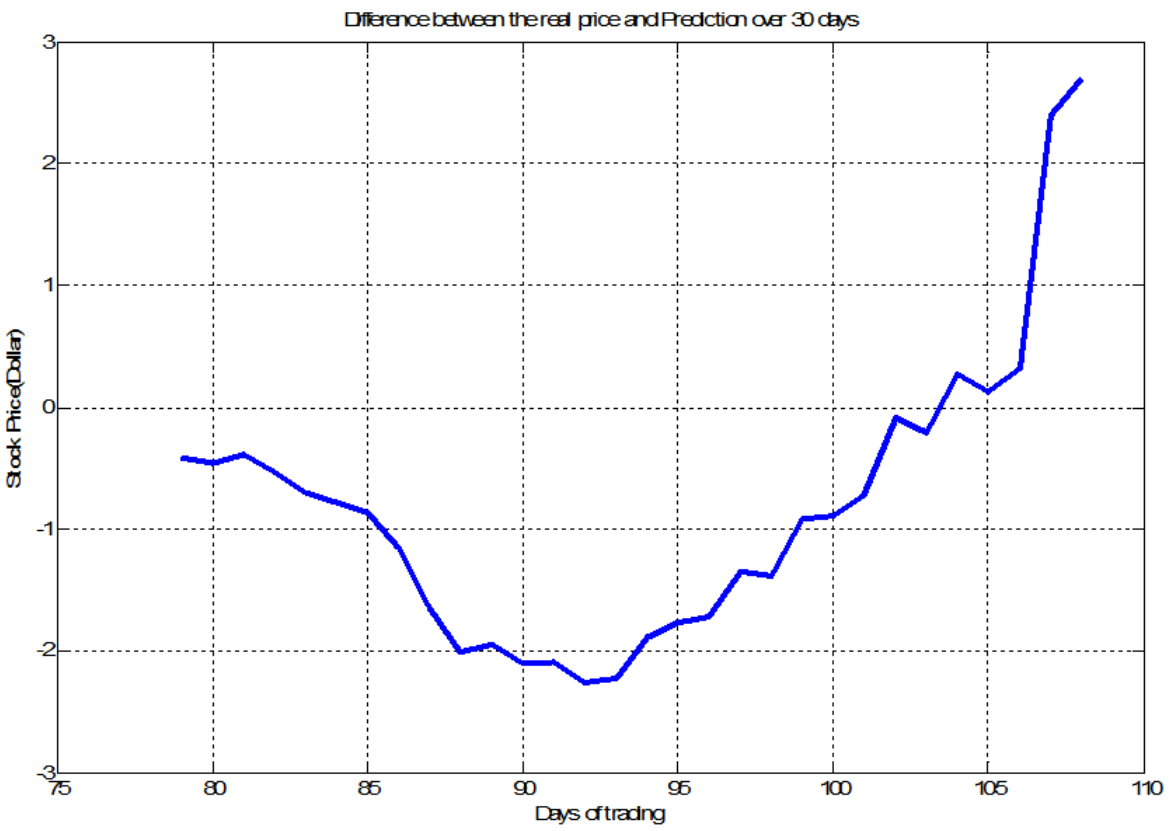


Figure 4: Difference between the actual stock trend and the prediction

MRV Communication Inc.

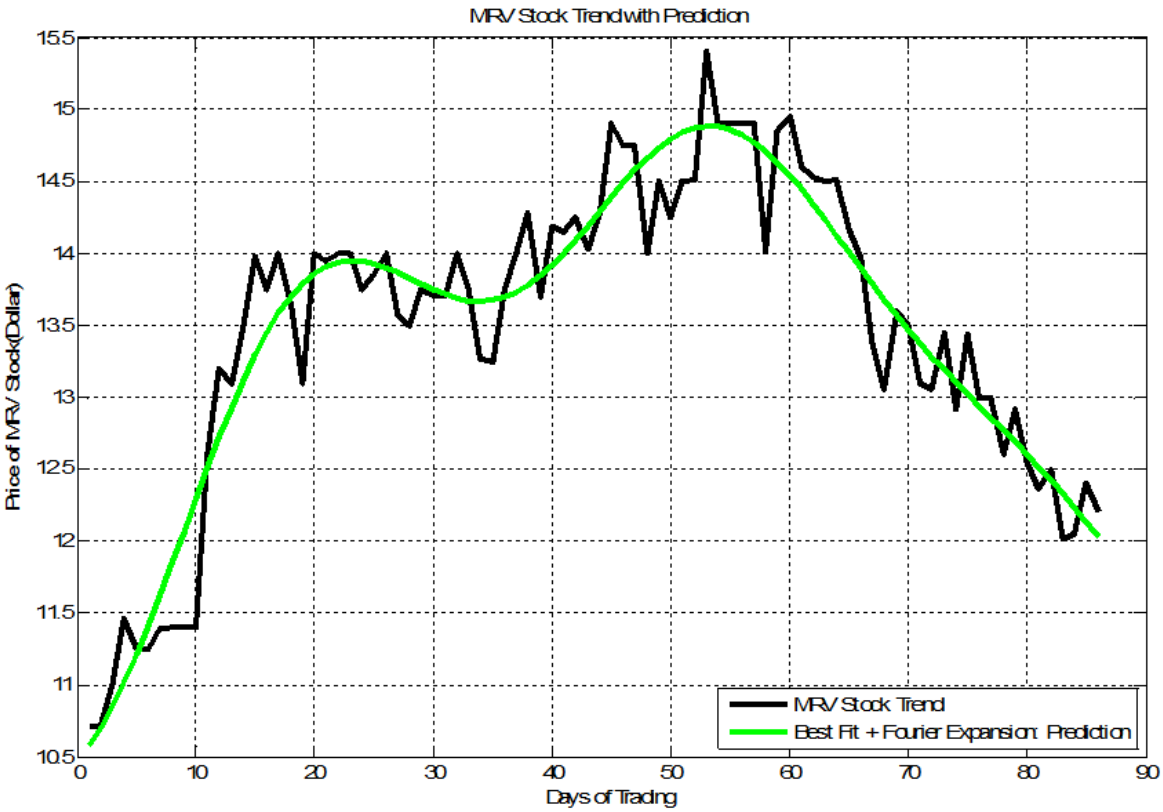


Figure 1: MRV actual stock trend with Fourier Model fitting

The Fourier Series Model fits almost perfectly the real trend of MRV Inc. Stock. This model which is the sum of the Best Fitting Line (Regression Line) and Fourier series expansion is used to extrapolate (predict) the stock price for 30 more days

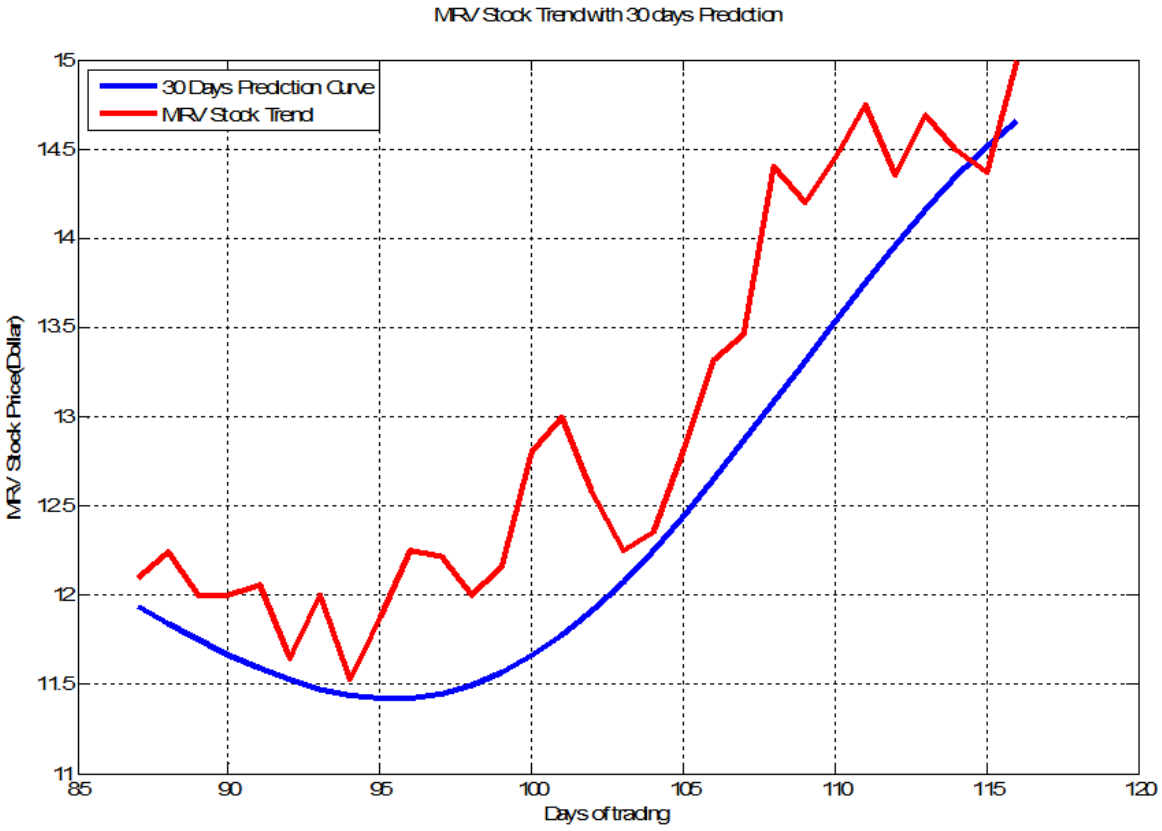


Figure 2: MRV stock trend with 30 days prediction curve

Prediction Analysis: The actual trend of the stock and the trend of the prediction are accurate with very minimal difference. Starting around $12 actual stock is trending high while our prediction started going down. Because, the difference is very small, we can say that the Fourier series model work well with MRV stocks.

