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FORECASTING OF TURKEY'S UNEMPLOYMENT RATE FOR FUTURE PERIODS WITH ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

In world economies, in order to achieve high national income level, employment has an important effect. Therefore, it is necessary for unemployment to be highly low. Labor force structure of a country specifies the state of that country, and that unemployment rates are at high levels is an indicator of that there is a deviation in the development and growth rate of country economy. In this context, forecasting unemployment rates in the next periods of Turkey, in order to develop solution suggestions for unemployment problem which is one of the most important problems of today, and make contribution to improving country economy, it was decided to conduct such a study. In this forecasting study conducted, due to the fact that the risk to obtain wrong results with traditional methods is high in the solutions of chaotic contented problems, it was decided to be used ANN (Artificial Neural Network) method, which presents healthy solutions of the chaotic problems including partly erroneous or over deviating data and is one of the contemporary methods, commonly used in the literature. In the study, utilizing the monthly basic economic indicators of Turkey belonging to the period of 2005-2018, forecast of unemployment rate for the next periods was made by ANN method, and the data belonging to totally six basic economic indicators were used in the forecast. As a conclusion of the study, it was identified that the forecast made by the model developed produced the reliable results that are quite close to the reality.

Keywords: Artificial Neural Networks, Forecasting, Unemployment, Error Tests.

Jel Codes: C45, J2, R22.

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YAPAY SİNİR AĞLARI YÖNTEMİYLE TÜRKİYE'NİN GELECEK DÖNEM İŞSİZLİK ORANI TAHMİNİ

ÖZ

Dünya ekonomilerinde yüksek milli gelir düzeyine erişebilmek için istihdam önemli bir etkiye sahiptir. Bu nedenle işsizliğin oldukça düşük olması gerekmektedir. Bir ülkenin işgücü yapısı o ülkenin iktisadi durumunu belirtmekte olup işsizlik oranlarının yüksek düzeylerde olması, ülke ekonomisinin kalkınma ve büyüme oranlarında bir sapma olduğunun göstergesidir. Bu bağlamda, Türkiye'nin gelecek dönemleri için işsizlik oranı tahmini yapılarak günümüzün en önemli problemlerinden birisi olan işsizlik sorununa çözüm önerileri geliştirmek ve ülke ekonomisinin iyileştirilmesine katkı sağlamak amacıyla geleceğe yönelik böyle bir araştırma yapılmasına karar verilmiştir. Yapılan bu tahmin çalışmasında; kaotik içerikli problem çözümlerinde geleneksel yöntemlerle yanlış sonuçlar elde etme riskinin yüksek olmasından dolayı, kısmen hatalı veya aşırı sapmalı verilerin bulunduğu kaotik problemlerin çözümünde sağlıklı çözümler sunan ve literatürde yaygınca kullanılan çağdaş yöntemlerden birisi olan YSA metodunun kullanılmasına karar verilmiştir. Çalışmada, Türkiye'nin 2005-2018 yıllarına ait aylık temel ekonomik göstergelerinden yararlanılarak gelecek dönem için işsizlik oranı tahmini YSA yöntemiyle yapılmış, tahminde toplam altı temel ekonomik göstergeye ait veriler kullanılmıştır. Çalışma sonucunda, geliştirilen modelinin yaptığı tahminin gerçeğe oldukça yakın ve güvenilir sonuçlar ürettiği tespit edilmiştir.

Anahtar Kelimeler: Yapay Sinir Ağları, Tahmin, İşsizlik oranı, Hata Testleri.

Jel Kodları: C45, J2, R22

INTRODUCTION

In world economies, in being able to achieve high national income level, employment has an important effect. Therefore, it is necessary for unemployment to be highly low. Labor force structure of a country indicates economic state of that country. If unemployment rates are seen to be at high level, this [case] shows that there is a deviation in the development and growth targets of that economy. Shortly, unemployment is the case that there are those demanding to work even at the low level of wage paid for employees through employers in market but in spite of this, that there are unemployed people (Guris and Yaman, 2018). Although the concepts related to unemployment are defined by national and international official organizations in detail, in general, unemployed is called for individuals, who take place in active population, have ability and desire to obtain job and income at the level of current wage, and seek job but cannot find it (Gur, 2017).

One of the main economic problems of the developed, developing, and less developed countries is unemployment. One of the struggle methods to be applied in eliminating unemployment is also to the selection of the relevant policies. Unemployment is a versatile problem countries face to. Depending on increase of this problem, many troubles appear from social and economic aspects. Especially in crisis periods, it leads the existing problems of country economies to gradually proliferate and bad course to accelerate. Unemployment rate is one of the most important indicators of the development level and economic power of a country.

Therefore, countries mostly taking care of general economic policies they apply to unemployment problem, have to produce policies targeting to reduce unemployment problem to minimum level.

In this context, forecasting the unemployment rates of Turkey for the next periods, solution ways can be found for unemployment problem and made contribution to improving country economy. As a result of literature view made, in this sort of forecast studies, namely, in the solution of chaotic problems including erroneous and over deviated data, it was identified that the method of Artificial Neural Networks (ANN) was mostly used.

