T.C.
BAHCESEHIR UNIVERSITY
INSTITUTE OF SCIENCE

STOCK MARKET BUSINESS CYCLE PREDICTION USING REGRESSIONANALYSIS AND ARTIFICIAL NEURAL NETWORK

M.Sc. Thesis

ALEV KARAKUŞ

İSTANBUL, 2015

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THESIS SUPERVISOR: ASST. PROF. ETHEM ÇANAKOĞLU

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PREFACE

I would like to thank my supervisor Asst. Dr. Ethem Çanakoğlu due to his valuable help and support he provided during my thesis study.

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ABSTRACT

STOCK MARKET BUSINESS CYCLE PREDICTION USING REGRESSION ANALYSIS AND ARTIFICIAL NEURAL NETWORK

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Economic movement influences business cycle which is also named as economic cycle. These business cycles express time of decline or rising and they are impressed by endless various economic conditions. Business cycle is characterized by a dynamic factor. This dynamism is first formed by Markov Switching Model. Transition from one state to another can occur with Markov chain in the cycle.

In this research, Regression Analysis and Artificial Neural Network were used to model stock market prediction. The market states are assumed to be related to macroeconomic variables. In this thesis, two methods were used to analyze this relationship. These are Regression Analysis and Artificial Neural Network. Moreover, the benefit of regime switching model was analyzed using a computational example.

Key Words: Business Cycle, Regime Switching, Markov, Artificial Neural Network, Stock Market Prediction.

ÖZET

REGRESYON ANALİZİ VEYAPAY SİNİR AĞI KULLANILARAK
STOK MARKET İŞ DÖNGÜSÜ TAHMİNİ

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Ekonomik hareketlilik; iş döngüsünü diğer adıyla iktisadi döngüyü şekillendirmektedir. Bu döngüler gerileme veya yükselme zamanlarını ifade eder ve sonsuz çeşitli ekonomik şartlardan etkilenmektedir. İş döngüleri; dinamik faktörlerle nitelendirilmiştir, bu dinamikliği ilk şekillendiren ise Markov modelidir. Döngü içinde bir durumdan başka bir duruma geçiş Markov zinciri ile olur.

Bu araştırmada yaygın olarak Regresyon Analizi ve Yapay Sinir Ağı kullanılarak stok market modellemesi yapılmaya çalışılmaktadır. Market durumlarının makroekonomik değişkenlerle ilişkili olduğu varsayılmaktadır. Bu tezde, bu ilişkiyi analiz etmek için iki metod kullanılacaktır. Bunlar, Regresyon Analizi ve Yapay Sinir Ağı'dır. Ek olarak, rejim anahtarı modelinin yararları hesaba dayalı örnekler kullanılarak analiz edilmektedir.

Anahtar Kelimeler: İş Döngüsü, Rejim Anahtarı, Markov Modeli, Yapay Sinir Ağı, Stok Market Tahmini.

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ABBREVIATIONS

ANN	: Artificial Neural Network
BLS	: The Bureau of Labor Statistics
CPI	: Customer Price Indexes
EViews	: Econometric Views
GPNN	: General Regression Neural Network
HCIP	: Harmonized Indexes of Customer Prices
HUD	: Department of Housing and Urban Development
ICA	: Independent Components Analysis
MSE	: Mean Squared Error
NBER	: National Bureau of Economic Research
SOC	: Survey of Construction
USA	: United States of America

1. INTRODUCTION

This thesis is provided for the Degree of MSc in Department of Industrial Engineering at the University of Bahçeşehir. In this thesis, stock market business cycle prediction was searched by using Regression Analysis and Artificial Neural Network.

This thesis has two parts. First of all, we aimed to show that regime switching was applied with Fama-French data using NBER states. Other part was showing how to relate the states of macroeconomic variables.

Types of the economic movement constitute fluctuations in business cycle. Business cycle is characterized by a dynamic factor model with regime switching. Dynamic factor is unidentified variable. In his seminal work, Hamilton (1989) studied on dynamic factors in time series with Markov switching model. However, he failed about monthly grow rate. He used regime switching and dynamic factors to evaluate business cycle turning points.

The relationship between risk and return is the main topic in this research. Market states become predictable with this area. This approach was showed by Harry Markowitz who is one of the considerable economists and improved linear programming and simplex method. They studied on optimal mean – variance portfolio to determine properly. However, there are some problems not giving certain results because of the variability.

In this thesis, Regression Analysis and Artificial Neural Network have been used to predict stock market business cycles. The future work, Hidden Markov Model, can be used to estimate the stock market prediction.

2. SURVEY OF LITERATURE

2.1 BUSINESS CYCLE

This section of the literature reviews aims to understand the history of the researches in related to the business cycle. According to the literature, business cycle can be specified and its features can be understood.

Business cycle or economic cycle refers fluctuations in activity and trade over several months or years because of variations of economic conditions. In business cycle, fluctuations are generated by the types of the economic movement. Therefore, fluctuations change economy. However, business cycles are not the only reason of fluctuations in economy. Seasonal fluctuation is also an important point.

First of all, the essential topic is economic cycle. Economic cycles that continue 8 and 11 years over are identified. Then, four stages have been defined that are expansion, crisis, recession and recovery. However, one of the most important issues for business cycles is their dates and interspaces. In present day, the analysis of the developed countries' economic fluctuations is described. Then, dates of the business cycle and their time space are defined.

Dynamism of economy is a situation that affects business cycle. Business cycles can be divided into different phases. The phase shifts are characterized by changes in the dynamics of economy. Phases of business cycle repeat themselves. However, their durations considerably vary from one to another. Economists and statisticians have been researched many statistical methods that automate the dating of business cycle peaks and troughs. One such technique is the Markov switching model and studies about this statement was done by Hamilton (1989). Hamilton focused on Markov switching model and used dynamic factors for time series with Markov switching. Although, this model was quite simple, Hamilton failed about monthly growth rate. Thereafter, in many studies, business cycle was showed to be related with common action of economic series. In addition to that, phase is defined relation is absolutely important for the

different series. Furthermore, some evidences about Markov switching models are provided. It procures defining of turning points of business cycle.

2.2 REGIME SWITCHING

Regime-switching models are well-suited to model nonlinearities in time series which is assumed different behavior (structural break) in one subsample (or regime) to another. Hamilton (2005) worked on time-series dynamics governed by a Markov process and regime switching.

From time to time, many economic time series exhibit dramatic breaks in their changes. These situations influence financial crises, and abrupt changes in government policy of countries. Dramatic changes can be understood thanks to regime switching.

Business cycles are experimentally qualified by a dynamic factor model with regime switching. Dynamic factors are indescribable variables and they are significant factors for business cycle and regime switching. There are some failed studies because they include non-switching dynamic factor representation. Hamilton (1989) used dynamic features with Markov switching model in time series. However, researcher failed monthly grow rate.

The general purpose is to model dynamic factors with the regime switching and optimal inferences of business cycle turning points. Regime model attend to change and it forecasts future values of series with maximum likelihood.

Economic activities are crucial for business cycle turning points. Some indicators are used to predict these turning points. Interest rates also affect economy. Regime switching model are well-proper to capture the non-linear in interest rates. Economic performance of regime switching is researched for interest rate. In general, one - regime switching is preferred more than regime switching. There are three reasons for this selection. Firstly, regime switching is hard to test for the present of regimes. Secondly, its estimation is very hard. Finally, data regime is not clear enough for classification.

2.3 MARKOV CHAINS AND STOCHASTIC MARKET

Many real-world systems include uncertainty in process of time. Stochastic processes (and Markov chains) are possible models for such systems.

In Markov chain, the outcome of an experiment only depends on the outcome of the previous experiment. In other words, knowledge of the outcomes of the previous experiments does not affect our predictions for the outcomes of the next experiment. Briefly, the next state of the system only depends on the present state, not the preceding state. According to Wikipedia, a Russian mathematician Andrey Markov began the study of an important process. In this process, the outcome of the experiment can influence the result of the next experiment. This type of process is called a Markov chain. It has a wide range of study fields such as chemistry, physics, information sciences, queueing theory, economics and finance, internet applications, genetics etc.

Another important term is stochastic that means a random variable. Stochastic process is a fundamental role in mathematical model of economics, statistic or in many fields of science. Lots of systems or processes can be estimated by using stochastic models. Stochastic system is one whose state is non-deterministic (i.e., "random") so that the subsequent state of the system is determined probabilistically. There are some examples which are related to the stochastic process: Companies estimate their recent demands, and they forecast demands in future months. This situation can occur very hard and unproductive if recent demands are unknown. Demand is stochastic, so it is a random amount. For this reason, mathematics, and especially statistics are absolutely significant and may be beneficial for this process.

As a model of stochastic market, researchers studied on a modeling a stochastic financial market by Markov chain and they worked with discrete time series. On the other hand, an interest rate model which is also important for Markov processes with continuous-time setting is regulated by a Markov process with continuous-time setting. Continuous time Markov Chain contains some finite or countable set and for which the time spent in each state takes non-negative real values and has an exponential distribution.

Stochastic process affects lots of fields, and the significant area in these fields is financial market. They have random risk, and they are several in various areas such as political, financial, economic etc. Market‘s states usually change and also return change. Therefore, financial markets have some risks and high level or variances of asset returns, and they are influenced due to the changes in local or global factors. For this reason, these factors may affect investment decisions.

Generally, all of this data are related with the market states, and this topic is focused more than other real subjects. Therefore, this model is an absolutely important problem for real market field to estimate market state trouble. For this reason, there are several alternatives methods are followed to solve this issue. These alternatives procedures are regression analysis, neural network, and regime switching. For example, regime switching provides better calculation and result for this problem. It has higher utilization in market sector. Also, regime switching ensures better results to estimate portfolio optimization. Using regime-switching in both volatility and correlation might provide better insight into the dynamic properties of the stock markets. Moreover, regime switching is an essential topic. This model is well-suited to calculate nonlinearities in time series to presume different behavior (structural break) in one subsample (or regime) to another. In addition to these methods, neural network is also a critical way. It has a wide field in the studies of artificial intelligence. Neural network is used to predict stock market for the analysis of time series, and it procures to provide maximum information for their investment decisions. It is important that it shows to forecast the certain and true values of the stocks, and price movement.

2.4 ARTIFICIAL NEURAL NETWORK

One type of network gives a name the nodes as ‘artificial neurons’. These are also called artificial neural networks (ANNs).Computers are improved day by day and they can solve hard and complex problems. Nevertheless, computers do not have same skills such as sensation, reading, and writing. As a result, computers are not working like a human brain. Therefore, computers are not sufficient. For this reason, scientists focus on simulating human brain in a computer. For instance, brain has more than 10 billion neurons, and neurons are brain cell. Also, dendrites provide connections between each

other. This information is helpful to create this model. Carlos Gershenson has defined that there are a lot of artificial neurons in the network and this system is called artificial neural networks in his article Artificial Neural Networks for Beginners.

As a result, scientists have been researching the transition of information from one neuron to another in the brain cells of people. And also, like a human brain, some functions like teaching, sensation can be made as real in computers.

To create artificial neural networks, researchers observed working principle of neurons. Then, ANN is implemented into the mathematical models of nervous systems in humans.

ANN can be used in a lot of fields. Some of them are health, security, entertainment, finance fields. For the finance areas, forecasting composite index, financial state, optimization, decision making etc. are the basic points. In the last ten years, ANN is generally used to forecast prediction of stock certificate.

Moreover, generally in 1990s, artificial neural network is used for portfolio management, prediction bond and stock certificate, and financial situations.

In 2009, the other examples are from "Yapay Sinir Ağları İle Borsa Tahmini" written by Birgül Kutlu and Bertan Badur, they defined that Bambang and his friend studied Indenosia, they used ANN to predict stock certificate of stock market, and other example is from the same article is about Phua and his friends examined on stock market Singapore, and they obtained a high performance result from ANN. The result accuracy was 81 percent.

When the history of Artificial Neural Network is investigated, ANN is separated in some parts to create it. One group generally interests in biological process of learning, another group is focused on algorithm to embed into the machine with providing high performance. About this topic, there are good examples in TomMitchellCh4 pdf (http://web.cs.swarthmore.edu/~meeden/cs63/f13/TomMitchellCh4.pdf), researcher

described that there are a lot of papers about biological neurons and artificial neural network.

2.4.1 Examples About Regression And Artificial Neural Network In The Literature

In this section, several instances are taken from the literature. Examples have been explained as a few words, goals, and methods that were used and they were studied for a solution in this thesis. Thus, different examples are related with various areas, so regression and artificial neural network are observed in these distinct topics, and information can be understood in different views. In this way, how to use these techniques is learned.

Artificial neural network can be utilized a lot of different areas with using different features. For this reason, different software about artificial neural network is created. For example, Capt. Dr. S. Santhosh Baboo and A.R.J.Vigneswari (2014) wrote the article about olive ridley sea turtle. The study used ANN software using different tools that are Matlab Software and Neuro Solution Software. Then, researchers compared them between each other and the article examined forecast of training data sets and the researchers compared their two tool's performance ratios. Finally, feed forward neural network was chosen.

The aim is to define of the turtles with their properties which are name, shape, color, length and breadth of turtles (Baboo and Vigneswari 2014). So, their variables sets are these features.

When the process was finished, the result obtained can be found in Table 2.1:

Table 2.1 : Comparative Analysis of Two Software

Software's	Number of Epochs	Error Rate in Training the networks	Training Time
Matlab	1000	0.001	0.00.01
Neuro Solutions	1000	16.00	0.00.07

Resource: Baboo and Vigneswari, (2014) *Identification of Olive Ridley Sea Turtle Using Two Software Tools*

From this example, ratio of performance can be also seen. Matlab Software was found to have better performance ratio than Neuro Solutions Software. Another example is about qualitative features based on genetic algorithm based fuzzy neural network and artificial neural network. Generally, quantitative factors are studied. This article is about qualitative features near the quantitative factors, because qualitative factors are not chosen to be worked for. For example, policy factor effects are important in the stock market. For this reason, this paper's objective is qualitative factors effects. In addition to this, R.J. Kuo et al., 2001, pg. 21 defined that the example of Taiwan stock market is about proposed intelligent system.