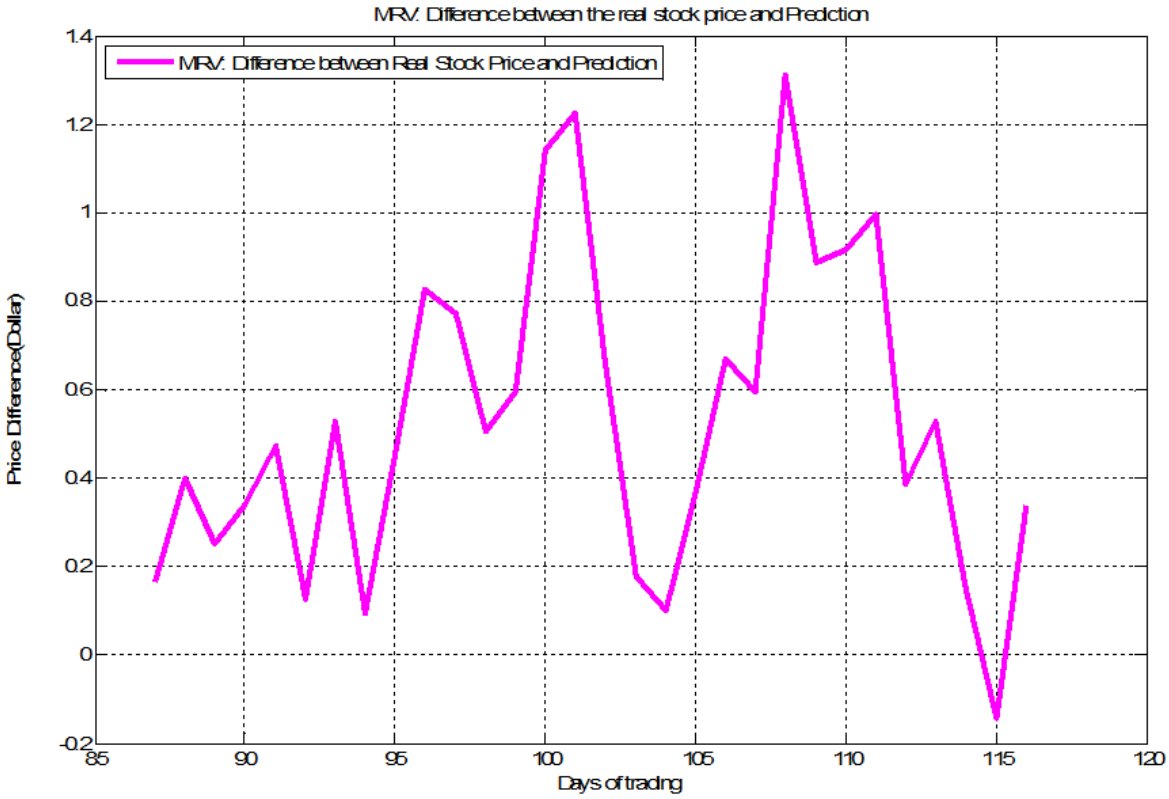


Figure 3: Difference between real stock price and Prediction

Model N Inc.