ANN is a computer system, which normally needs the abilities of human being to think and observe, can virtually realize learning process by means of advanced computer technologies, and uses nonlinear relationships between input and output for this (Sevinctekin, 2014), can discover and produce new information thanks to learning ability that is one of the feature of human brain (Ballı, 2014). ANN is an information processing method, which emerges with the thought to imitate the working principles of human mind, focuses on algebraically shaping biological neurons (Efe and Kaynak, 2000), and incorporates the same features as biological neural networks (Fausett, 1994).

ANN is n nonparametric and flexible modelling instrument (Tang and Chi, 2005) and was developed by imitating cognitive learning process of the mind. Since it has a highly important effect in the solution of complex problems, it can be easily used in solving many problems such as forecasting and clustering ANN, setting out from the past information in complex systems, has ability to solve problem via learning through examples (Efendigil et al., 2009).

Due to the fact that the risk to obtain wrong results with traditional methods or that they show excessive deviations, the solutions of chaotic-contented problems are not appropriate (Hu, 2002), and ANN, one of contemporary methods, is preferred in solution of chaotic problems including missing, partly erroneous, and over deviated data ANN can learn complex relationships, make generalizations, and thus, find solutions for not encountered earlier with acceptable error margins (Ozalp and Anagun, 2003). Due to these features, at the present time, it can be commonly used in a number of engineering applications and forecasts.

In this study, first of all, the relevant definitions were made and, later, making a broad literature review, those being appropriate were summarized and, in application part, utilizing the existing data of basic economic indicators, the forecast of unemployment rate for the next period of Turkey was made by ANN method. In order to test the reliability and validity of the data obtained from the study, the most commonly used error tests in the literature were again made, and positive results were obtained.

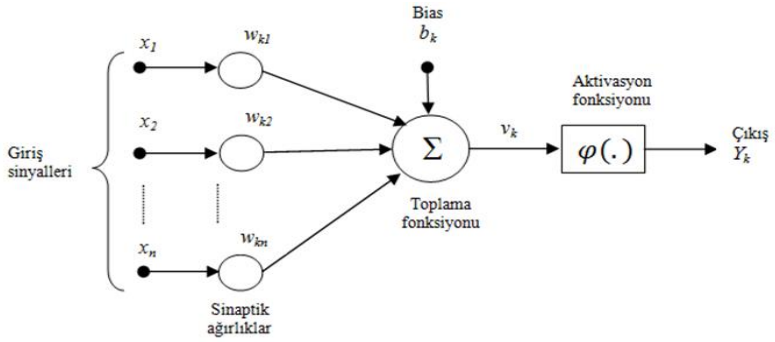
I. ARTIFICIAL NEURAL NETWORKS

Artificial neural networks is an information processing system, which emerges with the opinion that the working principles of human brain are imitated on digital computer, which concentrates on mathematically modelling biological neurons, and includes features similar to biological neural networks (Fausett, 1994; Efe and Kaynak, 2000).

ANN is a system consisting of interconnected artificial neural cells. Artificial neural cells, developed by mathematically modelling the run of biological neural cells, consist of simple elements termed as neuron. Signals are transmitted by connections between neurons, and each connection between neurons has a weight value; each neuron has a network output; and it is necessary for each network input to be passed through activation function (Hamzacebi, 2011).

A neural network model forming the essence of artificial neural networks is mathematically in Figure 1 as follows:

Figure 1: Mathematical Indication of Artificial Neural Network Model



Resource: Haykin, 1999; Efendigil vd., 2009.

The input data $x_1, x_2, \ldots, x_n$, seen in Figure 1, are the synaptic weights of the neuron; $w_{k1}, w_{k2}, \ldots, w_{kn}$ k and are linearly combined inputs according to the input data. b_k bias is activation function $\varphi(.)$ and y_k is output signal of neural function. Bias linear combinatory b_k here affects output u_k in foreseen way. A neuron (k) can be mathematically as follows:

$$u_k = \sum_{j=1}^{m} w_{kj}\, x_j \qquad y_k = \varphi\,(u_k + b_k)$$

$$v_k = u_k + b_k \qquad y_k = \varphi\,(v_k)$$

In the structure of ANN, there are three components as neuron, connections and learning algorithms. Neuron is an element of basic process. Neurons taking place in network receive one or more than one inputs according to the factors affecting

problem and give output as many as the number of results expected from the problem. That neurons come together into each other through connections forms artificial neural network. In a general network system, that neurons come together in the same direction forms layers (Yildiz, 2001).

ANN is a flexible and nonparametric modelling instrument (Tang and Chi, 2005). ANN is known as a method developed by imitation of cognitive learning process of brain. Since it is a highly effective in complex problems, it can present easy solutions for many problems such as forecasting, classifying, and clustering. The most important feature of neural networks, setting out from the past information belonging to complex systems, is ability to solve problem via learning through the examples (Efendigil et al., 2009). Traditional methods are not appropriate for the data containing missing or over deviation due to risk to obtain the wrong results (Hu, 2002). ANN approach does not depend on the data and can even evaluate the missing and partly deviated data. Even if they can learn and generalize complex relationships and, thanks to this, they can find answers for the previously at all not encountered problems with an acceptable error (Ozalp and Anagun, 2003). Due to these superior features, nowadays, in many engineering applications and demand forecast, ANN models are commonly used.