The researchers have been studying on influences stock market such as policy, finance, economy, international issues for many years. These dimensions are examined and they are put in order to their effects. For this reason, they calculate training MSE, testing MSE, standard deviation, mean value by using network.

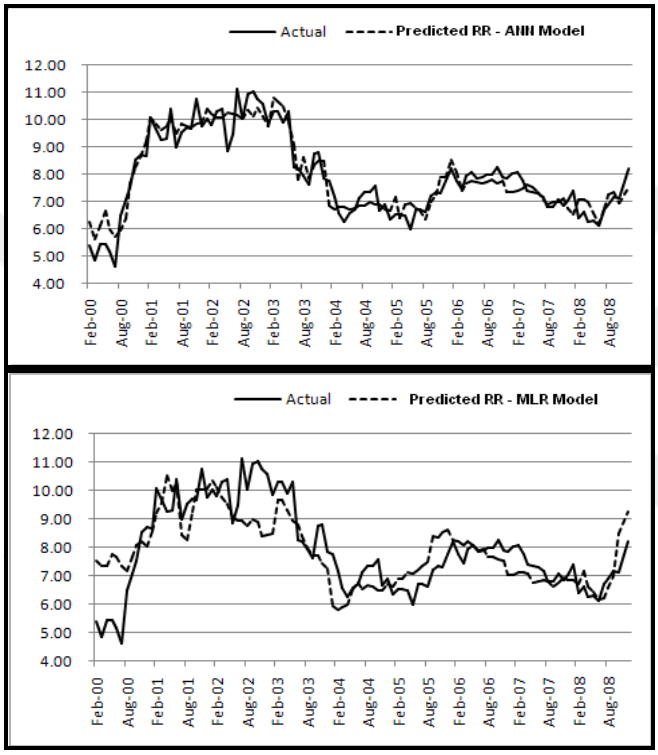
Other instances are about regression vs. artificial comparisons:

The article's goal was searching ANN for forecasting depositor return of Islamic Bank (Anwar and Watanabe 2011). Also, researchers compared multiple regression analysis with ANN. For these processes, they used six macroeconomic variables and ten years monthly data. These six variables were independent variables (Anwar and Watanabe , 2011, pg.9) defined that return's average rate of all Indonesian Islamic banks (RR) as dependent variable.

For the estimation, Eviews 5.0 was used to calculate the multiple regression analysis and Alyuda Neuro Intelligent Software version 2.2 was used to apply for ANN.

The result is:

Figure 2.1: Graph of actual vs. predicted R.R.



Resource: Anwar and Watanabe , (2011*) Performance Comparison of Multiple Linear Regression and Artificial Neural Networks in Predicting Depositor Return of Islamic Bank*

In the Figure 2.1, prediction rate of ANN was better than the multiple regression analysis. ANN had accuracy rate as 94.62 percent. On the other hand, multiple regression analysis was 90.07 percent accuracy rate (Anwar and Watanabe 2011).

3. REGIME SWITCHING MODELS

3.1 MARKOV CHAIN and STOCHASTIC MARKET

When Markov chain is defined, this statement is described in link below: https://en.wikipedia.org/wiki/Markov_chain)

$$\Pr(X_{n+1} = x \mid X_n = x_n, \ldots\ldots, X_1 = x_1) = \Pr(X_{n+1} = x \mid X_n = x_n) \quad (3.1)$$

In other words, there is a set of states, $S = \{s_1; s_2; \ldots; s_n\}$. The process starts in one of these states and follows from one state to another. Each move is called a step. If the chain is currently in state s_i, then it moves to state s_j at the next step with a probability denoted by p_{ij}, and it is important that this probability does not depend upon in which states the chain was before the current state. One state can proceed to next state or can stay on the current state. These alterations are known transition and the probabilities p_{ij} are called transition probabilities.

Moreover, model of stochastic market is an essential subject. Lots of researchers studied on modeling a stochastic financial market by a Markov chain within a discrete time framework. More recently, Markov interest rate model is an essential topic for researchers that Markov chain and the transition matrix are used both time independent. Under this issue, the bond price is provided.

Çanakoğlu and Özekici (2011) used the stochastic model. They defined that: Suppose that the state of the market in period n , and it is showed by Y_n and $Y = \{Y_n; n = 0, 1, 2, \ldots\ldots\}$. This statement is happened by a Markov chain with a discrete state space E and transition matrix Q which is written using transition probabilities. Transition matrix is occurred using transition probability that is calculated by moving from one state to another state such as Figure 3.1.Then,let $R_{(i)}$ denote the random vector of asset returns in any period given that the stochastic market is in state i . Also, they continued that variances and covariance of asset returns depend only on the current state of the

stochastic market. Covariance and variance is important terms to comprehend how variables affect with other variables are. In this thesis, covariance is estimated to understand regime switching. In addition to this, in probability theory, variance measures how far a range of numbers are expanded and it is always non-negative. The mean value is the expected value that is a weighted average of all possible values. Now, let $r_k(i) = E[R_k(i)]$ denote the mean return of the k^{th} asset in state i and $\sigma_{ij}(i) = Cov(R_k(i), R_j(i))$ denote the covariance between k th and j th asset returns in state i .The market involves of one riskless asset with known return $r_{f(i)}$ and standard deviation $\sigma_{f(i)} = 0$; and m risky assets with random returns $R^n(i) = (R^n{}_1(i), R^n{}_2(i), \ldots, R^n{}_m(i))$ in period n if the state of the market is i .Then, they assume that these states are independent from each other. Therefore, $R^n(i)$ is independent of $R^k(j)$ for all periods k is not equal to n and states i; j In Portfolio Selection in Stochastic Markets with HARA Utility Functions, Çanakoğlu and Özekici explained that the distributions of the asset returns depend only on the state of the market independent of time. For this reason, let $R(i) = R^n(i)$ denote the random return vector in any period n to simplify they notation.

Çanakoğlu and Özekeci (2011)described that they use the notation $E_i[Z] = E[Z \mid Y_0 = i]$ and $Var_i(Z) = E_i[Z^2] - E_i[Z]^2$ to denote the conditional expectation and variance of any random variable Z given that the initial market state is i .Conditional expectation is a mathematical expectation that is calculated using conditional probability distribution for a random variable. Conditional probability is evaluated using information that is assumed. Throughout this paper, unless otherwise stated, a vector z is a column vector so that its transpose, denoted by z', is always a row vector. The assumptions regarding the model formulation can be summarized as follows: (a) There is unlimited borrowing and lending at the prevailing return of the riskless asset in any period, (b) Short selling is allowed for all assets in all periods, (c) No capital additions or withdrawals are allowed throughout the investment horizon, and (d) Transaction costs and fees are negligible.

4. REGIME SWITCHING EXAMPLES

4.1 DATA FROM THE KENNETH R. FRENCH-DATA LIBRARY

Kenneth R. French is a Professor of Finance at the Tuck School Business at Dartmouth College. He is a specialist on the investment strategies and security prices.

Data is taken from Kenneth R. French – Data Library. Data is about market return value in US. In this research, return values are separated according to the rise and fall time of business cycle. Then, average, standard deviation, and variance are evaluated. Also, the same way is done without division due to business cycle. In addition to that, covariance is evaluated with distinction business cycle 0 and 1. Covariance is used to understand how variables changes with other variables are. It is important to understand the differences of variables to create the optimal portfolio. Because, this thesis is based on Markov Portfolio. Understanding variance and correlation is absolutely important. Moreover, 0 and 1 are counted to see the sum of 1 and 0. Then, percentage is evaluated as 0 and 1.

Return is divided into 0 and 1and it is called as ret0 and ret1. Then, the matrix showing the percentage of 0 and 1 in business cycle is called matrix Q. After these processes, covariance 0 and 1 are showed. All of these operations are loaded to Matlab Program.

In Matlab, data is filled to the matrix. For example, 5 Industry Portfolioshave5 columns data are remarked in BENCHMARKS from Kenneth R. French – Data Library and it has been showed in Table 4.1, Table 4.2, Table 4.3, Table 4.4,Table 4.5.

Table 4.1: Q matrix

	0	1
0	0.9500	0.0500
1	0.0148	0.9850

Resource: Matlab Program

Table 4.2: Ret0 matrix

-1.7271
-2.1938
-3.3833
-1.2247
-3.4990

Resource: Matlab Program

Table 4.3: Ret1 matrix

0.9451
1.2927
1,1068
0.9606
1.0685

Resource: Matlab Program

Table 4.4: Cov0 matrix

22.9515	21.9098	32.1205	17.5885	28.2537
21.9098	40.5524	42.4668	15.2903	23.7085
32.1205	42.4668	66.8935	25.6135	38.6635
17.5885	15.2903	25.6135	21.3392	22.0055
28.2537	23.7085	38.6635	22.0055	40.8493

Resource: Eviews Program

Table 4.5: Cov1 matrix

14.6463	10.2812	15.9103	7.8222	15.0167
10.2812	14.2261	13.5493	6.8829	13.5349
15.9103	13.5493	53.5431	13.1371	19.9717
7.8222	6.8829	13.1371	18.3005	11.1206
15.0167	13.5349	19.9717	11.1206	21.5909

Resource: Eviews Program

Moreover, to understand and compare some differences, business cycle is not divided 0 and 1. Therefore, return and covariance matrix are equal eachother. These matrixes are showed in Table 4.6, Table 4.7.

Table 4.6: Ret matrix

0.5854
0.5024
0.5024
0.6664
0.4536

Resource: Eviews Program

Table 4.7: Cov matrix

16.5962	12.9320	19.4903	9.8692	18.2205
12.9320	19.1861	19.2658	8.9023	16.6038
19.4903	19.2658	57.6891	15.9598	24.8771
9.8692	8.9023	15.9598	19.2659	13.7488
18.2205	16.6038	24.8771	13.7488	26.6138

Resource: Eviews Program

All of these evaluations are made according to the data that are 6 Portfolios Formed on Size and Long-Term Reversal (2 3) and 10 Portfolios Formed on Long-Term Reversal columns data sets in U.S. RESEARCH RETURNS from Kenneth R. French – Data Library. They contain 6 and 10 columns, respectively. The main idea was to understand Sharpe Ratio estimating with using all these examples, because Return, Q and Covariance matrixes were used for evaluating Sharpe Ratio and it shows us different results. In Section 4.2, Sharpe Ratio was told and results of examples are founded.

For example, we study with 6 data sets which has the same matrix name such as 5 data sets above. The same way is proceed that Q matrix is studied by percentage 0 and 1. Also, return value is calculated and called ret1 and ret0. And, covariance is finally

found for understanding the relationship between variables that is separated by 6 columns. The results are shown below;

Table 4.8: Q matrix

	0	1
0	0.9500	0.0500
1	0.0148	0.9850

Table 4.9: Ret0 matrix

-1.7390
-1.3180
-2.2623
-1.8385
-2.0200
-2.8533

Table 4.10: Ret1 matrix

1.4451
1.2456
1.2091
1.3631
1.0921
1.1517

Table 4.11: Cov0 matrix

67.0234	53.2911	70.2889	43.1869	34.8715	38.0940
53.2911	43.9753	55.6609	34.5235	29.3899	30.2710
70.2889	55.6609	82.1988	45.6435	36.9830	51.0563
43.1869	34.5235	45.6435	29.6292	24.2868	26.8186
34.8715	29.3899	36.9830	24.2868	23.9598	25.2287
38.0940	30.2710	51.0563	26.8186	25.2287	43.6897

Table 4.12: Cov1 matrix

37.2230	24.3755	30.1891	18.7588	13.1265	18.2039
24.3755	19.0090	22.5212	14.3711	11.5637	14.1742
30.1891	22.5212	26.3834	16.8907	13.8202	19.2939
18.7588	14.3711	16.8907	17.7026	12.4722	14.7887
13.1265	11.5637	13.8202	12.4722	12.5468	13.5383
18.2039	14.1742	19.2939	14.7887	13.5383	21.4478

In addition, for the case of 6 Portfolios Formed on Size and Long-Term Reversal (2 3) data set, business cycle is not divided 0 and 1to compare differences. For this reason, return and covariance matrix are equal. These matrixes are showed in Table 4.13and Table 4.14.