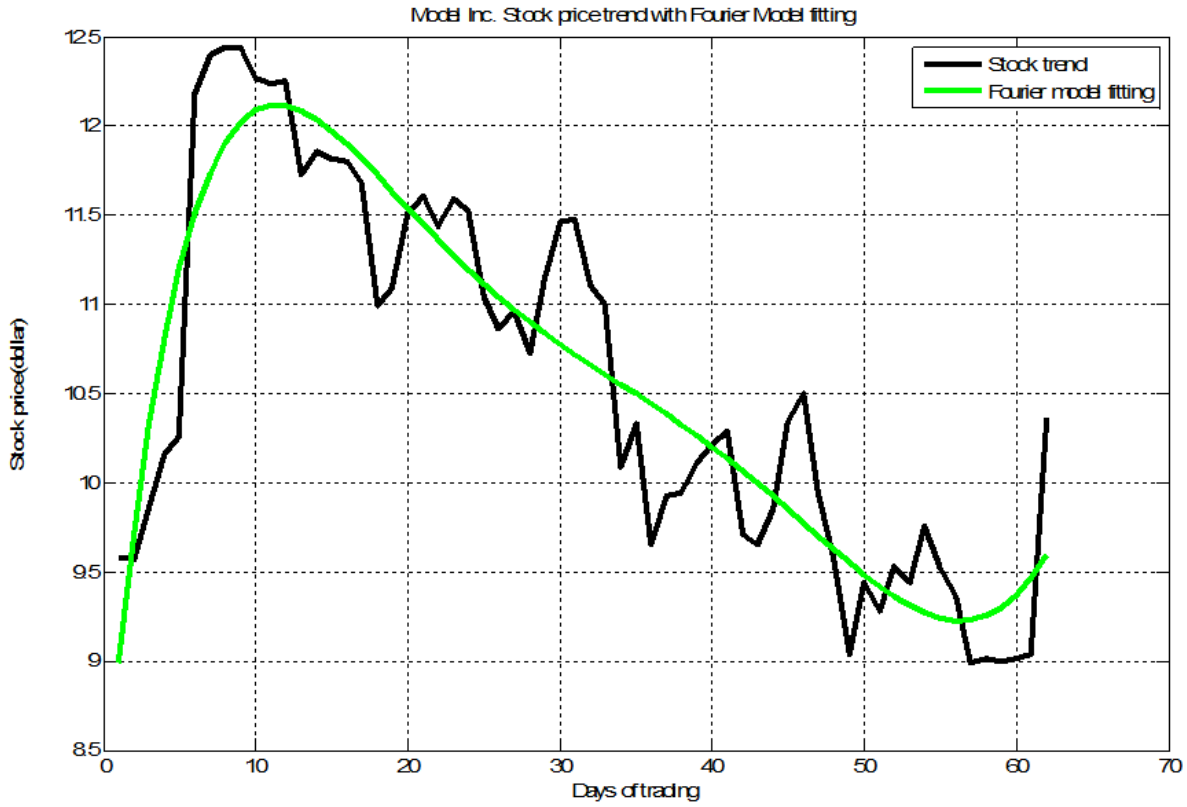


Figure 1: Model Inc. Actual historical price and Fourier Model Fitting

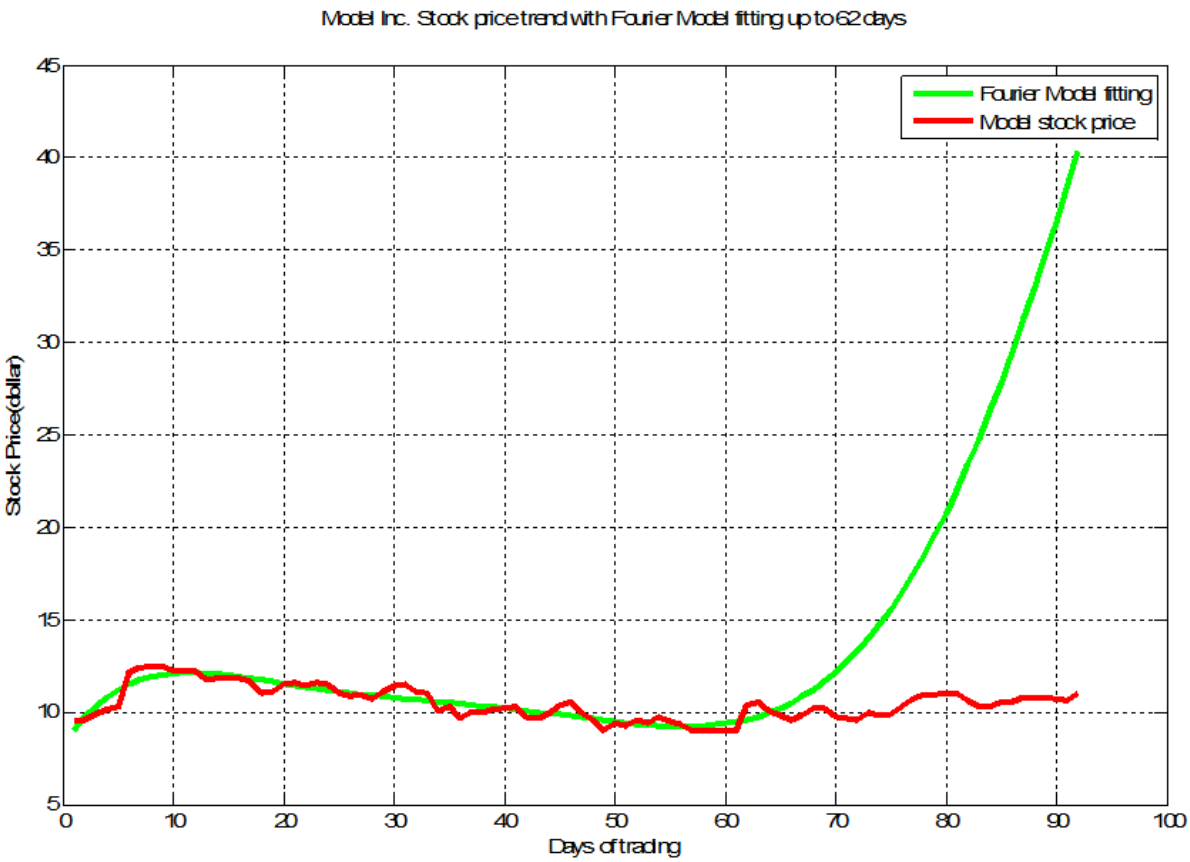


Figure 2: Stock price with fitting up to 62 days

The Fourier Series Model fits almost perfectly the real trend of Model Inc. Stock. This model which is the sum of the Best Fitting Line (Regression Line) and Fourier series expansion is used to extrapolate (predict) the stock price for 30 more days.

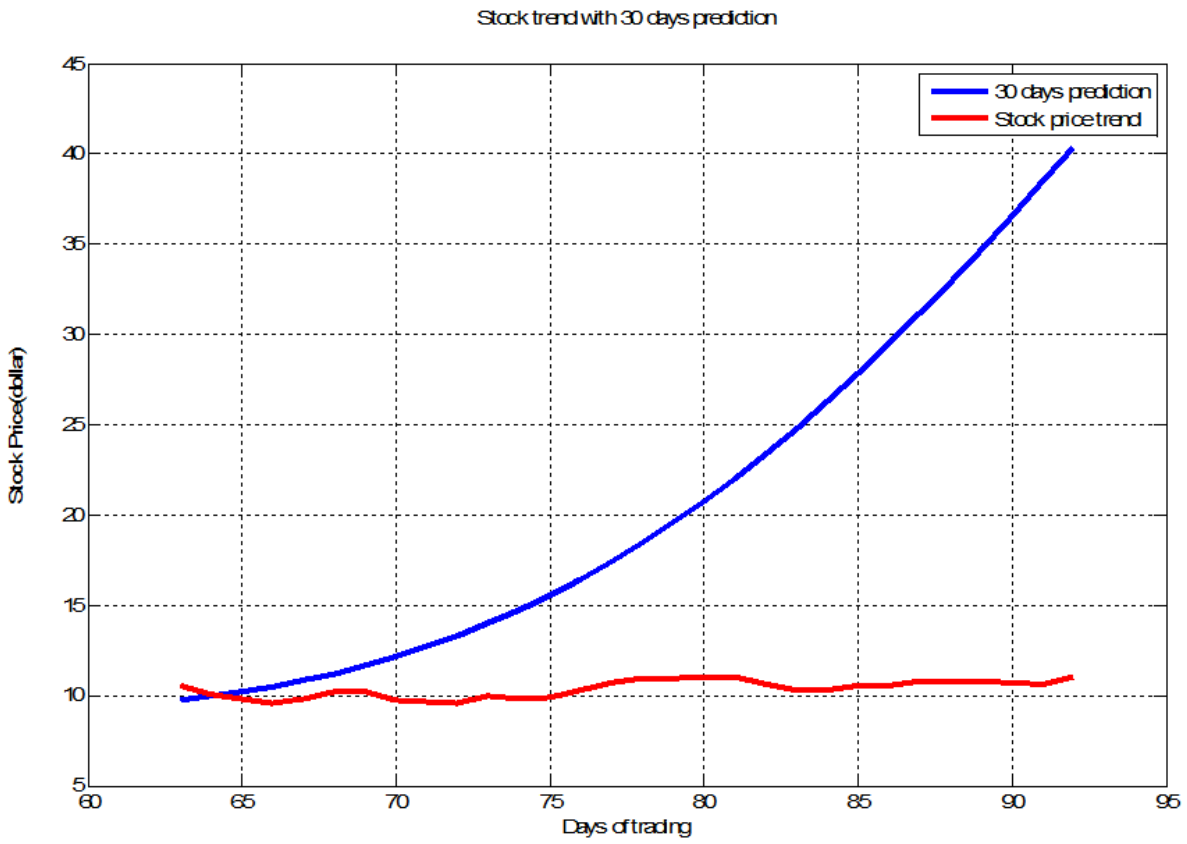


Figure 3: Stock trend and 30 days prediction

Prediction Analysis: Looking at the fitting curve and the actual stock trend, we can say that the prediction will be close to been perfect in our 61 days prediction. But it turns out that in the 30 days graph, the prediction has a continue trending up while the actual trending of the stock fluctuates up and down. Using this Model to predict a price for Model Inc. stock which gives many incorrect predictions will put investors at risk of losing money.

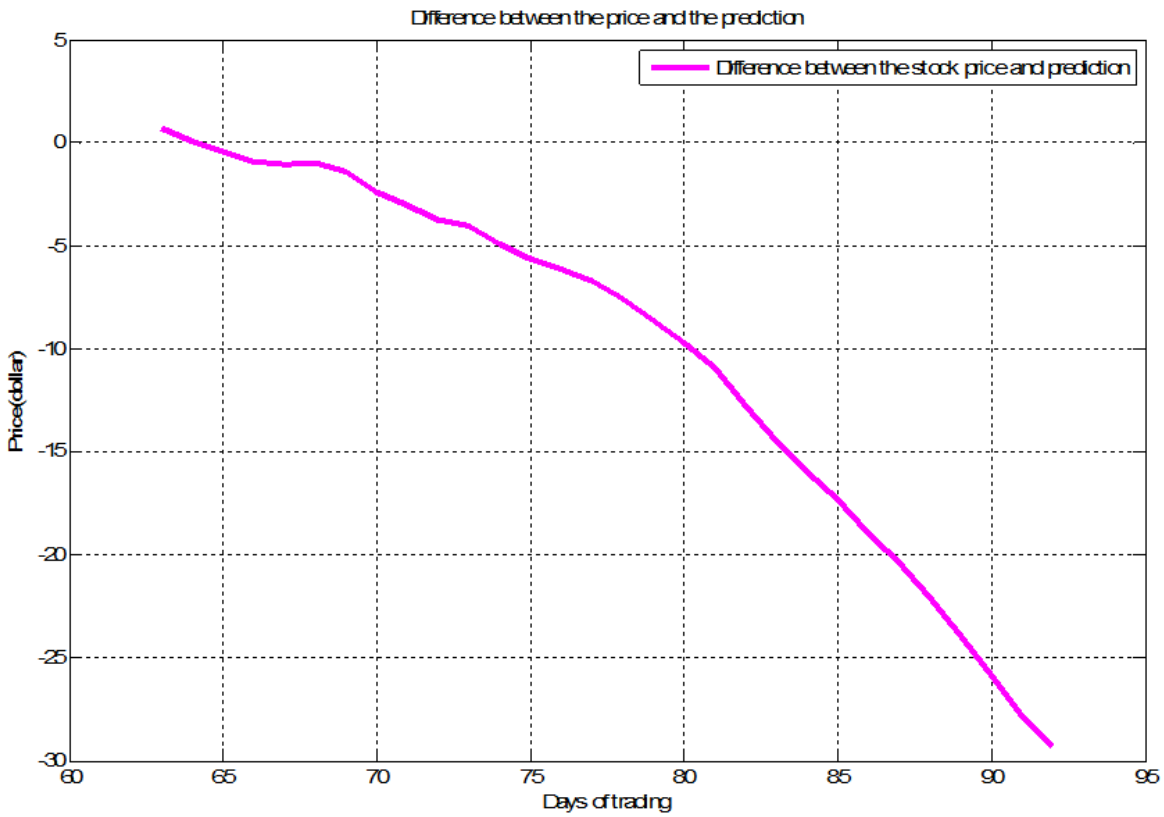


Figure 3: Difference between the stock trend and prediction line

Micrel Inc.