II. LITERATURE REVIEW

Tufaner, M. B. and Sözen, İ. (2021), in this study, they estimated the unemployment rate for the future with ARIMA and ANN models for Turkey. As a result of the study, it has been argued that ANN is more successful than the ARIMA model in estimating unemployment, and the unemployment rate estimated by the developed model is very close to the truth.

Çakır and Bolakar Tosun (2021), in this study, estimated the number of railway passengers using the variables that are effective on railway passenger transport, with Multivariate Regression (MDR) analysis and ANN models. As a result of the study, it has been argued that the most appropriate estimation is obtained by ANN and ANN can be used as a source in demand estimations.

Etci and Karagol (2019), in this study conducted, presented a general evaluation for conceptual framework related to unemployment and employment and the variation of unemployment and employment statistics in the period of 2000-2018. All of data were obtained from World Bank. As a result of the study, considering the cases of Turkish economy, it was put forward that it was necessary to support producers and entrepreneurs for reducing unemployment, invest to qualified areas, enable the proper individuals, and exhibit an import substitution attitude in many sectors.

Akcan and Ener (2018), in this study conducted, utilizing the data published by TUIK and TCMB, attempted to account for the variations occurring in the unemployment rates between the years of 2000-2015 by means of variance analysis. With the dataset formed, the study model was established and, in econometric

analyses made, ARIMA and similar methods were used. In the study, as macro variables, the data of credit volume, interest rates, GDP, import, monetary supply, exchange rate, unemployment, export, and inflation were used. As a result of analysis made, it was identified that real exchange rate was the best criterion stating the variation in unemployment rate and, in addition, that the approach of the growth, inflation, and export to unemployment rate was positive directional for every period.

Guris and Yaman (2018) in this study conducted, targeted on identifying the criteria affecting unemployment by means of panel-data model and thus, determined which variables would be guiding for lowering unemployment rates. In the study, stationarities of the variables were examined by means of Panel Unit Root Tests and, for identifying that panel data model is random or constant effective, Hausman Test was made. It was identified that he macroeconomic variables used in the study were unemployment rate, economic growth, public expenses, agricultural production, industrial production, current account balance, budgetary deficit, interest rate, exchange rate, saving rate, inflation rate, inflation and tax.

Urfalıoglu and Tanriverdi (2018), in this study conducted, with the interest and exchange rate data between 2002 and 2015, using ANFIS and regression analysis methods, predicted inflation. In order to test the reliability of the results obtained from the study, RMSE and MAPE statistics were used and decided that forecasts were reliable.

Erol and Aytur (2017), in this study examined the effect of syndication in Turkey on unemployment, used syndication and unemployment data, which belong to the period 1988-2009, they drew from TÜİK and ÇSGB websites. As a result of analysis, made by EKK method, a significant relation could not be identified between unemployment and syndication; in addition, as a result of Granger Causality Test, applied to model, it was concluded that there was no causality from unemployment to syndication and from syndication to unemployment.

Kock and Terasvirta (2016), in this study conducted, predicted macroeconomic performances of the G7 and four Scandinavian countries by means of single hidden layer feed forward ANN model, using consumer price index dataset belonging to the years of 1960-2009. According to the results obtained from the study, it was put forward that using ANN model in the forecasts of countries could be useful but linear AR model could be a serious rival for ANN.

Yuksel and Akkoc (2016), in this study conducted, in order to predict gold prices by means of ANN method, used the data of silver prices, petrol prices, USD/EUR parity, Dow Jones Index, USD bond interest rate and CPI index, considered that they could affect gold prices. In the study, the data of 2885 days belonging to the period 2002-2013. Error tests, in which the real values were compared with forecast results by ANN, were assessed by means of statistics such as RMSE, MAE and MAPE and it was decided that the findings were reliable. At the end of the study, it was expressed that ANN method could be successfully used

in forecasting gold prices. In addition, according to the results of sensitivity analysis made, it was seen that the leading factor affecting gold prices were silver and oil prices.

Kahyaoglu et al., (2016), in this study conducted, using quarterly data belonging to 2001-2015 period, examined the validity of unemployment hysteria in EU countries and Turkey by means of the methods of time series and Panel data analysis. In the analysis made, since the dimensions of frequency and time are considered together, the presence of unemployment hysteria was predicted by means of techniques based on Fourier-ADF and Fourier-IPS approaches. According to the findings obtained from the study, in EU countries other than Italy, Spain, and Estonia, it was concluded that unemployment rates exhibited a linear structure and that unemployment hysteria was valid.