Table 4.13: Ret matrix

1.0165
0.9005
0.7418
0.9321
0.6731
0.6126

Table 4.14: Cov matrix

42.4158	29.2190	36.8749	23.2348	17.2091	22.3671
29.2190	23.1355	28.0191	18.0401	14.8928	17.5372
36.8749	28.0191	37.8971	22.0561	18.1968	25.1893
23.2348	18.0401	22.0561	20.5022	15.2233	17.9019
17.2091	14.8928	18.1968	15.2233	15.2114	16.5640
22.3671	17.5372	25.1893	17.9019	16.5640	26.3105

If we study with 10 Portfolios Formed on Long-Term Reversal columns data sets and they have same matrix name. The results are:

Table 4.15: Q matrix

	0	1
0	0.9500	0.0500
1	0.0148	0.9850

Table 4.16: Ret0 matrix

-2.4290
-1.9443
-1.6629
-2.1886
-2.0005
-1.6933
-1.8476
-1.8495
-2.5224
-4.0700

Table 4.17: Ret1 matrix

1.4867
1.4439
1.2646
0.9801
1.2213
1.2132
1.0681
1.0153
1.2497
1.3440

Table 4.18: Cov0 matrix

42.8230	34.0433	34.2700	32.2648	27.9194	28.5979	22.5050	22.3971	20.2024	36.9448
34.0433	35.5169	33.3745	26.6564	24.4470	27.8502	24.9767	22.5102	26.2418	41.3950
34.2700	33.3745	37.5608	31.3818	25.7655	28.0225	22.7971	21.4818	23.3266	38.0889
32.2648	26.6564	31.3818	31.9708	26.4451	27.5316	22.5967	21.7289	21.7763	33.6290
27.9194	24.4470	25.7655	26.4451	26.6798	24.4412	18.4162	19.6170	19.7333	27.4076
28.5979	27.8502	28.0225	27.5316	24.4412	29.3628	24.3829	23.6779	27.1140	35.3294
22.5050	24.9767	22.7971	22.5967	18.4162	24.3829	26.5824	24.3021	29.0960	37.2333
22.3971	22.5102	21.4818	21.7289	19.6170	23.6779	24.3021	25.8540	28.5304	38.9051
20.2024	26.2418	23.3266	21.7763	19.7333	27.1140	29.0960	28.5304	38.6352	47.3718
36.9448	41.3950	38.0889	33.6290	27.4076	35.3294	37.2333	38.9051	47.3718	77.0433

Table 4.19: Cov1 matrix

38.8323	23.1586	19.4393	16.0686	14.6878	15.2943	14.9045	14.9757	16.2818	24.8324
23.1586	19.9361	14.8778	12.5144	12.1349	12.3241	12.8605	12.3608	13.5373	17.9498
19.4393	14.8778	16.4792	11.6227	12.2103	11.1082	12.0892	11.2592	12.9783	15.7127
16.0686	12.5144	11.6227	13.4220	11.1747	10.7520	11.9621	11.3171	12.3556	13.8839
14.6878	12.1349	12.2103	11.1747	14.8761	11.4475	12.1392	12.5331	13.2876	13.9516
15.2943	12.3241	11.1082	10.7520	11.4475	14.5830	12.3484	13.0116	13.2568	14.5357
14.9045	12.8605	12.0892	11.9621	12.1392	12.3484	14.7810	13.3305	14.2980	15.3339
14.9757	12.3608	11.2592	11.3171	12.5331	13.0116	13.3305	16.8516	15.8890	17.0272
16.2818	13.5373	12.9783	12.3556	13.2876	13.2568	14.2980	15.8890	19.0432	20.4136
24.8324	17.9498	15.7127	13.8839	13.9516	14.5357	15.3339	17.0272	20.4136	34.3940

Moreover, to compare differences, in business cycle is not divided 0 and 1 as above. Therefore, return and covariance matrix are equal. These matrixes are showed in Table 4.32 and Table 4.33.

Table 4.20: Ret matrix

0.9596
0.9878
0.8705
0.5536
0.7876
0.8219
0.6756
0.6337
0.7419
0.6152

Table 4.21: Cov matrix

41.1557	26.1694	22.7711	19.6943	17.9386	18.4110	17.2577	17.2679	18.5303	28.9326
26.1694	23.3708	18.5232	16.0727	15.0639	15.5613	15.6423	14.8460	16.7364	23.2428
22.7711	18.5232	20.3155	15.3632	15.1338	14.3763	14.5250	13.6021	15.6577	20.5712
19.6943	16.0727	15.3632	17.0887	14.4196	14.0837	14.4700	13.7651	15.0162	18.5404
17.9386	15.0639	15.1338	14.4196	17.6742	14.2875	14.0785	14.5506	15.5710	17.7949
18.4110	15.5613	14.3763	14.0837	14.2875	17.5567	14.9557	15.4073	16.3994	19.1680
17.2577	15.6423	14.5250	14.4700	14.0785	14.9557	17.3600	15.7703	17.5677	20.1208
17.2679	14.8460	13.6021	13.7651	14.5506	15.4073	15.7703	18.9997	18.8364	21.7603
18.5303	16.7364	15.6577	15.0162	15.5710	16.3994	17.5677	18.8364	23.3381	26.4216
28.9326	23.2428	20.5712	18.5404	17.7949	19.1680	20.1208	21.7603	26.4216	43.5499

The aim was to understand Sharpe Ratio with these examples.

Definition of Sharpe Ratio and all results of these data will be shown in Section 4.2.

4.2 RESULT OF DATA FROM THE KENNETH R. FRENCH-DATA LIBRARY

In Section 4.1, data are defined and this data are solved to understand and find Sharpe Ratio Using Matlab Program. For instance, 5 Industry Portfolios,6 Portfolios Formed on Size and Long-Term Reversal (2 3) and 10 Portfolios Formed on Long-Term Reversaldata sets are marked and we tried to understand their relationship with using covariance. According to the business cycle, 0 and 1 is evaluated with distinct columns that are separated with each other. Therefore, covariance and return are also different. In Table 4.22, 5 Industry Portfolios data sets were used and business cycles are evaluated as 0 and 1 separately.

Then, the result was evaluated by Matlab Program.

Table 4.22: Result

Rate =
4.964305417186949
1.724158043131822

Resource: Matlab Program

This result called Sharpe Ratio is found by return and is divided to Standard Deviations. This ratio describes that investors can select their investment depending on expected return value and their risk. Because this ratio evaluates expected return value under the risk factor. If investors can be noticed from this data, these situations can be beneficial for investment. This result affects creating optimal portfolio. This ratio can influence future decision to invest.

The business cycles 0 and 1 are separated and result can be seen thanks to this evaluation.

On the other hand, if 0 and 1 is not separated each other, data is used union. 0 and 1 in business cycle are not separated from each other. The result can be found in Table 5.12:

Table 4.23: Result2

Rate =
0.939551564589397

Resource: Matlab Program

By the same way, other data can be evaluated. For example; results of 6 Portfolios Formed on Size and Long-Term Reversal (2 3) data sets that are defined in Section 4.1. Table 4.24 shows that Shape Ratio with 6columns data sets, 0 and 1 values were separated.

Table 4.24: Result

Rate =
4.415252411554907
1.896709362705816

Resource: Matlab Program

If sharpe ratio is high, we can understand that expected return value of portfolio is also high depending on the investment risk.

On the other hand, 0 and 1 is not divided and the result is in Table 4.25:

Table 4.25: Result2

Rate =
1.083846973937178

Resource: Matlab Program

In addition, the result of 10 Portfolios Formed on Long-Term Reversaldata sets is in Table 4.26:

Table 4.26: Result

Rate =
4.496435056276080
1.808097419138522

Resource: Matlab Program

If 0 and 1 is not divided each other, the result is in Table 4.27:

Table 4.27: Result2

Rate =
1.500141999333570

Resource: Matlab Program

When we look the Table 4.22, Table 4.24 and Table 4.26 that are 5, 6 and 10 columns and 0 and 1 are not divided. The result shows that the outcomes in Table 4.22**,**Table 4.26, and Table 4.24. So, we separated the business cycles as 1 or 0 in Table 4.22, Table 4.26 and Table 4.24 results, according to this, we can see the Sharpe ratio in the rise and fall time in cycles. Therefore, the main aim was to predict that portfolio's expected return value is also high depending on the investment risk. For this, we used 5, 6 and 10 columned data sets obtained from Fama French and we found different Sharpe Ratios. We have interpreted these results according to definition of Sharpe Ratio. Together with, when we separated the business cycles as 0 and 1, we found the results in Table 4.23, Table 4.25 and Table 4.27. These results give us insight into expected earnings and risks when investing.

5. REGIME PREDICTION MODELS

5.1 LOGISTIC REGRESSION MODEL

Linear regression equation consists of dependent and independent variables. Dependent variables are affected by other variables. Independent variables are variables that affect the dependent variables.

In linear regression, the dependent and independent variables are defined with quantitative data and also gives numerical results. Logistic regression is used in which the dependent variable is handled as quality. A qualitative variable is expressed as qualitatively, it is not a measurable intent. For example, whether the patients gets better, or not, or is the gender female or male? The mathematical expression of this situation is the result of 1 or 0.

In https://en.wikipedia.org/wiki/Logistic_regression website, Wikipedia defines that The logistic function can take an any input from negative to positive infinity. However, the value of output is between zero and one. The equation is:

$$\sigma(t) - \frac{e^t}{e^t + 1} - \frac{1}{1 + e^t + 1} \tag{5.1}$$

$$t = \beta_0 + \beta_1 x \tag{5.2}$$

x is the independent variable, t takes a value depending on x,

As a result logistic function is:

$$F(x) = \frac{1}{1 + + e^{-(\beta_0 + \beta_1 x)}} \tag{5.3}$$

5.2 MODELLING OF ARTIFICIAL NEURAL NETWORK

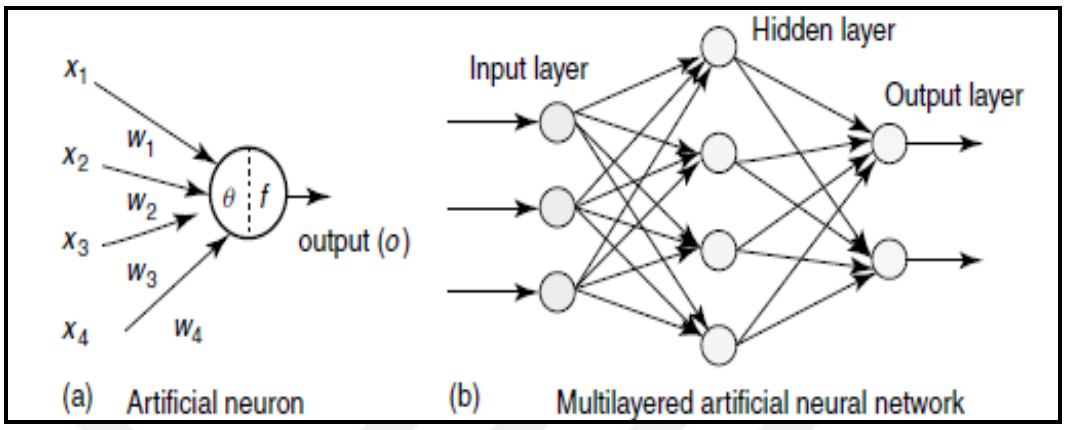
The brain operation is adapted to the artificial neural network (ANN). Human brain has about 100 billion neurons and these neurons have connections among each other. ANN is formed using neurons, mathematical model is written with using these neurons and image of their communications in the brain.

The ANN generally focuses learning from experiments and learning result of these experiments. Therefore, it has behaviors as much as similar with brain. The network has learning, training and giving results such as a brain.

As it is also understood from comparison, ANN is occurred such as a brain.

ANN has learning approach such as a brain. For other models that have learning approach, weight is very important. Thanks to them, performance of network can be higher than before. The modeling of ANN occurs with input, output and weight. The multilayered neural network is seen in Figure 5.1– (b) modeling is clarified such as in Figure 5.1. In Figure 5.1–(a), inputs enter with their weight, and then output is taken. If weight is positive, this situation means consolidation, but if it is negative, this event means that blocked (Abraham 2005). Arora et al. (2010, pg.3) defined that the weight provides to decrease the squared error on process. Therefore, weight is very critical issue for the network. In Figure 5.3–(a), ANN has layers, neurons are in these layers. There is only one input and output layer. However, only one hidden layer can be chosen, but if more than one hidden layer can be created, the performance result is better than one hidden layer.

Figure 5.1: The modeling of multilayered neural network



Resource: Ajith Abraham ,(2005) *Artificial Neural Networks*

In the ANN, using inputs and weight, the ANN architecture specified a mathematical model. In the article of Introduction to the Artificial Neural Network, researchers Andrej Krenker, Janez Bešter and Andrej Kos defined that inputs come to the body. And, all of them are multiplied weights. Then, every inputs are multiplied weight individually. In this article, model is described that:

$$y(k) = F\left(\sum_{i=1}^{m} W_i(k).\, X_i(k) + b\right) \qquad (5.4)$$

Where

- $X_i(k)$ is is input value in discrete time k where i goes from 0 to m,
- $W_i(k)$ is weight value in discrete time k where i goes from 0 to m,
- b is bias,
- F is a transfer function,
- $y_i(k)$ is output value in discrete time k.

The mathematical equation (1) is showed above. However, the critical issue is choosing the transfer function. This function is determined with using neurons and mathematical processes. Researchers Andrej Krenker, Janez Bešter and Andrej Kos specified that to

determine functions of the artificial neuron artificial neural network is very important. These functions are Step function, Linear function and Non-linear(Sigmoid) function.

Between input layer and output layer, hidden layer or layers exist. In the hidden layers, there is an activation function that is a mathematical process; it is dealing with signals for the output. These functions determine as far as type of problems.

If non-linear function is used, sigmoid function is chosen too often. In article "Introduction to the Artificial Neural Networks" Andrej Krenker, Janez Bešter and Andrej Kos explained that sigmoid function uses too often. Because, when important weight updates, this functions calculates easily in the network.

Another important issue is to determine numbers of hidden layers. This question is defined in Karsoliya's article (Karsoliya,2012). This study includes that this question can be changed according to the complexity and problem. If the problem is linear, there is no need to use the hidden layer such as activation function. But, if the problem is hard to solve, two or more hidden layers can be necessary. Karsoliya (2012, pg.714) defined that "But in case of problems which deals with arbitrary decision boundary to arbitrary accuracy with rational activation functions then one has to use two or three hidden layer". In addition to that, some articles claim that one hidden layer can be sufficient to solve problem. But, if more than one hidden layers used, solving the problem can be easier than using only one hidden layer. Özturan et al. (2008, pg. 26) described that hidden layer is beneficial to solve problems. However, only one hidden layer can be easier to solve some problem. Moreover, training time can determine to choose number of hidden layers. Karsoliya (2012, pg. 715) described that if lots of hidden layers are used in the network , the accuracy can be higher. Despite all of this information, if redundant hidden layers are used in network, this situation may negatively affect the network.

