Cumhuriyet ScienceJournal

e-ISSN: 2587-246X
ISSN: 2587-2680

Cumhuriyet Sci. J., 42(4) (2021) 942-950
http://dx.doi.org/10.17776/csj.1009362

Forecasting the returns of pension investment funds in Turkey with artificial neural network

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Abstract

Individuals start to experience the retirement period after completing their active working time. During the retirement period, the income generated during the work period is reduced. The Personal Pension System was organized on the basis that both individuals can able to generate additional income during the retirement period and the savings are increased and remain in the system. This system aims to enable individuals to increase their income during the retirement period through their savings. Funds operated according to the religious property principles created to drive investment into savings accumulated in individual pension accounts of participants seeking to retire and build up wealth are called pension funds. Pension investment funds are of great importance to our capital market and the future of our country.

Article info

History:
Received:13.10.2021
Accepted:08.12.2021

Keywords:
Pension mutual funds,
Artificial neural networks,
Financial forecasting

1. Introduction

The Personal Pension System (TPPS) is designed to drive the long-term investment of individuals' wealth throughout their working lives and to provide an income that will improve the living conditions of individuals during retirement. Individuals gain an income in addition to their retirement income by voluntarily and/or automatically participating in this system established The deposits are monitored in individual accounts and are stored in TAKASBANK, which is appropriate by the Capital Markets Board (TPPS). TPPS; is monitored and supervised by the Capital Market Board (SPK), the pension Monitoring Center (EGM), TAKASBANK, independent audit companies, and internal audit elements, especially the Undersecretariat of the Treasury [1].

As a complement to the social security system, TPPS also supports the economic development of countries. In our country, financial assets and markets are improving because the total amount of savings is insufficient. Financial markets have not been able to achieve the desired development due to limited demand for financial instruments. In Turkey, savings are often defined in the form of a cushion, and as a result, the fund accumulation to be transferred to investments is not sufficient. Therefore, small savings within the country can be assessed in financial markets for use in the growth of funds. More than that, market fluctuations and speculation can be prevented. In this context, the TPPS funds have increased the country's fund savings and have increased the net savings volume in recent years. The inclusion of pension funds among long-term investment funds in financial markets will have a deepening effect on markets. This effect will reduce borrowing costs in the private and public sectors. The need for public financing must be met at the lowest cost in the medium and long term, following developments in the domestic and foreign markets. In this case, pension funds are the most important long-term enterprise investment tools and can be intended for this purpose. With the development of individual pension funds in Turkey, it is expected to reduce the gameplay that may occur in financial markets. These funds have the opportunity to move longer-term, and therefore long-term paper is an important customer that can be sold for the Treasury [2]. Pension investment funds provide liquidity and stability in the market, with a fixed demand for securities, and provide investors

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with the opportunity to lower their costs. As a result, investments will become long-term and more return-yielded enterprise investments. The transfer of pension investment funds into capital markets as long-term investments reduces the gameplay in markets, thus enabling a stable growth opportunity.

Significant changes in the financial system may occur as a result of increased funding with TPPS in Turkey. These funds can block financial crises that can arise due to short-term variable capital movements in the country and can reduce the depth of a possible crisis. TPPS is widely used in the world and is a long-term financial resource for country economies. Therefore, it provides significant support for the country's economy in the long term [3].

Key indicators of individual pensions in Turkey are given in Table 1.

Table 1. Number of participants and Fund amounts of Pension companies in Turkey [1]

Retirement Companies	Number of participants	Participants' Fund Amount (TL)
Aegon Life and Retirement	37,671	132,128,516
Allianz Life and Retirement	94,630	2,801,049,763
Allianz Life and Retirement	728,934	12,158,903,088
Anadolu Life and Retirement	1,091,010	16,312,824,287
Avivasa Life and Retirement	787,046	16,801,925,214
Axa Life and Retirement	33,794	426,214,299
Bereket Life and Retirement	93,913	360,296,123
BNP Paribas Cardif Retirement	181,937	2,260,767,911
Cigna Finans Life and Retirement	83,601	707,565,760
Fiba Life and Retirement	91,108	1,614,645,975
Garanti Life and Retirement	1,111,079	12,694,233,683
Halk Life and Retirement	561,547	4,066,235,326
Katılım Life and Retirement	253,288	1,466,479,144
Metlife Life and Retirement	184,525	1,619,012,245
NN Life and Retirement	255,144	3,165,530,598
Vakıf Life and Retirement	547,507	7,224,409,572
Ziraat Life and Retirement	657,702	4,544,494,775
Total	6,794,436	88,356,176