Sonmez et al., (2015), in this study conducted, artificial neural networks model was used to predict the internal resources and active profitability of deposit banks. In application, as of 2013, the data of 24 deposit banks being active in Turkey, which belong to four periods, was analyzed. According to the results obtained from the study, it was put forward that all variables used had effects in varying rates on profitability and that the forecasts made was successful at acceptable level.

Bayrakdar (2015), in this study researched whether or not unemployment hysteria was valid for Turkey, utilized the quarterly unemployment data, which belong to the period 2000-2013, he obtained TUIK database. In the study, Phillips-Perron, Augmented Dickey-Fuller, Kwiatkowski-Phillips-Schmidt-Shin and structural–fractured Lee-Strazicich unit root tests were used. According to the study results, in the time dimension examined, it was made the comment that the shocks being effective in unemployment engendered the permanent results, namely, that the presence of unemployment hysteria for Turkey was valid.

Akcalı (2015), in this study conducted in the light of crises experienced in the past in MIST countries, tried to predict the possibility to occur crisis in the next periods. In the study, dataset consisting of totally 500 observations was reached from the database of IMF and, utilizing the monthly data belonging to the period of January 1990 and December 2014, financial pressure indices of countries were formed. In the study, Box-Jenkins and ANN methods, frequently used in the analyses of time series, were utilized. According to the study results, it was put forward that the next index values of four European countries would be much lower than threshold values and, in these countries, the comment that the possibility to arise crisis in these countries in the period of December 2014-March 2015 was very low was made.

Erdogan and Ozyurek (2012), in this study conducted forecasting daily prices of white appliance of firms taking place in İMKB 100 Index by means of ANN, aimed to contribute to the literature. In the study, the factors affecting the prices of stock were determined by making literature review, and the data belonging

to the factors were drawn from IMKB resource. Model was designed by means of MATLAB software, and forecast results and applicability of the model was tested, and positive results were obtained.

Goktas and Isci (2010) in this study conducted, aimed to eliminate multiple connection problems of the factors affecting unemployment rate and, using the basic components, to obtain the new variables from these factors. In the study, in order to predict unemployment rate, 26 variables and regression model were used, and the data were obtained from the official site of TUIK. At the end of the study, it was put forward that among 26 variables, the variable reducing unemployment rate the most was the rediscount rate of TCMB, and the variable increasing unemployment rate was export variation.

Haider and Hanif (2009), in this study in which used ANN model in the forecast of inflation in Pakistan, made a consistent forecast based on the criteria to reduce mean error squares which is 12 hidden layers and in which error fluctuation is reduced to minimum. In the study, the daily data covering the dates of July 1993 and June 2007 were used. In addition, forecast performance of ANN model was compared with AR and ARIMA models. According to the conclusion of the study, it was predicted that inflation at the end of the next fiscal year would be higher compared to the first quarter of this year.

Karaali and Ulengin (2008) in this study conducted, designed ANN model by means of Cognitive Maps Method. Using unemployment data of four periods between the years of 1988 and 2004, a forecast study was made. In the study, 11 macroeconomic factors (GDP% variation, capacity usage rate in manufacturing sectors, real effective exchange rate, inflation, real interest rate, real wage index in manufacturing sector, import made, total export, productivity index in manufacturing sector, private investments/GDP, public investments/GDP) were identified. As a conclusion of the study, it was expressed that the best forecast model could be reached by seasonality-free data, that linear and nonlinear activation functions used in the output layer had no a marked effect on network performance, that using seasonality-free factor and scale range positively affected forecast performance of neural network.

Coleman and Tettey (2008) in this study conducted, studied the effect of macroeconomic indicators on the performance of Gama Stock Market. In the study, monthly data covering the period of 1991-2005 were used. At the end of the study, it was concluded that the rate of lending rates of deposit banks had a negative effect on performance and, especially, that it was the biggest impediment in front of commercial growth in Gama.

Duruel (2007) in this study conducted, tried to reveal the characteristic features of long term unemployment in EU countries, and researched the effectiveness of the employment policies regarding this problem, produced in EU. In the study, it was targeted to define long term unemployment in EU,

determine its development and characteristic features, and research the causes of long term unemployment. Therefore, employment policies EU applied against long term unemployment problem were thoroughly examined and, at the end of the study, it was put forward that employment policies applied at EU level were successful, and it was seen that the evidence of this was long term unemployment indicators of unemployment.

Bilgin (2004) in this study conducted, analyzed the relationship of exchange rate policies, applied in Turkey, with unemployment by means of regression model. In the analysis, real exchange rate index of the period 1995-2004 and data related to unemployment were used, and the data were compiled from DIE and TCMB statistics. At the end of the study, it was identified that there was a close relationship between exchange rate and unemployment rate in Turkey, and it was put forward that unemployment could not be considered independently from exchange rate policies applied; that exchange rate affected unemployment via particularly export and import; and that the rise in the real exchange rate, especially increasing import, led to unemployment.

Tektas and Karatas (2004) in this study, studied applicability of ANN in financial area. In the study, stock prices of 7 companies being active in Turkey were predicted, in addition, ANN and their multiple regression methods were compared. At the end of the study, it was put forward that ANN method made more successful forecasts with weekly and daily data and produced more successful results than regression of ANN; and that it became more successful than alternative methods of financial analysis.