In addition, to determine the number of hidden layers, also the number of neurons is very essential in this subject. The artificial neurons are very similar with biological neurons. As biological neurons, artificial neurons take different signals, and they transfer to other artificial neurons with connections among each other. This connection

is done by weights. So, the number of neuron is one of the basic issues of the artificial neural network and also in determining their number. For the ANN, too many neurons are necessary. In the article of 'Introduction to the Artificial Neural Networks', Andrej Krenker, Janez Bešter and Andrej Kos described that if two or more artificial neurons are used, problems can be solve easily. On the other hand, only one artificial neuron can be inadequate for problems. Because, the real life problems can be more difficult.

For the artificial neural network, to choose different ratio of train parameters can affect the performance ratio. An example is showed in Chapter 6.

The hidden layer provides connections between input and output layers and activation function is also performed in the network. Numbers of neurons in the hidden layers become another critical topic. Karsoliya (2012, pg. 714) defined that a lot of researches has been tried to solve the number of neurons in the hidden layer but there is no certain result. Özturan et al.(2008, pg.26) defined that generally the number of neurons in the hidden layers can be solved with trial and error way. On the other hand, in the hidden layers, too many neurons provide better performance to solve the problem. In article 'Artificial Neural Networks', Ajith Abraham defined that if lots of hidden neurons can be used , the learning can be better in the system, and also the performance of the system and the data that is estimated can be better more than a few number of neurons in the network.

5.2.1 Network Types of Artificial Neural Network

According to the problem, neurons have different connections in ANN. The network is determined for the type of problem. There are lots of networks that can be used in the artificial neural network.

There are a lot of connection types for ANN to solve the problem. In that paper, only two networks are explained that are Feed Forward Neural Network(FFNNs)and Recurrent Neural Network(RNNs).

Feed Forward Neural Network (FFNNs): The direction is towards from input layer to output layer. Neurons settle in the network with regular layers from the beginning to the end. Information is taken and entered to the input layer and calculation starts. Then, this data proceed hidden layers respectively, and finally the data progress to the output layer. Therefore, this system has only one direction, and it march forward from enter to exit. There is no loop related with feedback. In article Artificial Neural Networks, Jitendra R Raol and SunilkumarS Mankame (1996)described that "The behavior of FFNN does not depend on past input. The network responds only to its present input."

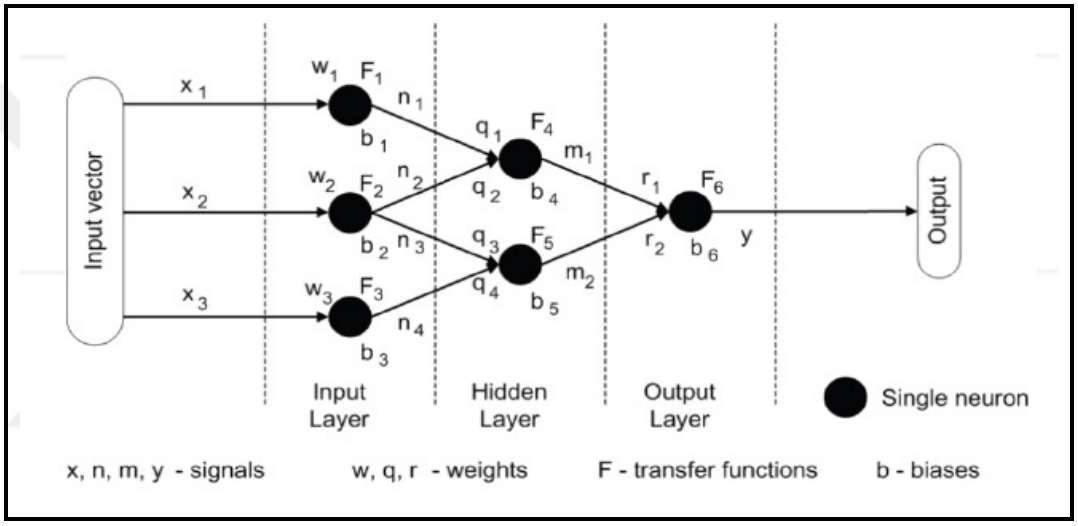
In this thesis, Feed Forward Neural Network is used. So, the connection of artificial neurons is Feed Forward Neural Network and there is no determination of layers. Also, in "Introduction to the Artificial Neural Networks", Andrej Krenker, Janez Bešter and Andrej Kos described that "The simplest feed-forward artificial neural network is a single perceptron that is only capable of learning linear separable problems. Simple multi-layer feed-forward artificial neural network for purpose of analytical description (sets of equations (3), (4) and (5)) is shown on Fig. 3.8.". From the same article, they defined the mathematical model of Feed Forward Neural Network in the below:

$$\begin{aligned} n_1 &= \mathrm{F}_1(W_1\mathrm{X}_1 + b_1) \\ n_2 &= \mathrm{F}_2(W_2\mathrm{X}_2 + b_2) \\ n_3 &= \mathrm{F}_3(W_3\mathrm{X}_3 + b_3) \\ n_4 &= \mathrm{F}_4(W_4\mathrm{X}_4 + b_4) \end{aligned} \tag{5.9}$$

$$\begin{aligned} m_1 &= \mathrm{F}_4(q_1\mathrm{n}_1 + q_2\mathrm{n}_2 + b_4) \\ m_2 &= \mathrm{F}_5(q_3\mathrm{n}_3 + q_4\mathrm{n}_4 + b_5) \\ y &= \mathrm{F}_6(r_1\mathrm{m}_1 + r_2\mathrm{m}_2 + b_6) \end{aligned} \tag{5.10}$$

$$y = F_6\left[\begin{array}{l} r_1(F_4[q_1F_1[W_1X_1 + b_1] + q_2F_2(W_2X_2 + b_2)] + b_4) + \dots \\ \\ \dots + r_2(F_5[q_3F_2[W_2X_2 + b_2] + q_4F_3(W_3X_3 + b_3)] + b_5) + b_6 \end{array}\right] \quad (5.11)$$

Figure 5.2: Feed forward neural network



*Resource:*AndrejKrenker, JanezBešter and Andrej Kos,*Introduction to the Artificial Neural Networks*

X_1, X_2 and X_3 are inputs of the cells. In biological way, inputs are taken by dendrites. Inputs are taken; inputs and weight are calculated with multiplication. Then, bias is added to this result of multiplication. After that, activation function included to the process. Finally, the result is calculated, and this result matches to the target. From this comparison, error rate is estimated. According to the rate, process is performed again. In the network, learning is better with this repetition. In every repeats, weights are changed by the network to achieve better performance. The aim was to procure better performance result with the loop.

Recurrent Neural Network (RNNs):One or more cells are located and at least one back link has to occur. The main different is originated from Feed Forward Neural Network that there is no only one and toward direction to the exit. Also, in the Feed Forward Neural Network, data does not relate to the previous data. However, this network can

use previous data in its memory. In addition to that, there is neither restriction about back process, nor back loop.

In the article Introduction to the Artificial Neural Networks, Andrej Krenker, Janez Bešter and Andrej Kos defined that the main basic topology of recurrent artificial neural network in their paper.

In addition to that Recurrent Neural Network is generally used for perceive design or one letter can be perceived by using this network

6. COMPUTATIONAL EXPERIMENT

In this thesis, lots of different data were used from several websites. In this chapter, it is explained that in which websites these data were taken from with explanatory information about them. Afterwards, which methods were used to achieve significant results with making use of data is expressed.

Generally, input data is taken from different questionnaires and also they have different subject and aim. According to business cycles that is taken from NBER website, this data is interpret with rising or decline of business cycle in the economy. This data related with to built new housing units, to decide strategic decision or to search rate of unemployment because, these situations are results of economy. For this reason, this data was chosen. Information about data was given with different sections in this chapter. With using this data, we want to compare with business cycles and data in the same time interval. Business cycles were taken from NBER website and also it is output. Input difference can be understood according to the differences in output. In addition to that, when this comparison is understood, we can comment in future.

First of all, informing was completed about output and input data. After that, where and for what purpose we used these data will be indicated by calculation.

6.1 NATIONAL BUREAU OF ECONOMIC RESEARCH

National Bureau Of Economic Research (NBER) is a nonprofit economic search organization and it is founded in 1920. NBER indicates economy movement. In this thesis, input data that are taken from websites, is commented using NBER data. In significant time interval, business cycles are taken from NBER. For this reason, NBER data is output in time interval between 1996 –2008. According to the phases of business cycles, 0 and 1 is determined. From this websites: http://www.nber.org/cycles/cyclesmain.html, data is taken. From peak to trough, this time interval is equal to 0 and from trough to peak time interval is equal to 1. This time period is calculated on a monthly basis. According these movement, input was interpreted. The first 8 years was calculated, and then subsequent 5 years was predicted.

In regression analysis, data that was called cycles, are business cycles. In addition to that, NBER is also used in artificial neural network.

6.2 DATA FROM THE UNITED STATES CENSUS

A lot of websites were investigated to apply for thesis subject, and data is studied on 'Monthly' values.

Firstly, this link is used: http://www.census.gov/construction/nrc/historical_data/ , and 'Monthly Seasonally Adjusted' is chosen for thesis examples. This link is from United States CENSUS, and an instance is related with New Residential Construction. Then, Historical Data can be seen in this page. Values are taken from 'Authorized by Building Permits' on New Housing Units column. Only this column is used from this website.

United States CENSUS has a wide extent, and researches can take advantage of data from Census. Examples are related with building permit survey. So, overview can be made to comprehend an instance. Primarily, over view is researched and then, some information is given about the surveys that are purpose, coverage, content, frequency, and users. The overview is to search regional and national data which correlate with new housing units authorized by building permits with under construction and completed. In the page of website remark that the data are for new, privately – owned housing units, excluding "HUD – code" manufactured homes. The data are taken from Building Permits Survey, and the Survey of Construction (SOC) that is not totally given by the Department of Housing and Urban Development (HUD). The survey specifies that local building permit data may be found on the Building Permits Survey webpage.

Building Permits Survey's purpose is to procure state, local and national statistics on new privately – owned residential construction. According to their expression this system can take voluntary responses. Then, it provides benefit to public records. This survey coverages all places issuing building. The survey specifies that over 98 percent of all privately-owned buildings constructed. Then, content of data are housing units' number, buildings' number and permit valuation by size of structure. Data divided two different part that are monthly and annually, but just only monthly side is used. Since 1959, all data can be gathered by the Bureau of Labor Statistics. In addition to this,

users can exploit very well and splendidly. The Conference Board uses the information to predict important economic indicators. Also, it noticed that The Department of Housing and Urban Development uses the data to designate housing programs. Then, researchers can use data to study on substantial investigations.

6.3 DATA FROM THE CONFERENCE BOARD

For The Conference Board, this link was used:
http://www.conference-board.org/data/consumerconfidence.cfm

Data can be used in Data Tables in Monthly CPI and HICP. Only monthly data is used in this thesis.

The Conference Board is a union working for the public interest worldwide. Also, it has independent business membership. In website, The Conference Board defined its mission in this link; http://www.conference-board.org/about/index.cfm?id=1974. The firm described that the main idea is economic and business information to help companies understand and deal with the most important and critical issues The Conference Board is very helpful for member companies. It deals with critical decisions of these companies. Because, The Conference Board has a business information and an independent source of economic. Therefore, it is a very important entity for establishments.

The Conference Board works and progresses on three main areas that are Corporate Leadership; Economy & Business Environment; and Human Capital. The Conference Board believes that companies can choose right strategic way to rise more than before thanks to The Conference Board. Because, corporations can analyze lots of decision, and can see the future situations for their ways.

This example is used for regression analysis that is mentioned in defining of it above, and this analysis proceeds with EViews program. There are two series which are used in the program. Again, the range is between 1996 and 2008. The series are International Indexes of Customer Prices in The Conference Board. The first serial is Customer Price Indexes (CPI), and monthly indexes. Another serial is Harmonized Indexes of Customer

Prices (HCIP). In the same topic, there are lots of countries in the website such as Austria, Belgium, USA, Canada, Denmark, Spain, Sweden etc. However, only USA is examined. Because, business cycle is related with USA. So, all of series and business cycles are involved with data of USA.

6.4 DATA FROM THE UNITED STATES CENSUS

The third data source that is used, data can be used from this link: http://www.census.gov/retail/. Like the part 4.1, United States CENSUS is very helpful to study the investigation. But, data is worked on different subject title from CENSUS. Information is from Monthly &Annual Retail Trade. On this page, in section Monthly Retail Trade Report, the Excel file is from Retail Inventories and Inventories/Sales Ratios. Another instance is about Retail and Food Services Sales.

Some information is given about United States CENSUS for the first example above. Thus, some knowledge can be explained about the Monthly Retail Trade Survey that its aim is to procure estimates of sales at retail and food services stores and inventories held by retail stores. All of these questionnaires ensure voluntary responses. About the coverage CENSUS defined that companies with one or more establishments sell merchandise and related services to final consumers. In addition to that retail companies ensure data on dollar value of retail sales and inventories. Since 1951, lots of samples are held by CENSUS. The way of method is a mail-out/mail-back questionnaire nearly 12,000 retail businesses, new employers, missed employers etc. obtained from benchmarking to the Annual Retail Trade Survey. Then, companies choose survey which is related to their business. Monthly Retail Trade Sales and Inventories calculations are released to the market nearly 6 weeks after the end of month. There are two estimates adjusted and unadjusted. But, only adjusted is studied about Monthly Retail Trade Sales and Inventories in this research. In addition to that, these data are used in a wide environment such as academic, business, communities etc. For example, The Bureau of Economic uses the calculations to estimate Gross Domestic Product. Another one is The Federal Reserve Board using calculations to appreciate recent trends about consumer purchases.