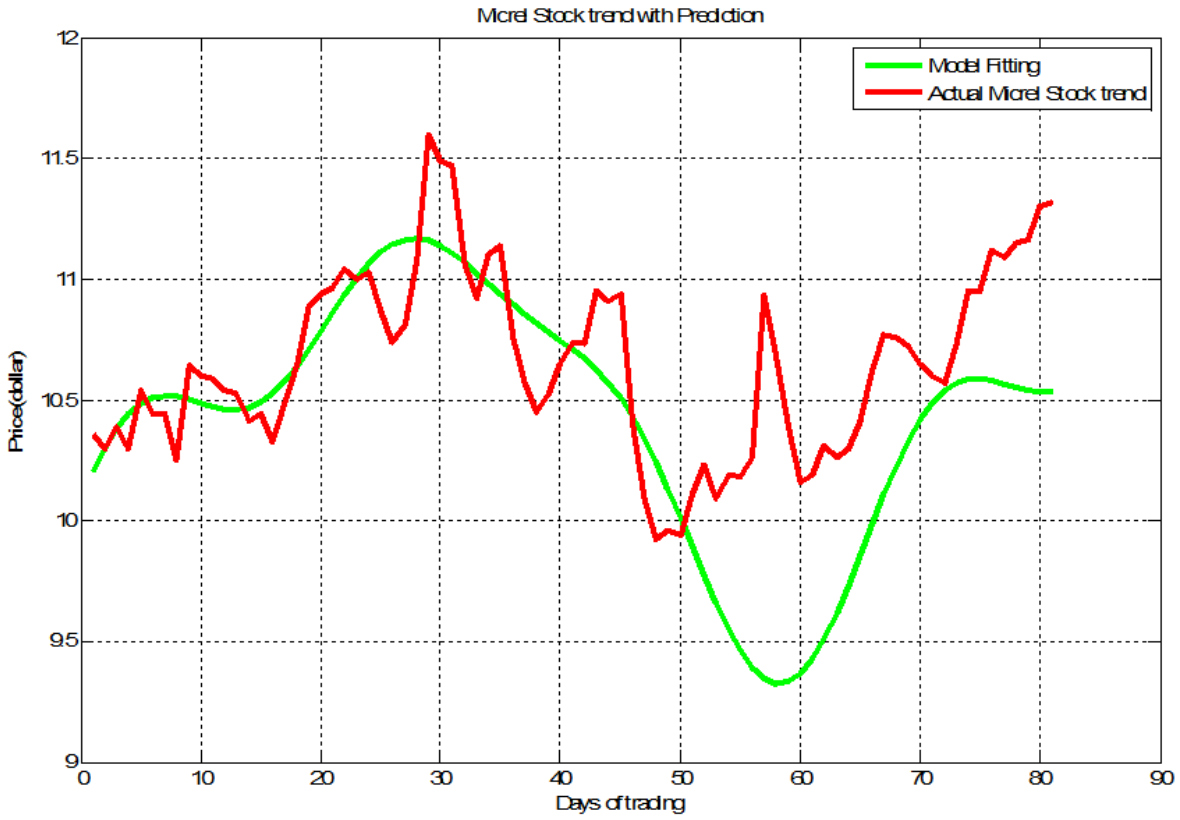


Figure 1: Actual historical price and Model fitting

The Fourier Series Model fits almost perfectly the real trend of Micrel Inc. Stock. This model which is the sum of the Best Fitting Line (Regression Line) and Fourier series expansion is used to extrapolate (predict) the stock price for 30 more days which graph is showing below.

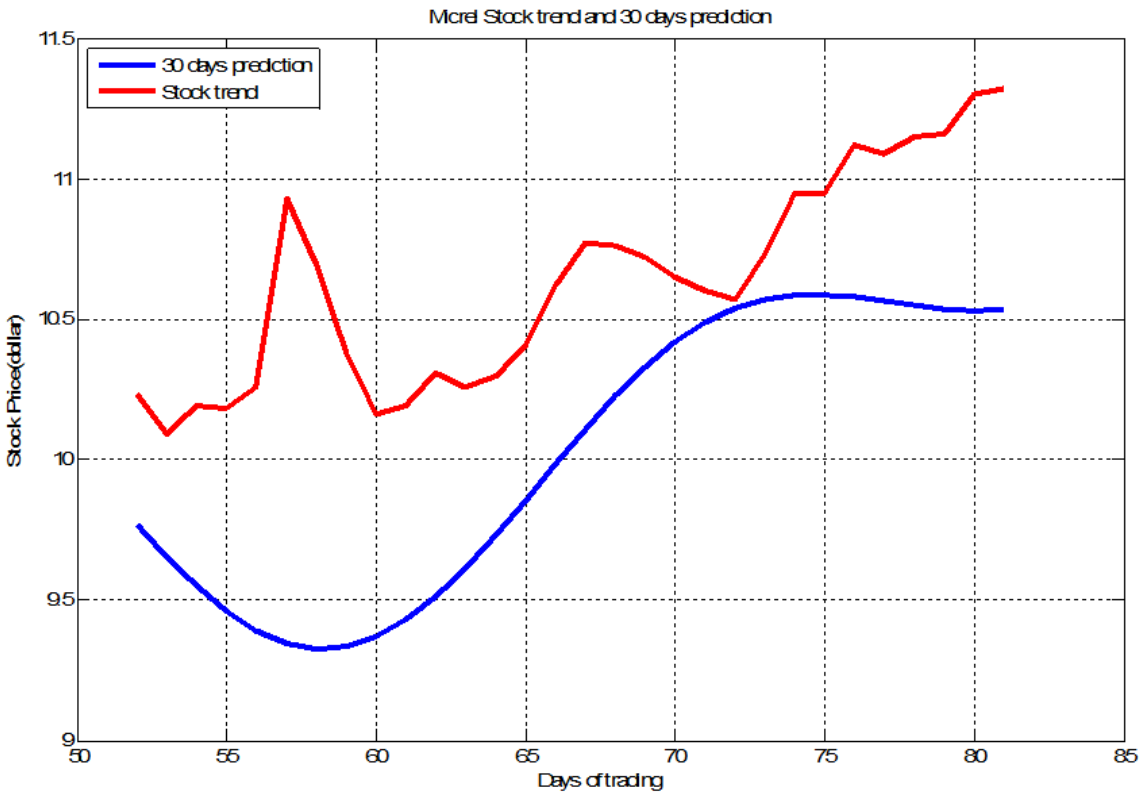


Figure 2: Micrel stock trend and 30 days prediction

Prediction Analysis: The graph shows that the beginning of the actual trend and the prediction is correct. Both curves are trending around Day 56 to day 60; both curves are opposite one and another and are both trending up and down from day 64 to day 70.

From day 72 to around day 82, both curves trend in opposite direction.