Moshiri and Cameron (2000) in this study conducted, he compared forecast performance of a back propagated ANN model with traditional econometric approaches. In the study, ARMA, vector autoregressive model, and Bayesian vector auto regression models were compared and, at the end of the study, the comment that hybrid ANN model showed better performance compared to all traditional economic methods.

III. THE OBJECTIVE AND METHOD OF THE STUDY

In the study, utilizing the basic econometric indicators of Turkey, which belong to the period 2005-2018, it was targeted to predict unemployment rate for the next period by means of ANN method and determine the effect degrees of the factors affecting unemployment. For this aim, in order to make forecast, data totally belonging to six economic indicators were used. In the study, utilizing the data of basic economic indicators of Turkey, which belong to the past years, the forecast of unemployment rate for the next period (the year 2019) was made.

A. THE DATA USED IN THE STUDY

In the study, the basic economic indicators of Turkey such as unemployment rate, inflation, employment rate, exchange rate, current deficit, and industrial

production data, which belong to the period 2005-2018 were used. These data were obtained from World Development Indicators of World Bank, Central Bank of Turkish Republic, and OECD data in 2019 (World Bank, 2019; OECD, 2019, TCMB, 2019). As the basic indicators used in calculations, those to be able to reach their data were selected from among the commonly used indicators in the studies of unemployment rates (Dasbası vd., 2019; Gur, 2017; Sevinctekin, 2014; Ballı, 2014) as a result of examinations made in the relevant literature and their rates of affecting unemployment were tested by means of ANN classification features, and affecting rate was used in the study of forecasting high indicators. It was accepted that these basic economic indicators selected were the most basic variables.

February 2010 data of the variable "foreign trade", September, October, November, and December 2018 data of the variable "trade", and September and October 2018 of exchange rate were identified anomaly data and, in analyses, the remaining 163 monthly data were used.

B. PLANNING FORECAST PROCESS

The first process of neural network model design that will make forecast process, arranging data, is to enable them to be entered to the model. Following it, selecting the method of training neural network, hidden layers are identified, and later, training model, test stage is proceeded. In this stage, transfer functions are identified, and forecast accuracy of the model is tested. Momentum, learning speed, and output are identified. In the next stage, the stage of forecast production of model designed and, finally, error tests of the forecast produced are made. In the relevant literature, it was identified that the mostly used error tests were deviation error (e), percentage error (p), mean squares error (MSE), root of mean squares error (RMSE), and mean absolute percentage error (MAPE) (Karahan, 2015; Yüksel and Akkoç, 2016) and error tests were applied in the study.

C. DEFINING ANN MODEL DESIGNED

In this part, using the data belonging to the variables of input (independent) and output (dependent) introduced in preparation of dataset, it was attempted to be designed the most appropriate ANN model. As the output variable of the model, unemployment rate was used, and inflation, employment rate, current deficit, and production data were taken as input variables. 19 years of data (168 months) belonging to each variable were used, and data structure is in the form of matrix consisting of 6 columns and 168 lines.

In developing ANN model, forward feed and back propagated neural network algorithms, the most preferred in the literature. The causes of preferring this ANN algorithm are forecast achievement in linear and nonlinear models, use easiness, and high convergence rate.

While multiple -period forecast is made with ANN, two different approaches can be used as singe period approach and iterative approach, in which more than one

period are simultaneously used. In this study conducted, iterative approach, in which the case of problem is appropriate, was preferred and the model designed was established by means of Alyuda Neuro Intelligence 2.2 Software, developed by Alyuda Research Inc. Analysis stages such as training and testing the model and producing forecast were also realized by this software.

The first step following data entering to program is to identify the missing, erroneous input, and anomaly values. In this stage, scanning the data by the software, erroneous input data are marked. In this study conducted, February 2010 value of the variable "foreign trade", September-October-November – December 2018 values of the variable inflation were identified as anomaly data. These data were cancelled and analyses were made through the remaining data of 163 months.

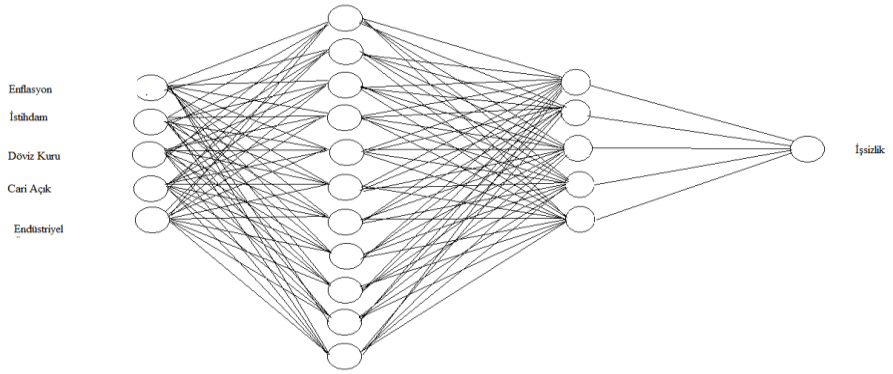
Dataset used in the study is divided into 3 subsets as training, validation, and test. In this sort of studies, about 70% of dataset consist of training set and 30 of it, test set (Benli, 2005). While the data are distributed to subsets, software used data of 111 months corresponding to 68% for education set for training set and data of 26 months for validation and test sets corresponding to 16%. In assigning the data to subsets in stated rates, random method was preferred from among random and sequential methods.