Different examples with the same titles were worked on Estimates of Monthly Retail and Food Services Sales by Kind of Business: 2014. These data are taken from the same link. Thus, this information is collected from United States CENSUS, and it's part of Monthly & Annual Retail Trade. Then, from Monthly Retail Trade Report, Retail and Food Services Sales data are used for exampling. Two serials are used from this websites.

6.5 DATA FROM THE UNITED STATES DEPARTMENT OF LABOR

Finally, I use that link: http://www.bls.gov/cps/cpsatabs.htm , and again 'Monthly' data is used for thesis. This link is from United States Department of Labor, and examples are Bureau of Labor Statistics. After this link is clicked, data can be seen in this page, information is easily found.

Starting with the definition of The Bureau of Labor Statistics(BLS) can facilitate to apprehend data. In the website, BLS defines their mission (http://www.bls.gov/bls/infohome.htm) like that The Bureau of Labor Statistics of the U.S. Department of Labor is deal with measuring labor market activity, working conditions, and price changes in the economy. The firm aim is to estimate and analyze economic knowledge to promote decision-making. Because, BLS wants to provide important information to select better strategy foe companies. In addition to that their vision is also considerable. BLS will provide information about work force, products and services developing its business processes to U.S., and all around the world. Since 1884, The Bureau of Labor Statistics has tried to procure important economic knowledge. Also, since 2009, The Bureau of Labor Statistics controls customer satisfaction for websites of BLS to check that it uses the American Customer Satisfaction Index (ACSI).

From The BLS, four different subjects are studied for this thesis.

First instance is "Table A-4.Employment status of the civilian population 25 years and over by educational attainment". Also, its title is Employment-Population Ratio - Bachelor's degree and higher, 25 yrs. & over. According to researcher, time slot can be

arranged. Lots of criteria such as degree of education, age of people etc. can be specified.

The method is the same with other three examples' method. There is a business cycle that is defined before, and these data are taken from BLS, and these series are entered in the EViews program.

The title of second illustration is Employment-Population Ratio - Some College or Associate Degree, 25 yrs. & over.

The business cycle and these data were taken from BLS. These series were entered to the EViews program. After the two series were chosen, then Quick Estimation Equation was followed. In the BLS, title of the third example is Job Losers as a Percent of Total Unemployed.

The last an example from BSL is about Employment-Population Ratio, and people who are age of 16 and over, are examined.

Table 6.1 : The summary data table used for the regression analysis

DATA FROM THE UNITED STATES CENSUS **Note: 1 serial is used(Housing Unit)*
DATA FROM THE CONFERENCE BOARD DATA FROM THE CONFERENCE BOARD **Note: 2 serial is used*(United State Table 1,United State Table 5)
DATA FROM THE UNITED STATES CENSUS **Note: 2 serial is used*(Retail and Food Services Sales, Retail Inventories)
DATA FROM THE UNITED STATES DEPARTMENT OF LABOR **Note: 4 serial is used*(College Graduate, Job Losers, Less Than a Barchhelor Degree , Sixteen and Over)

Resource: Excel

Totally 9 serials were used. In Section 6.8 and 6.9, only 4 series were used for regression analysis in these 9 series. The reason has been explained in the sections. However, additional data to 9 series in ANN were used, all data used for ANN are expressed in Section 6.7.

6.6 ADDITIONAL DATA FOR ARTIFICIAL NEURAL NETWORK

The data is used for regression analysis; all of them are utilized for artificial neural network. 9 series are taken from regression analysis. With this 9 series, additional data is used to calculate for artificial neural network. The time interval is the same that is 1996-2008 such as regression analysis. Only additional data is used, and totally we have 151 series to evaluate artificial neural network. When 9 series are already taken the same resource for regression analysis, source of 142(151-9) series are described with Table 6.3 and 6.4.

In Eviews program, data is required about their meaningful for regression analysis model. On the other hand, all of data is used for Artificial Neural Network, because the artificial network does not calculate, if data is non-meaningful. For this reason, data can be used not checked their meaningful for artificial neural network.

6.6.1 Data from The Conference Board for Artificial Neural Network

The same link is used for the Artificial Neural Network. The same link that is: http://www.conference-board.org/data/consumerconfidence.cfm from The Conference Board, and 8 tables that contains not only USA, there are different countries' data. 122 series are taken from this websites for ANN. Table 6.3 shows that number of series that are related with values of different countries.

Table 6.2: Data from the Conference Board for Artificial Neural Network

Table1. Customer Price Indexes (CPI) ** Note: 15-1(serial is taken from regression analysis)=14 series are used.*
Table2. CPI - based annual inflation rate ** Note: 15 series are used.*
Table3. CPI - based monthly inflation rate ** Note: 15 series are used.*
Table4. Change in CPI - based annual inflation rate ** Note: 15 series are used.*
Table5. Harmonized Indexes of Customer Prices (HCIP) ** Note: 15-1(serial is taken from regression analysis)=14 series are used.*
Table6. HCIP - based annual inflation rate ** Note: 15 series are used.*
Table7. HCIP - based monthly inflation rate ** Note: 15 series are used.*
Table8. Change in HCIP - based annual inflation rate ** Note: 15 series are used.*

Resource: http://www.conference-board.org/data/consumerconfidence.cfm

The time interval that is determines 1996- 2008.

6.6.2 Data from The United States Department of Labor For Artificial Neural Network

For artificial neural network, also 20 additional series are used from The United States Department of Labor website. The same link: http://www.bls.gov/cps/cpsatabs.htm is utilized. From website, data is Table 6.4:

Table 6.3: Data from the United States Department of Labor for Artificial Neural Network

Table A-1. Employment status of the civilian population by sex and age [Numbers in thousands] Men, 16 years and over de Civilian non institutional population (Not seasonally adjusted) ** Note: 1 serial is used.*
Table A-1. Employment status of the civilian population by sex and age [Numbers in thousands] Women, 16 years and over de Civilian non institutional population (Not seasonally adjusted) ** Note: 1 serial is used.*
Table A-1. Employment status of the civilian population by sex and age

[Numbers in thousands] Women, 20 years and over de Civilian non institutional population (Not seasonally adjusted) ** Note: 1 serial is used.*
Table A-1. Employment status of the civilian population by sex and age [Numbers in thousands] Both sexes, 16 to 19 years de Civilian non institutional population (Not seasonally adjusted) ** Note: 1 serial is used.*
Table A-2. Employment status of the civilian population by race, sex, and age [Numbers in thousands] BLACK OR AFRICAN AMERICAN Employment-population ratio(Seasonally adjusted) ** Note: 1 serial is used.*
Table A-2. Employment status of the civilian population by race, sex, and age [Numbers in thousands] WHITE Employment-population ratio Seasonally adjusted ** Note: 1 serial is used.*
Table A-3. Employment status of the Hispanic or Latino population by sex and age [Numbers in thousands] HISPANIC OR LATINO ETHNICITY de Employment-population ratio (Seasonally adjusted) ** Note: 1 serial is used.*
Table A-9. Selected employment indicators [Numbers in thousands] AGE AND SEX de Men, 16 years and over (Seasonally adjusted) ** Note: 1 serial is used.*
Table A-9. Selected employment indicators [Numbers in thousands] AGE AND SEX de Women, 16 years and over (Seasonally adjusted) ** Note: 1 serial is used.*
Table A-11. Unemployed persons by reason for unemployment [Numbers in thousands] UNEMPLOYED AS A PERCENT OF THE CIVILIAN LABOR FORCE New entrants(Seasonally adjusted) ** Note: 1 serial is used.*
Table A-16. Persons not in the labor force and multiple jobholders by sex, not seasonally adjusted [Numbers in thousands] NOT IN THE LABOR FORCE Total not in the labor force (Total) ** Note: 1serial is used.*
Table A-16. Persons not in the labor force and multiple jobholders by sex, not seasonally adjusted [Numbers in thousands] MULTIPLE JOBHOLDERS Total multiple jobholders(Total) ** Note: 1 serial is used.*
Table A-16. Persons not in the labor force and multiple jobholders by sex, not seasonally adjusted [Numbers in thousands]

NOT IN THE LABOR FORCE Persons who currently want a job(Total) ** Note: 1serial is used.*
Table A-16. Persons not in the labor force and multiple jobholders by sex, not seasonally adjusted [Numbers in thousands] NOT IN THE LABOR FORCE Marginally attached to the labor force(Total) ** Note: 1 serial is used.*
Table A-16. Persons not in the labor force and multiple jobholders by sex, not seasonally adjusted [Numbers in thousands] NOT IN THE LABOR FORCE Discouraged workers(Total) ** Note: 1serial is used.*
Table A-16. Persons not in the labor force and multiple jobholders by sex, not seasonally adjusted [Numbers in thousands] NOT IN THE LABOR FORCE Other persons marginally attached to the labor force(Total) ** Note: 1serial is used.*
Table A-16. Persons not in the labor force and multiple jobholders by sex, not seasonally adjusted [Numbers in thousands] MULTIPLE JOBHOLDERS Primary job full time, secondary job part time (Total) ** Note: 1serial is used.*
Table A-16. Persons not in the labor force and multiple jobholders by sex, not seasonally adjusted [Numbers in thousands] MULTIPLE JOBHOLDERS Primary and secondary jobs both part time(Total) ** Note: 1serial is used.*
Table A-16. Persons not in the labor force and multiple jobholders by sex, not seasonally adjusted [Numbers in thousands] MULTIPLE JOBHOLDERS Primary and secondary jobs both full time (Total) ** Note: 1serial is used.*
Table A-16. Persons not in the labor force and multiple jobholders by sex, not seasonally adjusted [Numbers in thousands] MULTIPLE JOBHOLDERS Hours vary on primary or secondary job(Total) ** Note: 1serial is used.*

Resource:http://www.bls.gov/cps/cpsatabs.htm

6.7 RESULT OF DATA FROM THE UNITED STATES CENSUS

The first example is from United States Census. It is about New Residential Construction. The values are from 'Authorized by Building Permits' on New Housing Units column. Two series can be entered on the EViews program and estimation is

done. Some information is given about the EViews, and regression analysis in Section 6.3.

Table 6.4: Result of housing units

	Variable	Coefficient	Probability	Prob.(LR statistic) Model
Serial	C	0.275001	0.3666	0.004471
	Housing Units	0.000615	0.0041	

Resource: Eviews Program

The dependent variable is showed in the result table. For the meaningful of the regression analysis, Probability Value is checked. According to confidence interval, probabilities of variables are less than 0.05. Therefore, in this model, variable is not meaningful. For the meaningful of model, Prob.(LR statistic) is less than 0.05. On the other hand; model is meaningless. The equations are:

$$BUSINESSCYCLES = \beta_1 + \beta_2 \, HOUSINGUNITS + U \qquad (6.1)$$

$\boldsymbol{\beta_1}$: When HOUSINGUNITS is constant, BUSINESSCYCLES increases 0.3666. (Coefficient)

$\boldsymbol{\beta_1}$: If HOUSINGUNITS increases 1 unit BUSINESSCYCLES increases 0.0041. (Coefficient)

Another topic is correlation that is dispersed between -1 and 1.In statistics, correlation specifies direction and strength of linear relationship of two random variables. Thanks to it, inferences can be done about relationship of variables. If values are positive, this situation shows linear relationship has straight direction. Antithetically, if values are negative, this result shows linear relationship has reverse direction. In all of examples, correlation is showed.

For Correlation, this way is followed in EViews program: Quick→Group Statistics Correlations. From United States CENSUS, correlations of data that is called New Privately Owned Housing Units Authorized by Building Permits in Permit-Issuing Places and business cycles in Table 6.6:

Table 6.5: Business cycles and housing units correlation

	Business Cycles	Housing Units
Business Cycles	1.000000	0.231401
Housing Units	0.231401	1.000000

Resource: Eviews Program

This comment can be done that correlation which is between Housing Units and Business Cycles is0.231401. Therefore, the magnitude of correlation is 0.231401, and it has linear relationship which its direction is straight. Correlation is important to separate risk for optimal portfolio.

6.8 RESULT OF DATA FROM THE UNITED STATES DEPARTMENT OF LABOR

Values of probabilities must be checked to understand whether the model is meaningful or not. For this reason, probabilities have to be less than 0.05. The result can be seen that the model is statistically meaningful.

The business cycle and these data is taken from BLS. These series are entered to the EViews program. The model and variables are meaningful. For this reason, to evaluate regression analysis, only 4 series are used in Table 6.6.

In the BLS, examples are population that Less Than a Bachelor Degree, College Graduates Job Losers as a Percent of Total Unemployed. The last example from BSL is about Employment-Population Ratio, and people who are age of 16 and over, are examined.

The business cycle and these data are entered to the EViews program. The result can be seen in Table 6.7:

Again, the probabilities of variables and model are meaningful. Because, the value of 0.05 is checked.

Table 6.6: Regression Result

	Variable	Coefficient	Probability	Prob.(LR statistic) (Model Probability)
Serial-1	Less Than a Barchhelor Degree	0.282388	0.0041	
	C	-18.74185	0.0065	0.002546
Serial-2	College Graduates	0.378231	0.0027	
	C	-27.92973	0.0038	0.000925
Serial-3	Job Losers	-0.146728	0.0001	
	C	8.495650	0.0000	0.000017
Serial-4	Sixteen and Over	0.449235	0.0101	
	C	-27.22480	0.0133	0.007100

Resource: Eviews Program

In addition, for all of four examples, estimating of correlations can be seen below. In this way, relationship between independent and dependent variables can be easily understood.