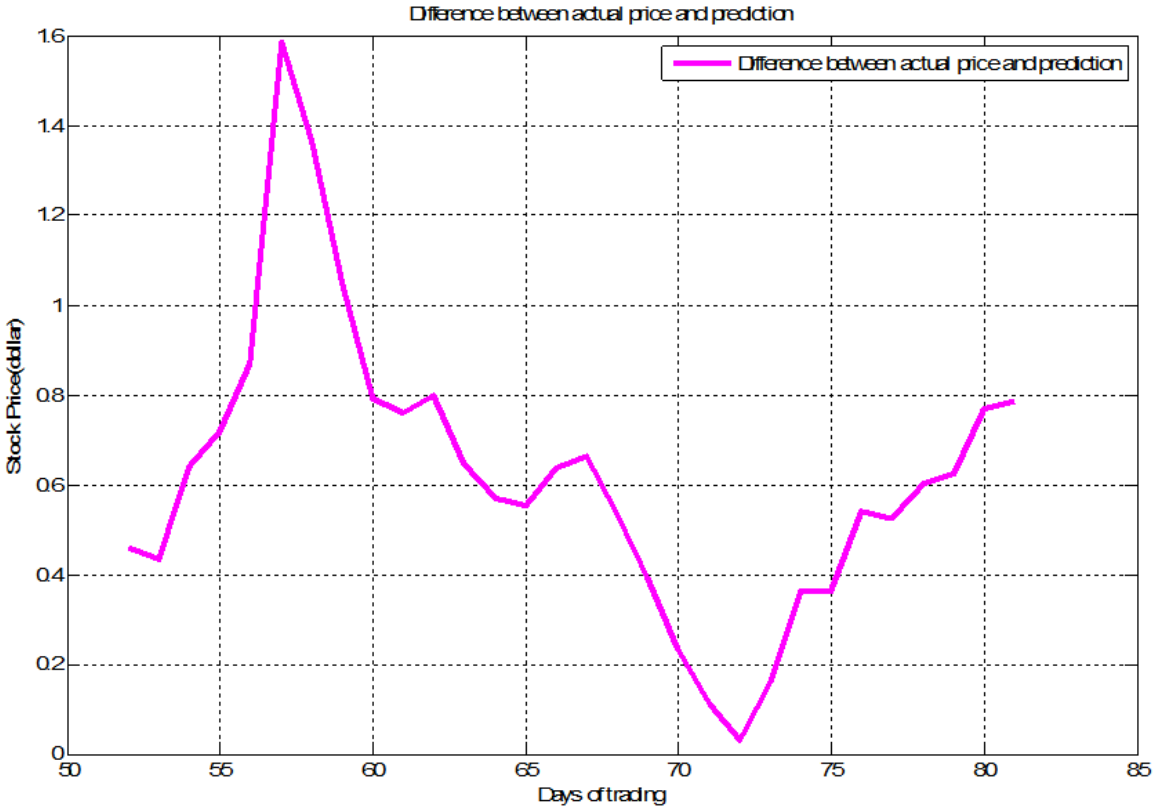


Figure 3: Difference between stock price trend and prediction.

Inteliquent Inc.

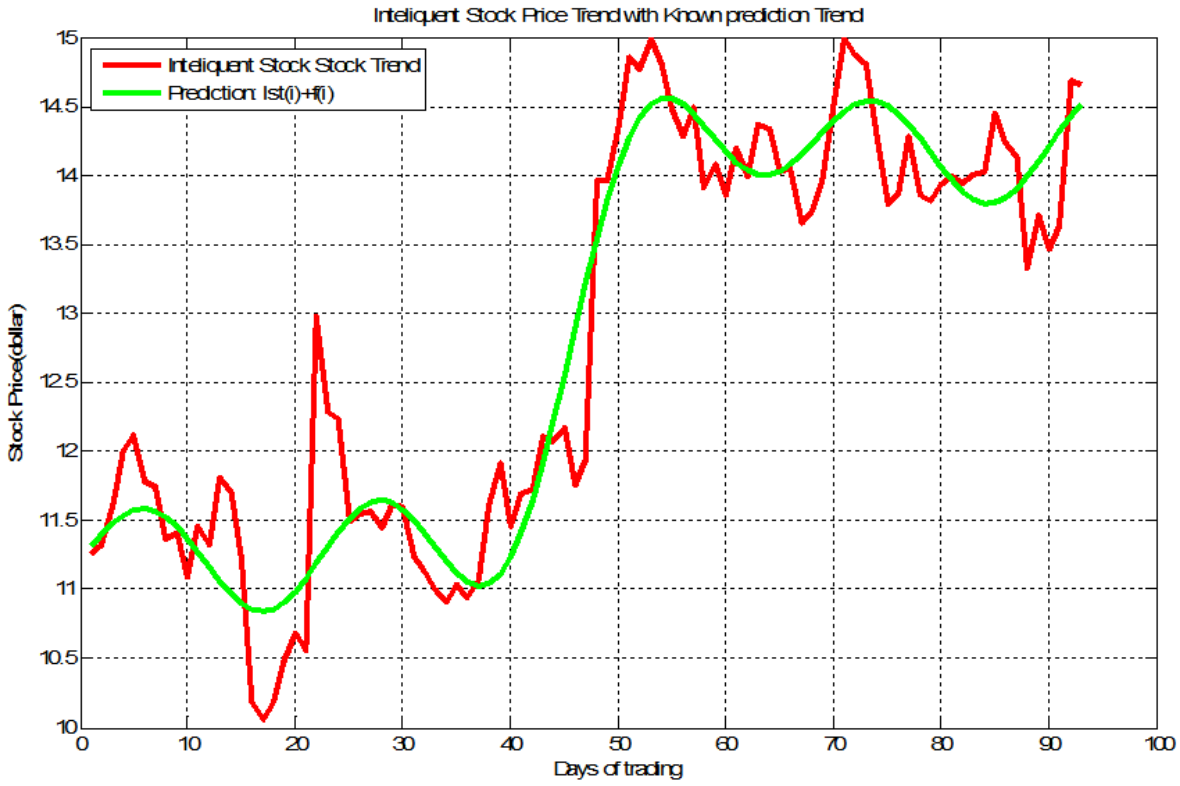


Figure 1: Actual stock trend with Model fitting over 93 days

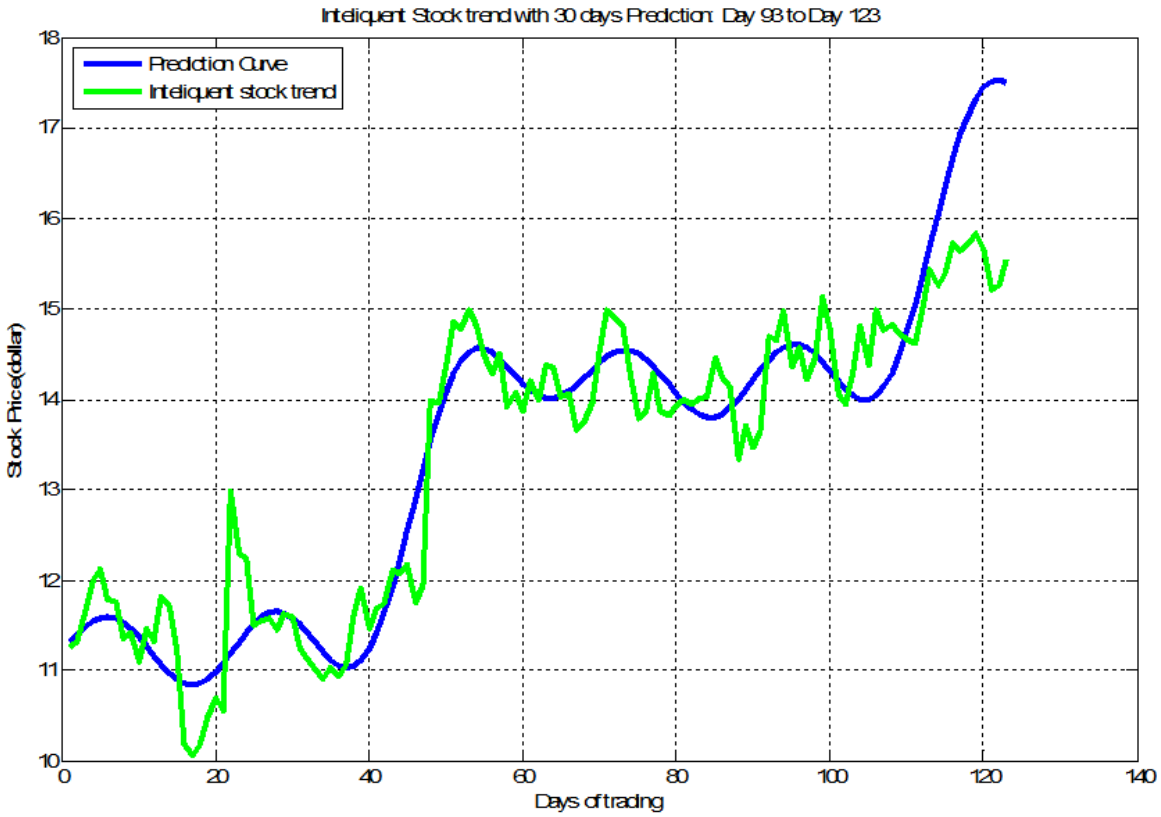


Figure 2: Stock trend with Model fitting over 123 days

The Fourier Series Model fits almost perfectly the real trend of Inteliquent Inc. Stock. This model which is the sum of the Best Fitting Line (Regression Line) and Fourier series expansion is used to extrapolate (predict) the stock price for 30 more days which graph is showing below.