The values specified in dataset belonging to input variables, subjecting to normalization process by the software, it was converted to the interval [-1, 1]. The values of the output variable; since the logistic function is selected as the output layer activation function, it is subjected to normalization process by the program and reduced to the range [0,1].

ANN architectural design process consists of the steps of learning algorithm of network, the number of hidden layer, and identifying activation functions. As learning algorithm, Quick Propagation Algorithm were preferred. As a result of obtaining better results from the tests made with the other algorithms, it was decided to use Quick Propagation Algorithm. In addition, while determining the most appropriate network architecture, for activation functions of input and output, the most generally preferred logistic function was selected. However, as error function, it was seen fit to be used sum of squares and Heuristic method (Karahan, 2011; Akdag, 2014).

As a result of the tests made for determining the numbers of hidden layer and processor, the decision was made to use two hidden layers. İt was seen fit to use 11 processor elements in the first hidden layers and 5 processor elements in the second hidden layer. Thus, as seen in Figure 2, network architecture was designed in the form of [5-11-5-1]. In the following Figure 2, the input layer, hidden layers, and output layer of neural network are seen.

Figure 2: Layers of the Designed Artificial Neural Network Model



As seen in Figure 2, for ANN model to make forecast process, the periodic data belonging to five independent variables (inflation, employment rate, exchange rate, current deficit, industrial production) was used as input. The dependent variable of the model is monthly unemployment rate. In Model, there are two hidden layers with five and eleven elements, and one output layer.

D. TRAINING AND TESTING ARTIFICIAL NEURAL NETWORK

Training neural network is to find weighted values minimizing MSE function for the available dataset. In this stage, training set is introduced to network and thus the least level of error is reached. For network training, online back propagation algorithm is used and, in selection of weight values giving the best performance, error values of confirming set obtained at the end of training are used. In this study, ANN is trained by Quick Propagation Algorithm and, while deciding whether or not network is trained at adequate level, as completing training time, iteration number was selected as a criterion.

In evaluating performances of forecast models, there are various criteria and the leading one is Absolute Error (AE). As stated in the part of model design, dataset is divided into three part as training, validation and test. Hence, training model is determining according to the difference between the value of network output (forecast) produced among input variables in training set and target value (actual) i.e. according to the amount of error. After determining conditions related to training, training stage of ANN was proceeded. Making 500 iterations in network training was found sufficient for testing and the best learning actualized in 410 iterations.

The stage following training stage of network is test stage. In test stage, firstly, all values given in training stage are reintroduced to network. Namely,

introducing the hidden values and synaptic weights to architectural network, it is aimed that program makes forecast with the least error. Whether or not algorithm approaches to the real results is supervised at the test stage. In Table 1, performance results of training, validation, test, and all data set are shown together.

Table 1: Performance results of ANN data sets (Test phase)

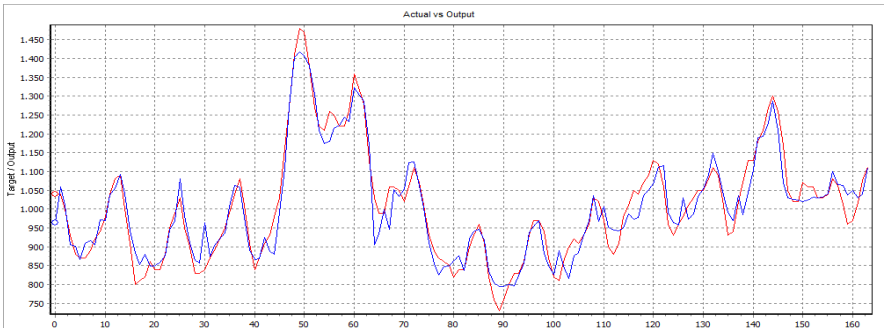
	Absolute Error			
	Education Set	Verification Set	Test Set	Complete Data Set
Average	999,441	1009,615	1021,615	1004,601
St.deviation	135,052	162,089	151,237	142,576
Minimum	730	800	760	730
Maximum	1410	1470	1480	1480
Correlation	0,967	0,957	0,936	0,959
Regression (R^2)	0,927	0,893	0,852	0,908

As seen in Table 1, among training, validation, and test sets, the set, whose mean absolute error value is the lowest, is training set; this is followed by validation set and test sets. Minimum value of absolute error takes place in training set, test set, and validation set in order. Maximum value of absolute error takes place in training set, test set, and validation set. The fall forming in absolute error expresses that model begins to reduce the probability of making error and that model also manages to learn the past information. According to these results, it can be said that network becomes successful in learning and test. It can be again concluded that from the results of training and test, network does not memorize and, in the direction of these results, it can be concluded that training network becomes successful.