The correlation of first example is in Table 6.8:

Table 6.7: Variables and cycles correlations

Less Than a Bachhelor Degree	0.243096
College Graduates	0.245820
Job Losers	-0.334055
Sixteen and Over	0.216403

Resource: Eviews Program

This comment can be written that correlation which is between Less Than a Bachelor Degree data from The Bureau of Labor Statistics and business cycle is 0.243096So, the magnitude of correlation is 0.243096, and its direction is straight.

The correlation between College Graduates data from BLS and business cycle is 0.243096. So, the magnitude of correlation is 0.245820 and its direction is straight.

The correlation between Job Losers data from The BLS and business cycle is -0.334055. So, the magnitude of correlation is 0.334055, and its direction is reverse.

This comment can be understood that correlation which is between Sixteen and Over data from The BLS and business cycle is 0.216403. So, the magnitude of correlation is 0.216403, and its direction is straight. The reason of correlation calculation was to understand the relationship of financial instruments in the same portfolio, and the main reason was to reduce possible risk. Thus, to create optimal portfolio, these correlation results can provide us to commend about portfolio risk created.

6.9 DIFFERENT RESULTS OF ARTIFICIAL NEURAL NETWORK WITH USING DIFFERENT NUMBER OF HIDDEN LAYERS, NEURONS AND PERCENTAGE OF TRAINING, TEST AND VALIDATION OF NETWORK

First of all, there is different Artificial Neural Network software can be found. In this thesis, Neuro Solutions for Matlab was used.

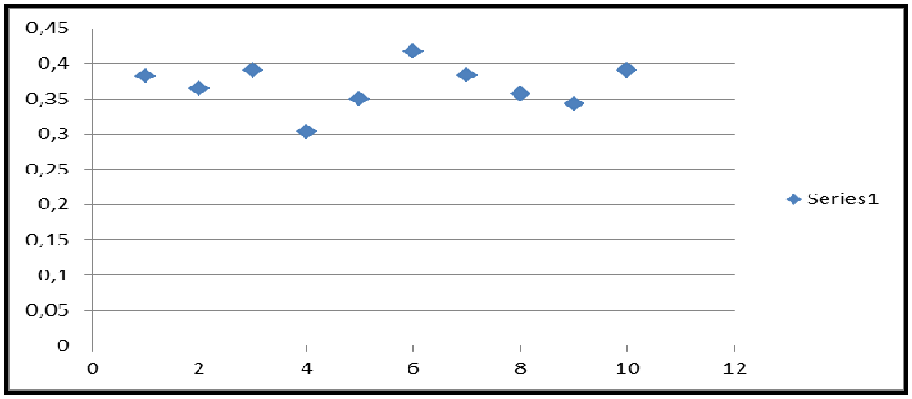
To start process, input and output data loaded to the Neuro Solutions for MATLAB. Input data have 151 samples, and these are related with different topics between each other. As shown in Chapter 4 - Data and Methods, data is taken from The Conference Board, United States Department of Labor (The Bureau of Labor Statistics (BLS). Also, output is business cycles, and its time interval in this thesis. Therefore, time interval is 13 years between 1996 and 2008. While input is worked in network, the result compares to the target.

6.9.1 Different Performance Ratio With The Same Network

The most important disadvantage of artificial neural network is obtaining no certain result. Every trying has different numeric value, so trial and error is the one way to get good result. Even the network is not changed, the result can evolve. According to the function of network, network performance is evaluated. In this thesis, network performance is calculated based on Mean Squared Error (mse).With using *for* loop, a lot of iterations can be worked. In MATLAB Neural Network Solutions with using this code, 10 different performance ratios can be seen as:

```
for a=1:10;
net=feedforwardnet([20 20])
net=train(net,input',output')
netq{a}=net;
y=net(input')
perf(a)=perform(net,output',y')
display(perf)
a=a+1;
end
```

Figure 6.1: Distribution of Network Performance Ratio



Resource: Excel

With using *for* loop, different performance ratio is found. This network has *feed forward,* 2 hidden layers with 20 neurons. As shown in Figure 6.1, network performance ratio can change.

In addition to the performance ratio, there is no exact number of hidden layers, neurons and train ratio in ANN to get result of network. In part of 6.10.2, 6.10.3 and 6.10.4, several examples are tried to see results of selecting several ways.

6.9.2 Effect of Number of Neurons in The Network

Neurons are fundamental issues in the network. Because, system takes input thanks to neurons like a human brain.

In the hidden layers, the number of neurons is absolutely important. According to the researchers, if the neurons' number is chosen too high, the performance rate is better than before. But, it should not be chosen huge number of neurons, because neurons optimize inputs, so if huge numbers of neurons are selected, the process doesn't work. Neurons do not find the input to optimize it.

Input and output data is embedded to the network. In this research, Feed Forward Neural Network (FFNNs) is used. Then, firstly, network is created with this keyword:

net=feedforwardnet([55])

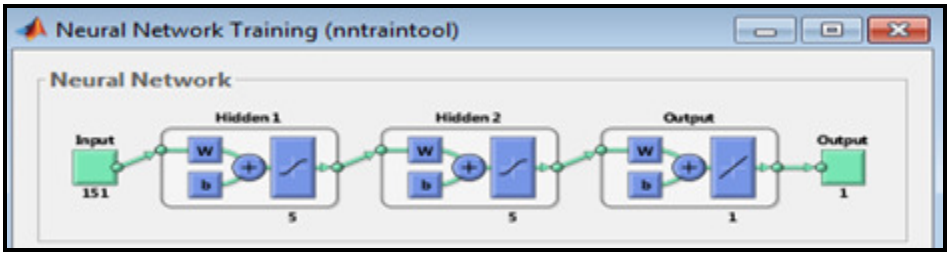
In this statement; two hidden layers are happened and every layers have 5 neurons in the network and their ratio of train, test and validation is respectively: 0.5, 0.25 and 0.25.

Then, *train* function is worked with this keyword:

net=train(net,input',output')

The network result is:

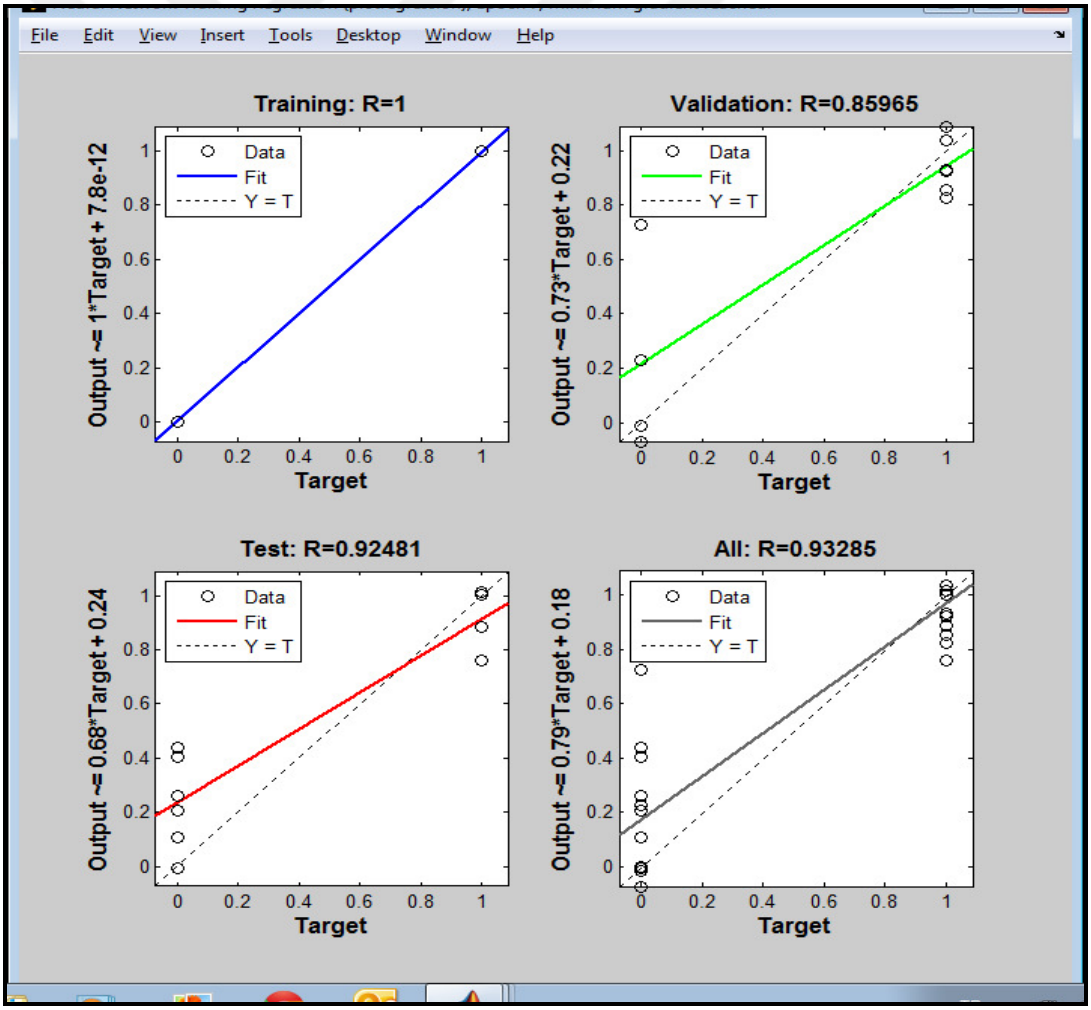
Figure 6.2: Network result-1



Resource: NeuroSolutionsfor MATLAB

The regression result is:

Figure 6.3: Regression result of network-1



Resource: NeuroSolutionsfor MATLAB

Firstly, we put input and target data. Input data consists of 151 series, and target data are the cycles that are taken from NBER websites and it is between 1996 and 2008. ANN is used for this data and it gives result plots.

According to the regression plot, Figure 6.3, we can see harmony between target and data that is used. For example, we can look part of Test, and it has an equation:

$$Output = 0.68 * Target + 0.24$$

If we put the data in the equations thanks to graphical value (x *and* y *axis*), we can see that how can be fit with this target and output data, and $R = 0.92481$,, this result shows that prediction has a high rate.

If the result value is bigger than 0.9, it means that it is a good result. So, R value is 0.93285.

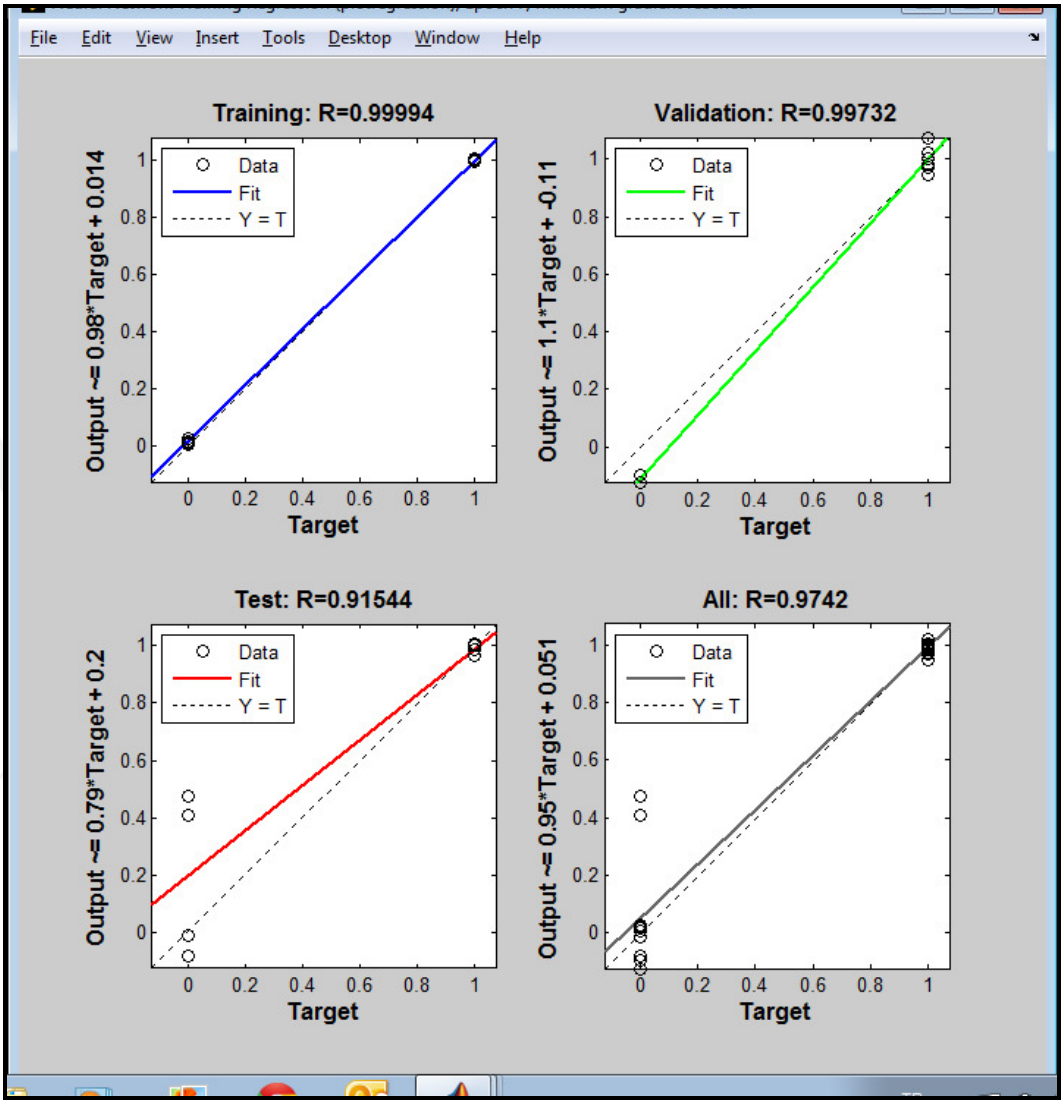
It's mse result is:

```
>>pef=mse(net,output',y)

pef =

  0.0334
```

On the other hand, if neurons are chosen more than 5 neurons, better result is achieved in the Figure 6.4 with 20 neurons with the same ratio of train, test and validation is respectively: 0.5, 0.25 and 0.25.So, only neurons are increased.