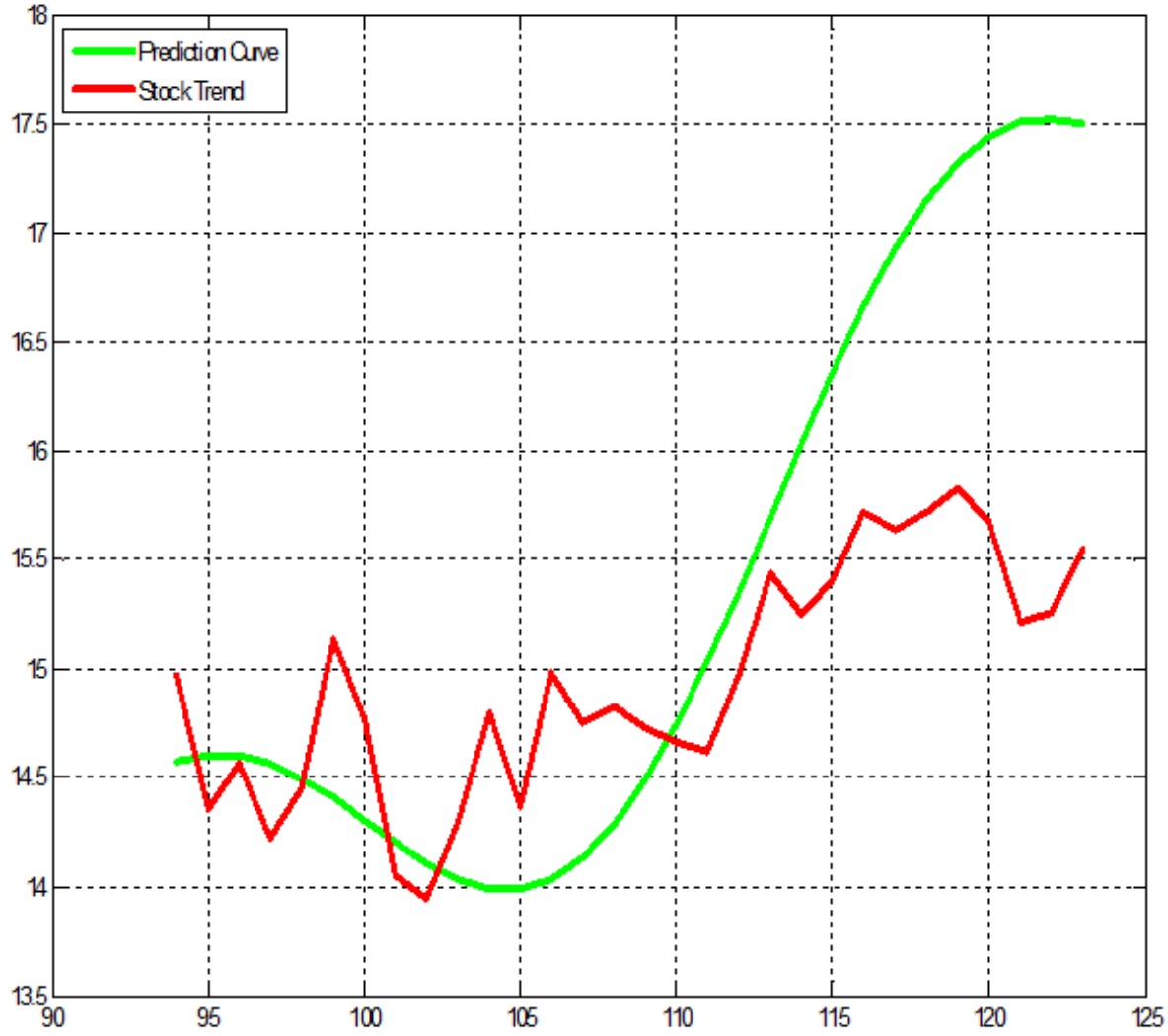


Figure 3: Actual stock trend with 30 days prediction.

Prediction Analysis: At the beginning of the 30 days prediction, the prediction is almost flat while the actual real trend of the stock is trending down. From Day 105 to 107, the prediction is correct and from Days 110 to 114, both curves are trending up and the stock goes down while the prediction is continuing going up. Then from Days 114.5 to 117, both curves trend up with a quick down trend of the actual stock.

The Fourier Model works fairly well with this stock prediction.

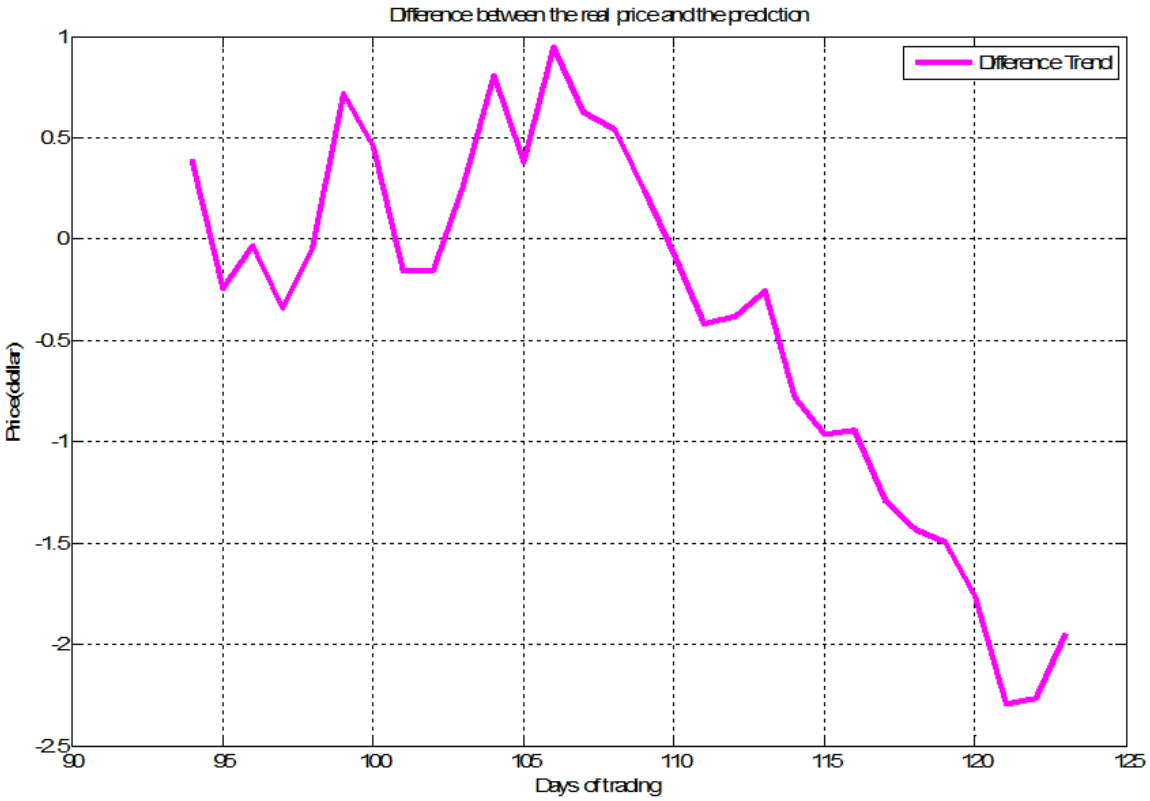


Figure 4: Difference between the real stock price and the prediction

Summary of the analysis of each of the stock prediction

Apple Inc.

Prediction Analysis: The prediction curve matches with the stock trend in some periods of the graph and is out with big gap in other range. As we could see, from day 87 to day 105, the prediction is fairly accurate. When the trend of the stock goes down or up, the prediction also follow the trend. The prediction is way out from around days 112 and 117 where the actual stock drops sharply while the prediction still trading high.

Google Inc.

Prediction Analysis: At the beginning of the 30 days prediction on day 87, the actual trend of the price of the stock (red curve) and the prediction curve match well. Both curves are trading down until approximately day 93 where the stock is trading up while the prediction is going down. Around day 97 the trend are accurate with both curves trading up. From 105 to 117, the prediction is fairly accurate with both curves trading up and down.

Microsoft Corporation

Prediction Analysis: Considering the prediction line starting from $40.5 and end approximately $41.00, we can see that the prediction is upward from day 100 to day 115. During the same period of time, the actual stock price fluctuated up and down. While the forecast continues to go up, the stock itself goes down from the beginning(day 100) and started going up from about Day 102 for two days before going down around day 104. From there, it went up until day 107 before going down. This up and down trend of the actual stock continue until the end of the 30 days prediction where both curves meet with the prediction going down while the actual stock is going up. It is important to note that the difference between the stock trend and the prediction is approximately $2.00 which means that the prediction is not way off the chart.

IBM Corporation

Prediction Analysis: The IBM prediction is way with the difference between the actual stock trend (red) and the prediction, difference which graph is below. It shows that the difference is about $55 which is way too much. Following this prediction by IBM stock buyers will result in a loss of money during the 30 days. Only very small days show that the prediction is correct. Example: Days 78 to 80; Days 84 to 85; days 91 to 95 and day 96 to 99, all show both the prediction and the stock trend go up. It is also correct from Day 98 to 103 where both curves go

down. So, out of 30 days, only 11 days prediction is correct. The 19 other days are wrong which mean that investors will lose money if following this prediction.