When regarded to correlation coefficients in Table 1, it is seen that training set has a correlation value over 96%. Although correlation values of validation set and test set are over 93%, correlation value of all dataset is at high level with 95%. Hence, it is interpreted that there is a strong relationship in positive direction between high correlation values obtained and forecast values obtained by actual values belonging to unemployment.

In the test stage, it is also possible to graphically see how many dataset approaches to actual values. Since all dataset also includes the training, validation, and test datasets, here, comparison graphic of all dataset is given place. In the following Figure 3, the graphic comparatively showing actual values belonging to all dataset and output values produced by network is given.

Figure 3: Comparison of the Estimate and Actual Values of the Whole Data Set



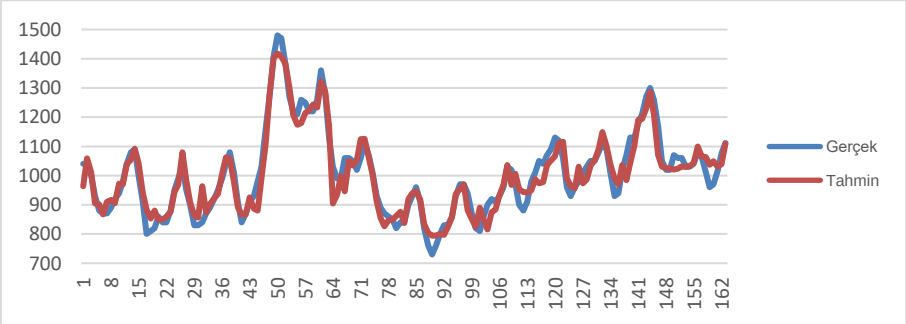
As seen in Figure 3, vertical axis shows unemployment rate and horizontal axis, analysis period (January 2005-December 2018). According to this, the difference (deviation) between the curves of actual values and forecast (output) values in red color produced by ANN shows markedly forecast error. Looking at the graph in Figure 3, it can be seen that forecast values are generally close to the actual values. Here, the deviation between actual values and forecast values and analyses belonging to absolute error and percentage absolute error will be given in detail as follows.

E. FORECAST OF UNEMPLOYMENT RATE BY MEANS OF ANN DESIGNED

In this part of application, the data belonging to 6 variables were entered to ANN model designed and, based on the data belonging to the period 2005-2018, the stage of forecasting unemployment rate belonging to 2019 (of 1 years), expected to actualize in the future, was proceeded.

In this scope, entering the past data of 168 months to ANN model designed, model was asked to produce for the period of next one years. The forecast values the model produced and the actual forecast values were shown in Figure 4. In the graph seen in Figure 4, the actual value, produced by ANN model, was compared to forecast values and, in addition, performance of model was visually expressed.

Figure 4: Comparison of actual and estimated unemployment rate values



As seen in the graph in Figure 4, unemployment rate in Turkey is seen to be at the highest level in 10th month of 2008 and in 3rd month of 2009 (46-51 period). The period of 3rd month of 2012 and 8th month of 2012 (86-91 period) is seen to be at the lowest level. This case was interpreted in the way that over 19 years, unemployment rate in Turkey fluctuated in the range of approximately 7% and 15%.

F. IMPORTANCE OF INPUT VARIABLES ON OUTPUT VARIABLE

The feature of artificial neural networks to make contribution to the result of input variables is an important feature due to the fact that input data directly affects the performance of model and result. This feature is used in identifying datasets to make the best contribution to output by trying the various alternatives in the stage of selecting input data

The main working principle in ANN can be summarized in the form of producing values as a result of taking and processing input values. Therefore, the effect of which input variable is so significant on output production will facilitate to decide about knowing how much this significance level is. According to ANN structure, the significance percentage of the effect of five input variables i.e. factors affecting unemployment on unemployment were calculated by means of package program. The information belonging to the significance levels obtained is given in Table 2.

In this part of the study, those most used from among many variables, expressed that they affected unemployment in the literature, were selected, and at which quantity these affected unemployment rate were measured by using classification feature of ANN, and the significance level of affecting rates were shown in Table 2. When regarded to the significance levels on the factors related to unemployment, it is seen that employment is the most effective with 43.14% and that this is followed by exchange rate with 25%; industrial production, with 13.35%; foreign trade, with 10.50%; and inflation, with 7.96%.

Table 2: Contribution Rates of Input Variables to the Results

Input Variables	Importance Rates (%)
Inflation	07,962
Employment	43,140
Exchange rate	25,051
Foreign trade	10,491
Industrial Production	13,353

In Table 2, the percentages showing the significance level of the factors affecting unemployment were presented. The variables having the most affecting rate is the

variable "employment" with the rate of 43%, and the variable having the least affecting rate is the variable "inflation" with the rate of 7%.