The regression result is with 20 neurons:

Figure 6.4: Regression result of network-2



Resource: NeuroSolutionsfor MATLAB

Abrupt and smooth line shows the closeness between output and target data. For example; part of Training, these lines nearly the same. So, when we look the $R = 0.99994$. Accuracy is high. On the other hand; part of Test, this rate decreases and also, the $R = 0.91544$.. If we put the values that are seen on graph, in the equations, we can see the proximity between target and output data.

If we want to evaluate mse value:

>>perf=mse(net,output',y)

perf =

0.0120

In Figure 6.4, the value of R = 0.9742 is goes up with more than additional number of neurons.

Also, when value of *mse* is checked, it is 0.0334 for the first network, 0.0120 for the second network. So, while R value increases, the *mse* value decreases.

6.9.3 Effect of Number of Hidden Layers in The Network

As number of neurons, hidden layers' number is also important to see better result. The first step is to create network. So, the second step is to determine number of neurons and hidden layers.

First of all, only two hidden layers with 10 neurons are created. Then, train process '*net=train(net,input',output')'* is worked. Then, we can see the regression plots.

For the evaluate *mse* value:

>>perf=mse(net2,output',y)

perf =

0.0164

Another example has three hidden layers with 10 neurons are created, and it's *mse* value

>>perf=mse(net5,output',y)

perf =

2.3373e-04

Therefore, increasing of hidden layers, *mse* value decreases.

Also, when the regression plot is calculated:

Table 6.8: Regression Plot of Different Number of Hidden Layers

	Two hidden layers with 10 neurons	Three hidden layers with 10 neurons
Regression Result:	All: $R = 0.96402$	$All: R = 0.99956$

Resource: NeuroSolutionsfor MATLAB

Regression plot has three different parts that are Training, Validation and Test. Therefore, *All* is contain all of these three dimensions. As we can see that three hidden layers *R* value is higher than two hidden layers.

6.9.4 Comparative Results With Different Ratio of Train Parameters In The Network

Train process has three different evaluations types that are *train, test* and *validation*. In the train process, if ratio of these evaluations types can be changed by keywords, different result can be seen.

```
>>net.divideParam
ans =
   Function Parameters for 'dividerand'
   Training Ratio trainRatio: 0.7
   Validation Ratio valRatio: 0.15
   Test Ratio      testRatio: 0.15
```

And the result is with 2 hidden layers and 20 neurons:

```
>>perf=mse(net,output',y)
perf =
      0.0430
```

In the same hidden layers and number of neurons, only the ratio is changed:

>>net.divideParam

ans =

Function Parameters for 'dividerand'

Training Ratio trainRatio: 0.5

Validation Ratio valRatio: 0.25

Test Ratio testRatio: 0.25

>>perf=mse(net3,output',y)

perf =

0.0120

The result is in Table 6.10:

Table 6.9: Regression Plot Different Ratio of Train Parameters

	Train Ratio: 0.7 Val Ratio: 0.15 Test Ratio: 0.15	*Train Ratio: 0.5* *val Ratio: 0.25* *test Ratio: 0.25*
Regression Result:	All:$R = 0.93227$	$All: R = 0.9742$

Resource: NeuroSolutionsfor MATLAB

Therefore, ANN is not exact way to get the best result. In the examples above, selecting different number of neurons, hidden layers and determining varied *train, test and validation* interval affect the result. In the section of 5.2MODELLING OF ARTIFICIAL NEURAL NETWORK, some information has been given to choose different number of neurons and hidden layers for better results. According to this information, these situations have been tried using several examples.

6.10 COMPARISONOF THE RESULTS OF REGRESSION AND ARTIFICIAL NEURAL NETWORK

The aim is to predict the last 5 years with using the first 8 years, and then to compare result of regression analysis and artificial neural network with some calculations. This section shows thesis result of regression and artificial neural network.

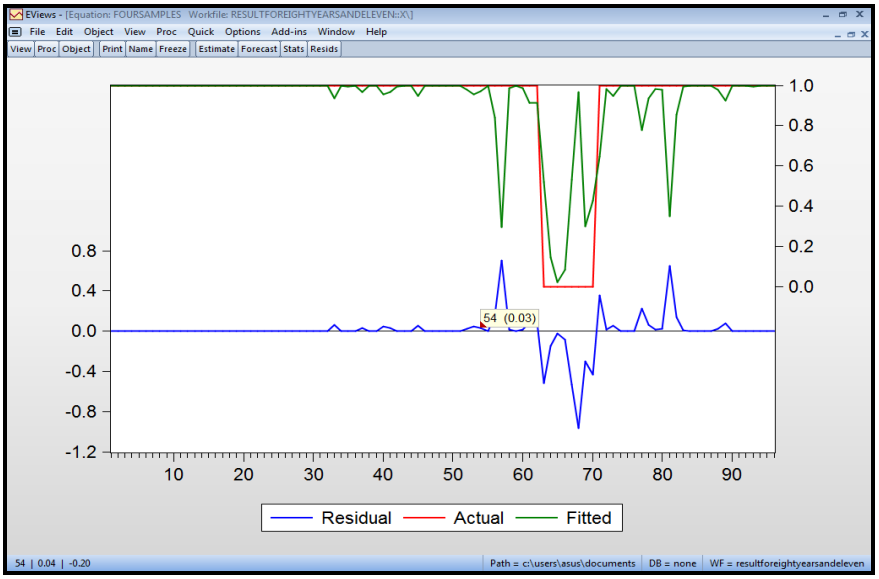
Firstly, several graphs are showed both of regression analysis and artificial neural network. Then, regression and ANN was compared by some dimension.

6.10.1 Regression Analysis of Result Graphs

Only four samples are examined for meaningful of variables and model. Meaningfulness is determined by the confidence interval that is 0.05. For this reason, the probability of variable and model is lower than 0.05. Therefore, four samples are studied to understand regression analysis from series.

Comparison of actual variable and variable worked on were studied and total 96 observations in the first 8 years is seen graphic image in the Figure 6.5:

Figure 6.5: Fitted, Residual, Actual Graph

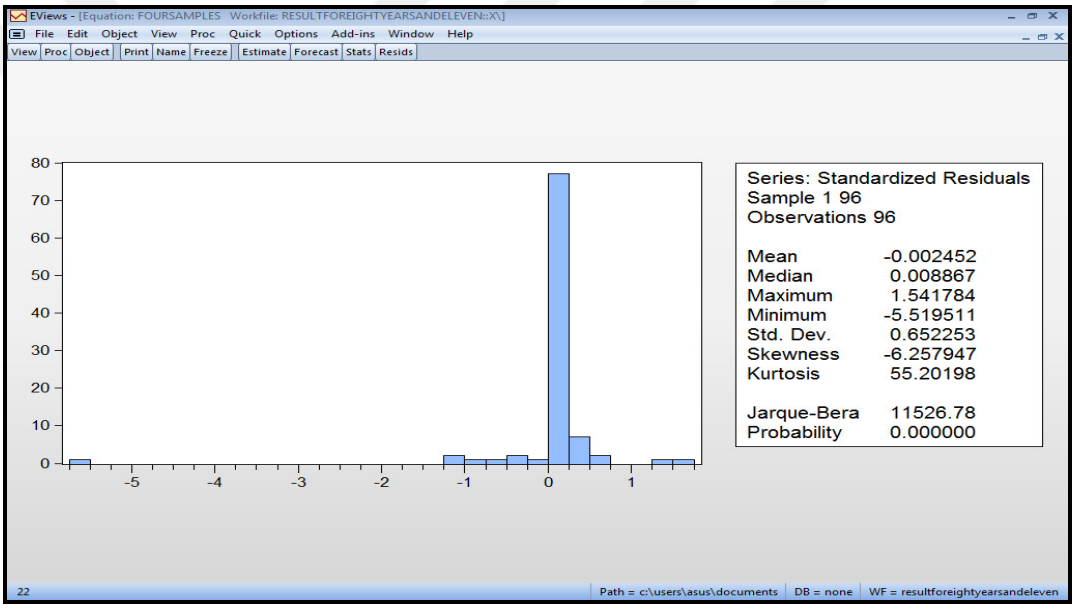


Resource: Eviews Program

From this Figure; *Fitted* + *Residual* = *Actual* equation shows the difference between actual and fitted data. In Figure 6.5, *residual* data is added the *fitted* data, we can see the *actual* data line. So; variables that are used, how was the proximity with the actual variables.

From the Figure 6.6; *mean, median, standard deviation* can be seen for four samples. Also; for example *skewness*, if it is higher than zero, it can right tilted, if not, left tilted. In the graph below; it is left tilted.

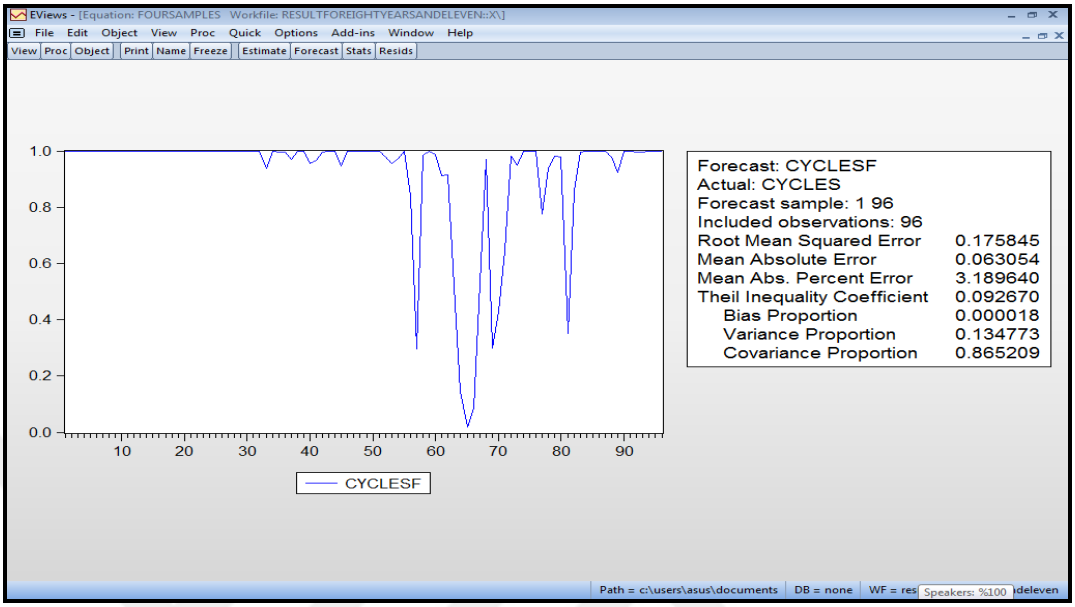
Figure 6.6: Calculations



Resource: Eviews Program

In the Figure 6.7; forecast graph can be showed.

Figure 6.7: Forecast Graph



Resource: Eviews Program

Four series are used that are 'College Graduates, Job Losers, Less Than a Barchhelor Degree and 16 and over'. According to the regression equations thanks to Eviews Program and NORMDIST function with Excel, the result from these 4 series are evaluated month by month in the last 5 years. Then, target and evaluations are compared and several calculations are done. The result is:

The *mse* value of regression analysis is: 0.216667.

The forecast is 73.33 %.

6.10.2 Artificial Neural Network of Result Graphs

In regression analysis, last 5 years are selected. For this reason, network cannot perform randomly. Series are evaluated rankly. Therefore, this keyword is written:

[net.divideParam.trainInd,net.divideParam.testInd,net.divideParam.valInd]=divideind(156,1:96,97:156,[])

'Ind' means that these series are calculated rankly. Such as a regression analysis, first 8 years are training nd then last 5 years are predicted. Then, observation interval is

determined. By the same way, train, test and validation ratio are arranged such as below:

net.divideParam.trainRatio=0.615

net.divideParam.testRatio=0.385

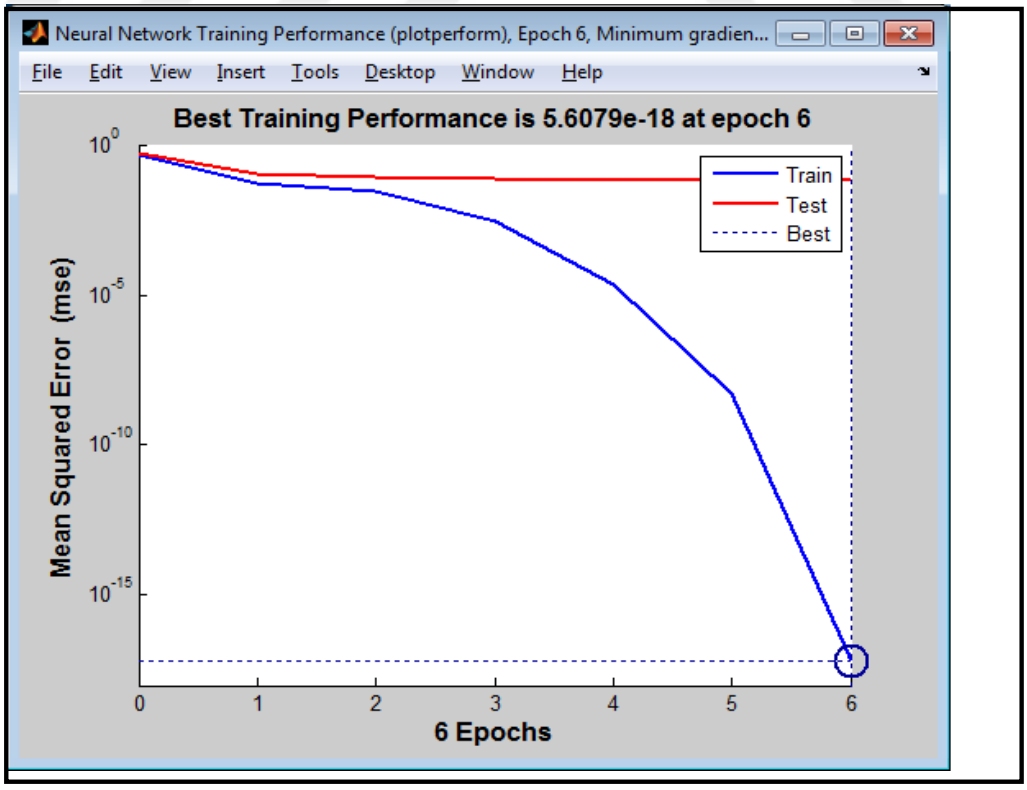
net.divideParam.valRatio=0

By this way, last 5 years are tested and predicted.