Facebook Inc.

Prediction Analysis: In order to see correctly the trend to the stock along with the prediction, we must adjust the stock price axis(y axis) origin. Instead of -250 as origin, we take it from 0. Doing so, limit the prediction curve to 103 instead of 117 which give us the total 30 days prediction.

We notice that both the stock price trend and the prediction started both around $60.00. From that price, the prediction shows a constant decreasing up to 30 days. The stock itself goes slightly up and down but is around the starting price of $60.00.

Believing in this prediction can be a waste of an opportunity because, believing that the stock will continuously go down, investors will not buy it. But in reality, the stock goes up more than it goes down during these 30 days. From day 100 up to 117, the stock is consistently up and above $60.00. The only time that the prediction is correct is from the beginning (Day 89) up to day 93 and from day 96 to Day 99 where the both the prediction and the stock price go down. So the prediction is correct only for 9 days out of 30.

MRV Communications Inc.

Prediction Analysis: The actual trend of the stock and the trend of the prediction are accurate with very minimal difference. Starting around $12 actual stock is trending high while our prediction started going down. Because, the difference is very small, we can say that this Fourier series model work well with MRV stocks.

Model N Inc.

Prediction Analysis: Looking at the fitting curve and the actual stock trend, we can say that the prediction will be close to been perfect in our 30 days prediction. But it turns out that in the 30 days graph, the prediction has a continued trending up while the actual trending of the stock fluctuates up and down.

Using this Model to predict a price for Model Inc., with give many incorrect prediction putting investors at risk of losing money.

Micrel Inc.

Prediction Analysis: The graph shows that the beginning of the actual trend and the prediction is correct. Both curves are trending around Day 56 to day 60; both curves are opposite one and another and are both trending up and down from day 64 to day 70.From day 72 to around day 82, both curves trend in opposite direction.

Inteliquent Inc.

Prediction Analysis: At the beginning of the 30 days prediction, the prediction is almost flat while the actual real trend of the stock is trending down. From Day 105 to 107, the prediction is correct and from Days 110 to 114, both curves are trending up and the stock goes down while the prediction is continuing going up. Then from Days 114.5 to 117, both curves trend up with a quick down trend of the actual stock. The Fourier Model works fairly well with this stock prediction.

6. Problem and Solution

Going through each stock from its original price trend to its final trend plotted in our 30 days prediction, we can clearly see that the Fourier series expansion Model used to extrapolate or predict the stock price did not work for all the ten stocks we choose to work for our project.

Apple Inc.: Out of the 30 days, about 20 days prediction is accurate. This means that 66.66% or ~ 67% of our prediction is accurate.

Google Inc.: The prediction from Day 87 to Day 103 and from Day 104 to Day 114 is accurate. This means that out of 30 days, 20 days prediction is accurate which is equal to 66.66% or ~ 67% of accuracy in the prediction.

Microsoft Corporation: For this stock, the Fourier Series Model does not work for the prediction. About 95% of the prediction curve has opposite trend to the real stock price trend. Using this model to predict Microsoft stock is misleading. This means that only 5% of our prediction is correct where both curves trend in the same direction.

IBM Corporation: Our analysis shows that there are about 11 days where the forecast of the stock price is correct. This means that 36% of our prediction is correct. This is relatively good prediction when using the Fourier series Model.

Facebook Inc.: Only 9 out of 30 days show a correct prediction where both curves trend in the same direction. It means that our prediction in this case has only 30% of accuracy.

Intel Corporation: A total of 17 days show a good prediction (Day 80 to Day 95, both days include). For this stock, our prediction is 56.66% or about 57% of correct prediction.

MRV Communication: The Model work pretty well for this stock where about 24 days show accurate prediction where both curves (actual and prediction's trend) go in the same direction. It means that for this stock, 80% of the prediction is correct.

Model Inc.: The analysis of the prediction graph shows that approximately 3 days prediction is correct. In another word, only 10% of the prediction is accurate. The Fourier series expansion model is not fit to use for this stock.

Micrel Inc.: The analysis of the prediction graph shows 13 days of correct prediction. This is 43.33% of accuracy which is about just 43% of accuracy.

Inteliquent Inc.: A total of 13.5 days prediction is accurate in the analysis of this stock using the Fourier series expansion model. In a percentage term, this means that we have achieve 45% of correct prediction.

Summary

Our goal is to achieve 95% to 100% correct prediction. But since we cannot get that with our Fourier series model, if we say that we want to consider 50% correct prediction as recommendable for stock price, only four companies stocks can be recommended: Apple Inc., Google Inc., Intel Corporation, and MRV Communications Inc.

7. Conclusion

Our goal is to give new and experienced or veterans in stock market, a simple and inexpensive tool that allows them to invest with confidence in stock market by predicting the price of upcoming days. But as we see in the analysis, the Fourier Model that we used can be recommend to investors for only four companies stocks out of ten.

This IQP project needs to be improved further to get the precise range of the Confidence Interval for each stock and update the predicted price in figure 1 of this project. This will present a better and precise picture of what a Fourier Series Model is capable of. Since the prediction is a result of sum of the best fitting line and the Fourier series expansion, our recommendation is to use different polynomial best fitting line and test the model again after adding them up to Fourier series expansion with Level 1 through Level8. This will give a precise idea of which one works best.

Finally, since the price of the stock is strictly tied to thousands of unpredictable events, it is recommended to proceed with caution when using any stock prediction tool and with this prediction tool in hands, getting educated with other prediction tools will be a big help. This allows a comparison of tool to use and avoid uninformed risks taking.

8. Acknowledgment

I could not have accomplished this IQP if Professor Humi Mayer does not show a high quality of advising a great sense of patience and encouragement with “Can do” attitude. I started this IQP with absolutely no knowledge in Matlab Programming. I am exiting the IQP with a capability to write, read other students Matlab Code and base on my level of knowledge, help to correct and improve them if necessary. I am forever thankful and grateful for all his time and dedication to see me make it to the end of this project. Thank you, professor Humi.

9. References

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[2] Hamilton, J. D. *Time Series Analysis*. Princeton, NJ: Princeton University Press, 1994