G. ERROR TESTS OF FORECAST MODEL PRODUCES

There are many criteria to be able to be used for forecast accuracy. *Simple error term sigma test* that is one of these is calculated, considering the difference between predicted values, x(t) and actual values, f(t) and can be formulated as follows (Bayir, 2006).

$$e(t) = x(t) - f(t)$$

Then, percentage error of forecast, *p(t)*, is calculated by means of the following formula, dividing simple error i.e. deviation by the value predicted.

$$p(t) = \frac{e(t)}{x(t)}$$

Later, from error measurements commonly used in measuring the consistency of ANN forecast results and shown their formulas below, calculating the values of Mean Squared Error (MSE) and Mean Absolute Percent Error (MAPE) by means of the following formulas, their results are shown in Table 3.

$$MSE = \frac{1}{n}\sum[e(t)]^2 \qquad MAPE = \frac{1}{n}\sum|p(t)|$$

$$RMSE = \sqrt{\frac{1}{n}\sum[e(t)]^2}$$

The results of error calculation made by means of the formulas above, deviations belonging to the forecasts produced by model and results related to confidence are shown in Table 3.

Table 3: Error and Reliability Results of the Forecast

	Correlation	R^2	MSE	MAPE	RMSE
YSA	0,96	0,91	1295,59	0,031	35,994

As seen in Table 3, in the period related to the forecasts ANN produced, correlation value between actual values was calculated as 0.96. According to this, explanatories of the model can be said to be 96% i.e. considerably high (Monks, 1996; Tekin, 2009). The rate of input variables to affect the result (regression R^2) was calculated as 0.91. This result was also interpreted in the way that the value calculated was highly good, namely, that the forecast model made was consistent.

The least forecast error neural network was seen in the forecast made in 5th month of the year 2010 (e=-125,554). In addition, root mean square error (RMSE) value was calculated as 35.9. According to these results, it can be said that the values

calculated form highly good results, namely, that the forecast model made were reliable and consistent.

A method frequently used in measuring the accuracy of forecasts is the statistics of Mean Absolute Percentage Error (MAPE). In the literature, the cause of that MAPE statistics is more acceptable compared to the other statistics is that forecast errors have a meaning alone, since they are expressed as percentage (Akgul, 2003). In addition, in the study, MAPE value of ANN model was calculated as 0.031 (3%). (Table 3). In the relevant literature, if MAPE value below 10%, forecast models are at the accuracy level of "high accuracy" and, in the models, in which it is between 10% and 20%, it is classified as accurate forecast models (S.F. Witt and C.A. Witt, 2000; Zeren and Erguzel, 2014). In the same way, the models whose MAPE values below 10% in the relevant literature are classified as "very good"; the models between 10% and 20%, "good"; the models between 20% and 50%, "acceptable"; and the models above 50%, "wrong" or "erroneous" (Lewis, 1982; Cuhadar et al., 2009). According to this, it can be expressed that the forecasts model produces are consistent and reliable.

CONCLUSION

For world economies to be able to reach high national income level, the effect of employment is considerably more. However, it is also important for unemployment rate in country to be low levels. Since labor force structure of a country shows economic situation of that country, that unemployment rates in the country are at high level is an indicator of that there is a deviation in the development and growth rates in this country. In this context, the study related to unemployment rates of Turkey in the next periods was conducted to find a solution for unemployment problem, one of the most important problems of today, and make contribution to improving country economy.

In this forecast study conducted, ANN method, which is commonly used in the literature and which produces forecasts that are more healthily and close to the reality, was used to minimize faults the traditional methods frequently made in the solutions of chaotic-contented problems including partly erroneous or over deviated data.

According to the results obtained from the study, utilizing main economic indicators of Turkey, while forecasting the unemployment rates in the next periods, the rates of five factors unemployment to affect the result were also identified by means of ANN classification feature. According to this result obtained, that affecting unemployment rate the most is unemployment factor and the lowest effect belong to inflation factor. However, it is seen that the factors of exchange rate, foreign trade, and industrial production have a little reducing effect on unemployment. Due to the fact that these variables dealt with the study have important effects in the policy of reducing unemployment in the country, it is very important to make improvements

according to significance levels for being successful in struggling with unemployment.

When generally regarded to the variation graph of unemployment rates between the years of 2005-2018 in Turkey, it is seen that unemployment rate is at the highest level in 10th month of 2008 and 3 months of 2009 (46-51 period). In addition, (between) 3rd month of 2002 and 8th month of 2012 (86-91 period), it is seen that unemployment rate is the lowest. According to these results, the comment that unemployment rate in Turkey fluctuates in the range of 7% and 15% can be made.

According to the correlation value calculated between the forecasts ANN model produced and actual values in the relevant period, it was identified that explanatories of model was considerably high. As a result of calculation made (regression), it can be expressed that the rate of input variable to affect the result is good enough, namely, forecasts made in the model are consistent. As a result of MAPE statistics, one of the frequently used methods in measuring the accuracy of forecasts, it can be said that accuracy degree of the forecasts model produced is good at high level and that forecasts are reliable and consistent.

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