In Section 6.10, different number of neurons, hidden layers and percentage of train, test and validation can be determined. In the result, 2 hidden layers and 20 neurons are used with trial and error to provide high accuracy rate.

For the result, 6 iterations are done by the ANN. Then, the best training performance graph is in Figure 6.8. It is the performance graph.

Figure 6.8: Best Training Performance

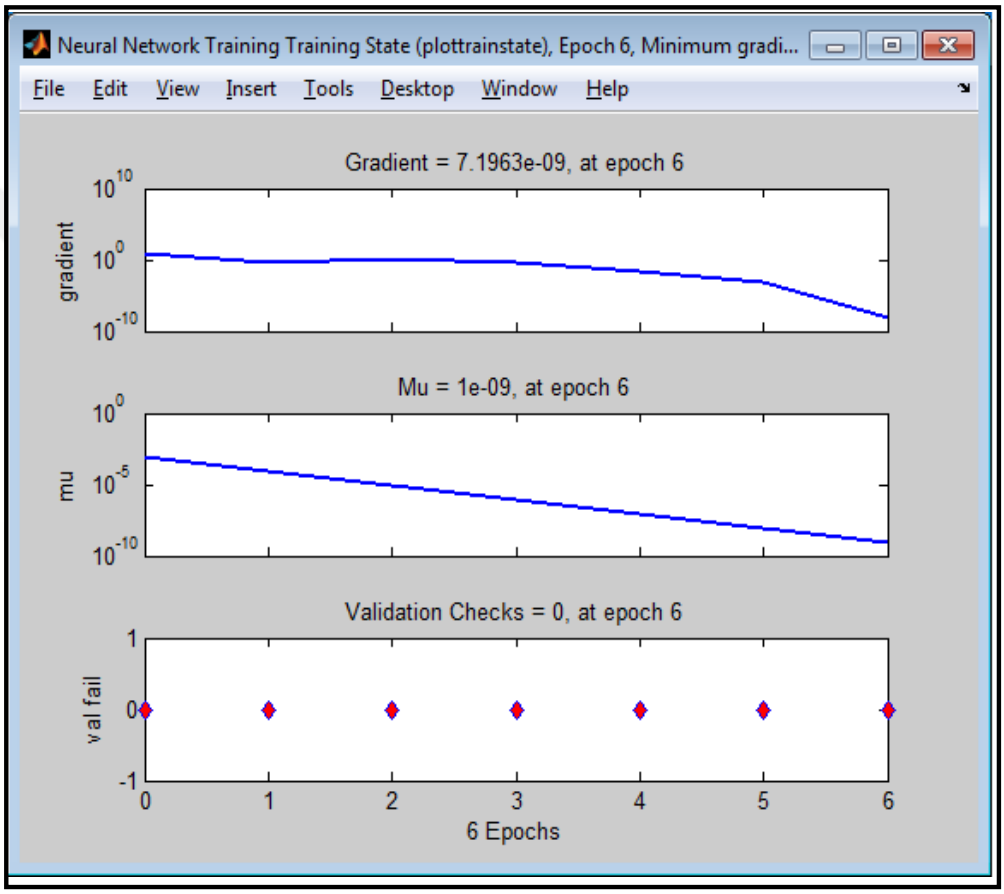


Resource: NeuroSolutionsfor MATLAB

In Figure 6.9, validation is minimum in the circle. In the graph, there are 6 iterations. The aim of the graph is showing where validations performance is minimum.

Training State graph describes the progress of the other training variables.

Figure 6.9: Network Training State



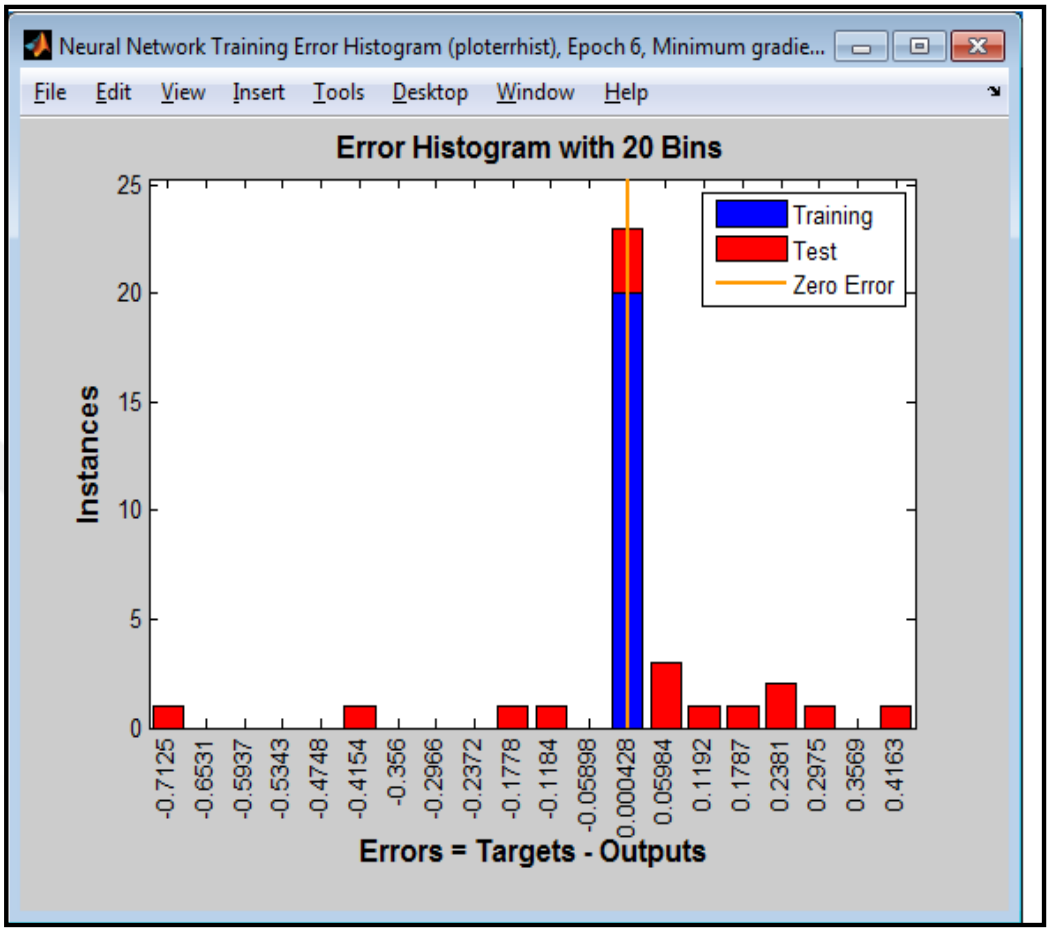
Resource: NeuroSolutions for MATLAB

The gradient is about minimum of the performance and when training will stop. According to the Mathwoks (www.mathworks.com) "If the magnitude of the gradient is less than 1e-5, the training will stop".

The validation checks number shows successive iterations while performance of validation falls through to decrease.

Error Histogram Graph shows the distributions of error in network that is showed in Figure 6.10:

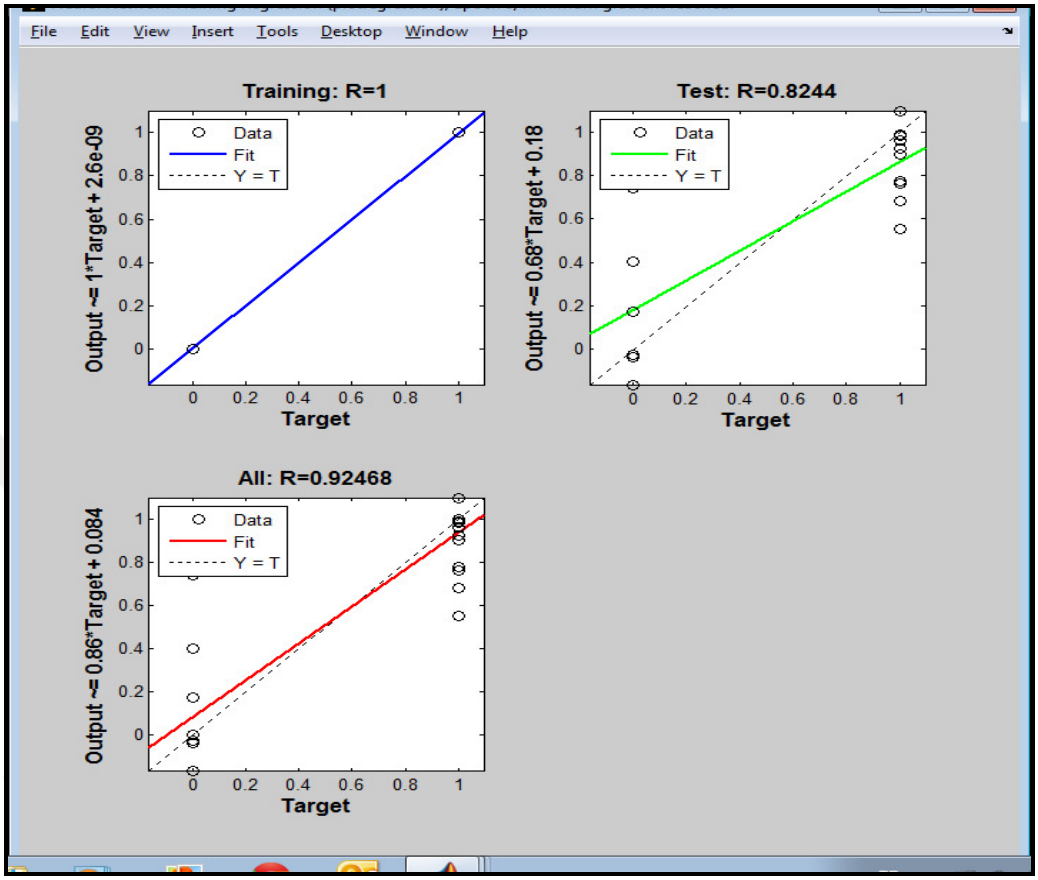
Figure 6.10: Error Histogram Graph



Resource: NeuroSolutions for MATLAB

Regression Graph shows the relationships between outputs and targets of the network that is created. In the solid line, best fit linear regression line is understood by using outputs and targets in Figure 6.11:

Figure 6.11: Regression Result of ANN



Resource: NeuroSolutionsfor MATLAB

The value of *mse*:

>>perf=mse(net,output',y)

perf =

0.0335

Table 6.10: Comparison Regression Analysis And Artificial Neural Network

Regression Analysis	Artificial Neural Network
mse: 0,216667.	mse: 0.0335
percentage of accuracy: % 73,33.	percentage of accuracy: % 92

In the Table 6.10, the artificial neural network has better performance.

7. COMMENTS AND FUTURE WORKS

In this thesis, to predict the stock market business cycles, regression analysis and artificial neural network have been used. Transitions of states are performed by Markov model. Macroeconomic variables were studied to predict the real market states because real market states are not observed. In this study, two analyses which are named as regression analysis and alternatively artificial neural network are carried out. Finally, results of two analyses were compared. According to the results, these evaluations show that artificial neural network provided better result than regression analysis.

This study was worked based on Markov portfolio approach and macroeconomic variables which were selected from USA values. Moreover, shape ratio with regime switching is very important. Because, if investors are noticed the results of shape ratio, these situations can be beneficial for true investment. For this reason, portfolio approach can have better prediction with using shape ratio. Therefore, the results were related with the stock market of USA. The contribution of this study, when investors aim to invest in USA, probability of stock market's situations can be predictable thanks to regression analysis and artificial neural network.

Artificial neural network has become a beneficial approach and it has very wide areas. It also has a lot of advantages. For example, neurons work concurrent and if one neuron does not work, the system cannot work. Therefore, ANN use examples and it learns them like a human brain and this system works like a human brain. In addition to that, ANN can do classification of these examples and it can associate other examples. On the other hand, some disadvantages are the critical issues. For example, there is no a certain way to achieve the best results. There is also no rule to determine construction of network. Furthermore, when this network is finished is not known. So, these disadvantages are important and future works about these situations should be carried out.

Moreover, as we know that artificial neural network is used to analysis time series. Because of the state changes not observed, evaluation of certain circumstance was studied with macroeconomic variables. For this problem, stock market prediction can be

studied based on Hidden Markov Model with using artificial neural network. This model can be contributed to the problem. ANN and regression analysis can be evaluated together. Thus, certain and true information become an aim for the stock values.

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