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10- Appendix

```
load('IBM.mat')
p1=Close4(:,1);
plot(p1);
[m,n]=size(p1);
autocorr(p1,252);
p2=p1(1:74);
[m,n]=size(p2);
for i=1:74
    x(i)=i;
    y(i)=p2(75-i);
end
p=polyfit(x,y,1);
for i=1:74
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
hold on
plot(x,lst,'r');
figure
plot(x,(y-lst),'m');
f=fit(x',(y-lst)','fourier3'); % Fourier Series
for i=1:74
    yh(i)=lst(i)+f(i);
end
plot(x,y,'r');
hold on
plot(x,yh,'g');
load ('IBM_1.mat')
for i=75:104
    x(i)=i;
    yh(i)=p(1)*i+p(2)+f(i);
    y(i)=Close1(105-i);
end
figure
plot(x,yh,'b');
hold on
plot(x,y,'g');
figure
plot(x(75:104),yh(75:104),'b');
hold on
plot(x(75:104),y(75:104),'r');
figure
plot(x(75:104),y(75:104)-yh(75:104),'m');
```

```
load('APPLE _Inc.mat');
price=Closeap(:,1);
plot(Closeap);
[m,n]=size(price);
autocorr(price,251);
for i=1:87
    pr2(i)=price(i);
end
[m,n]=size(pr2);
for i=1:87
    x(i)=i;
    y(i)=pr2(88-i);
end
zz=polyfit(x,y,1);
for i=1:87
    lst(i)=zz(2)+zz(1)*i;
end
plot(x,y,'b');
hold on
plot(x,lst,'r')
figure
plot(x,y-lst,'b')
ff=fit(x',(y-lst)','fourier3'); % Fourier Series
for i=1:87
    yh(i)=lst(i)+ff(i);
end
plot(x,y,'k');
hold on
plot(x,yh,'g');
load('APPLE1 Inc.mat');
for i=88:117
    x(i)=i;
    yh(i)=zz(2)+zz(1)*i+ff(i);
    y(i)=Closeap1(118-i);
end
figure
plot(x,yh,'g');
hold on
plot(x,y,'r');
figure
plot(x(88:117),yh(88:117),'b');
hold on
plot(x(88:117),y(88:117),'r');
figure
plot(x(88:117),y(88:117)-yh(88:117),'m');
```

```
load('FSB.mat');
price=Close2(:,1);
plot(Close2);
[m,n]=size(price);
autocorr(price,251);
for i=1:87
    pr2(i)=price(i);
end
[m,n]=size(pr2);
for i=1:87
    x(i)=i;
    y(i)=pr2(88-i);
end
zz=polyfit(x,y,1);
for i=1:87
    lst(i)=zz(2)+zz(1)*i;
end
plot(x,y,'r');
hold on
plot(x,lst,'b')
figure
plot(x,y-lst,'m')
ff=fit(x',(y-lst)','fourier3'); % Fourier Series
for i=1:87
    yh(i)=lst(i)+ff(i);
end
plot(x,y,'k');
hold on
plot(x,yh,'g');
load('FSB_1.mat')
for i=88:117
    x(i)=i;
    yh(i)=zz(2)+zz(1)*i+ff(i);
    y(i)=Close(118-i);
end
figure
plot(x,yh,'g');
hold on
plot(x,y,'r');
figure
plot(x(88:117),yh(88:117),'b');
hold on
plot(x(88:117),y(88:117),'r');
figure
plot(x(88:117),y(88:117)-yh(88:117),'m');
```

```
load('GOOG.mat');
price=Close1(:,1);
plot(Close1);
[m,n]=size(price);
autocorr(price,252);
for i=1:87
    pr2(i)=price(i);
end
[m,n]=size(pr2);
for i=1:87
    x(i)=i;
    y(i)=pr2(88-i);
end
zz=polyfit(x,y,1);
for i=1:87
    lst(i)=zz(2)+zz(1)*i;
end
plot(x,y,'r');
hold on
plot(x,lst,'b')
figure
plot(x,y-lst,'m')
ff=fit(x',(y-lst)','fourier3'); % Fourier Series
for i=1:87
    yh(i)=lst(i)+ff(i);
end
plot(x,y,'k');
hold on
plot(x,yh,'g');
load('Google1.mat')
for i=88:117
    x(i)=i;
    yh(i)=zz(2)+zz(1)*i+ff(i);
    y(i)=CloseG(118-i);
end
figure
plot(x,yh,'g');
hold on
plot(x,y,'r');
figure
plot(x(88:117),yh(88:117),'b');
hold on
plot(x(88:117),y(88:117),'r');
figure
plot(x(88:117),y(88:117)-yh(88:117),'m');
```

```
load('Intel.mat')
p1=Close4(:,1);
plot(p1);
[m,n]=size(p1);
autocorr(p1,252);
p2=p1(1:74);
[m,n]=size(p2);
for i=1:74
    x(i)=i;
    y(i)=p2(75-i);
end
p=polyfit(x,y,1);
for i=1:74
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
hold on
plot(x,lst,'r');
figure
plot(x,(y-lst),'m');
f=fit(x',(y-lst)','fourier3'); % Fourier Series
for i=1:74
    yh(i)=lst(i)+f(i);
end
plot(x,y,'r');
hold on
plot(x,yh,'g');
load ('IBM_1.mat')
for i=75:105
    x(i)=i;
    yh(i)=p(1)*i+p(2)+f(i);
    y(i)=Close1(106-i);
end
figure
plot(x,yh,'b');
hold on
plot(x,y,'g');
figure
plot(x(75:105),yh(75:105),'b');
hold on
plot(x(75:105),y(75:105),'r');
figure
plot(x(75:105),y(75:105)-yh(75:105),'m');
```

```
load('inteliquent.mat')
p1=Closet(:,1);
plot(p1);
[m,n]=size(p1);
autocorr(p1,251);
p2=p1(1:93);
[m,n]=size(p2);
for i=1:93
    x(i)=i;
    y(i)=p2(94-i);
end
p=polyfit(x,y,1);
for i=1:93
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
hold on
plot(x,lst,'r');
figure
plot(x,(y-lst),'m');
f=fit(x',(y-lst)','fourier3'); % Fourier Series
for i=1:93
    yh(i)=lst(i)+f(i);
end
plot(x,y,'r');
hold on
plot(x,yh,'g');
load ('inteliquent1.mat')
for i=94:123
    x(i)=i;
    yh(i)=p(1)*i+p(2)+f(i);
    y(i)=Close(124-i);
end
figure
plot(x,yh,'b');
hold on
plot(x,y,'g');
figure
plot(x(94:123),yh(94:123),'g');
hold on
plot(x(94:123),y(94:123),'r');
figure
plot(x(94:123),y(94:123)-yh(94:123),'m');
```

```
load('Microsoft.mat');
price=Closem(:,1);
plot(Closem);
[m,n]=size(price);
autocorr(price,251);
for i=1:99
    pr2(i)=price(i);
end
[m,n]=size(pr2);
for i=1:99
    x(i)=i;
    y(i)=pr2(100-i);
end
zz=polyfit(x,y,1);
for i=1:99
    lst(i)=zz(2)+zz(1)*i;
end
plot(x,y,'r');
hold on
plot(x,lst,'b')
figure
plot(x,y-lst,'m')
ff=fit(x',(y-lst)','fourier3'); % Fourier Series
for i=1:99
    yh(i)=lst(i)+ff(i);
end
plot(x,y,'k');
hold on
plot(x,yh,'g');
load('Microsoft1.mat');
for i=100:129
    x(i)=i;
    yh(i)=zz(2)+zz(1)*i+ff(i);
    y(i)=Closem1(130-i);
end
figure
plot(x,yh,'g');
hold on
plot(x,y,'r');
figure
plot(x(100:129),yh(100:129),'b');
hold on
plot(x(100:129),y(100:129),'r');
figure
plot(x(100:129),y(100:129)-yh(100:129),'m');
```

```
load('MODN.mat');
p1=Closet(:,1);
plot(p1);
[m,n]=size(p1);
autocorr(p1,251);
p2=p1(1:61);
[m,n]=size(p2);
for i=1:61
    x(i)=i;
    y(i)=p2(62-i);
end
p=polyfit(x,y,1);
for i=1:61
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
hold on
plot(x,lst,'r');
figure
plot(x,(y-lst),'m');
f=fit(x',(y-lst)','fourier3'); % Fourier Series
for i=1:61;
    yh(i)=lst(i)+f(i);
end
plot(x,y,'r');
hold on
plot(x,yh,'g');
load ('inteliquent1.mat')
for i=61:91;
    x(i)=i;
    yh(i)=p(1)*i+p(2)+f(i);
    y(i)=Close(92-i);
end
figure
plot(x,yh,'b');
hold on
plot(x,y,'g');
figure
plot(x(61:91),yh(61:91),'g');
hold on
plot(x(61:91),y(61:91),'r');
figure
plot(x(61:91),y(61:91)-yh(61:91),'m');
```

```
load('MCRL.mat');
price=Close7(:,1);
plot(Close7);
[m,n]=size(price);
autocorr(price,252);
for i=1:51
    pr2(i)=price(i);
end
[m,n]=size(pr2);
for i=1:51
    x(i)=i;
    y(i)=pr2(52-i);
end
zz=polyfit(x,y,1);
for i=1:51
    lst(i)=zz(2)+zz(1)*i;
end
plot(x,y,'r');
hold on
plot(x,lst,'b')
figure
plot(x,y-lst,'m')
ff=fit(x',(y-lst)','fourier3'); % Fourier Series
for i=1:51
    yh(i)=lst(i)+ff(i);
end
plot(x,y,'k');
hold on
plot(x,yh,'g');
load('Micrel_1.mat')
for i=52:81
    x(i)=i;
    yh(i)=zz(2)+zz(1)*i+ff(i);
    y(i)=Close(82-i);
end
figure
plot(x,yh,'g');
hold on
plot(x,y,'r');
figure
plot(x(52:81),yh(52:81),'b');
hold on
plot(x(52:81),y(52:81),'r');
figure
plot(x(52:81),y(52:81)-yh(52:81),'m');
```

```
load('MCRL.mat')
p1=Close7(:,1);
plot(p1);
[m,n]=size(p1);
autocorr(p1,252);
p2=p1(1:50);
[m,n]=size(p2);
for i=1:50
    x(i)=i;
    y(i)=p2(51-i);
end
p=polyfit(x,y,1);
for i=1:50
    lst(i)=p(1)*i+p(2);
end
plot(x,y);
hold on
plot(x,lst,'r');
figure
plot(x,(y-lst),'b');
f=fit(x',(y-lst)','fourier3'); % Fourier Series
for i=1:93
    yh(i)=lst(i)+f(i);
end
plot(x,y,'r');
hold on
plot(x,yh,'g');
load ('inteliquent1.mat')
for i=94:123
    x(i)=i;
    yh(i)=p(1)*i+p(2)+f(i);
    y(i)=Close7(124-i);
end
figure
plot(x,yh,'b');
hold on
plot(x,y,'g');
figure
plot(x(50:80),yh(50:80),'g');
hold on
plot(x()50:80,y(50:80),'r');
figure
plot(x()50:80,y(50:80)-yh(50:80),'m');
```