In Turkey, the participants of the pension companies total of 6,794,436 and the funding of the participants is TL 88,356,176 billion. The various and distributions of pension investment funds in Turkey are given in Figure 1

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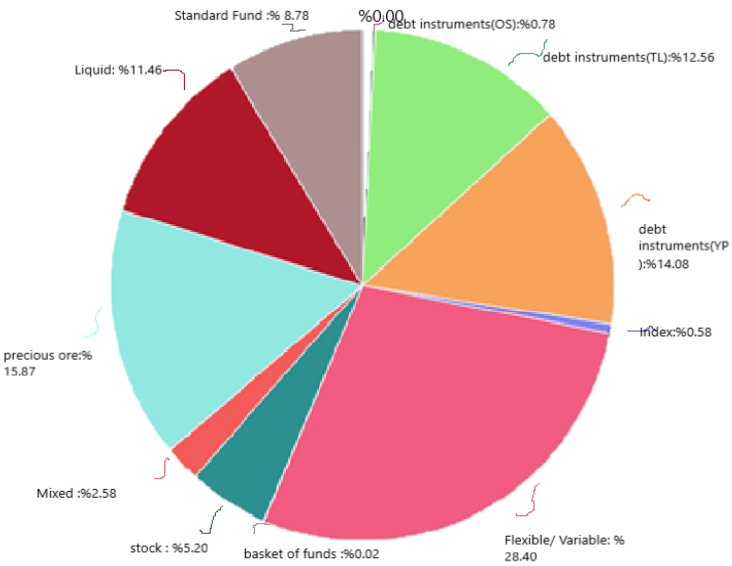

Figure 1. Various and distributions of pension investment funds in Turkey [1]

In the literature, studies have been carried out comparing the ARIMA method and the classic time series method to determine the prediction success of the Artificial Nerve Networks (ANN). In many of these studies, The prediction success of it's models has been determined to be better than conventional time series methods. In some studies, it was determined that the methods examined do not outperform each other.

Qi and Zhang [4], have developed a model and with this model, it is determined that the architectural selection criteria are not sufficient to examine short-term and long-term time series with artificial neural networks.

Eğrioğlu and Aladağ [5] compared architectural selection criteria for using artificial neural networks in predicting long-term dependent time series. In the study, it was stated that the time series in the curve and linear structure can be modeled with the and the biggest problem encountered in ANN was the number of nodes in the plates.

Avcı [6] used the multi-layered artificial neural networks model to predict the daily and seance returns of the National 100 Index, and stated that this method is an effective method. It is also stated that IT is possible to further increase the estimation powers of the model using different variables and model structures.

Wallace [7] examined ANN models from a conceptual point of view and examined the fields used in the finance literature. Wallace (2008) stated that the most basic use of artificial neural networks is financial forecasting. In addition, it is stated that ANN can be used to test the validity of the efficient market theory.

Düzgün [8] worked to estimate the GDP for Turkey in the period 1987 and 2007, and it was stated that the ARIMA model is better in terms of foresight than its model.

Nitin et al [9] used different ARIMA and ANN models for India Stock Exchange data and stated that the ARIMA model's prediction performance is better.

Irmak et al [10] used Winter Exponential Correction method to estimate the number of patients and they indicated that the Winter Exponential Correction method was better.

Akel and Karacameydan [11] have used the Artificial Nerve Networks (ANN) method to estimate the net asset values of investment funds in Turkey. The study used 19 of type a and 19 of type b and 38 of total investment funds for the period January 2001 through December 2008, and six macro-economic variables were used to estimate net asset values for these funds. In the study, if the hedge fund to predict the net asset value, and regression analysis has been used and predictions obtained by both methods have been compared. According to the analysis results, it has been determined that their models have more successful results.

Keskin Benli and Yıldız [12] used linear time series methods and nonlinear but model and estimated the price of gold. Then, the predictive success performance of the methods used was compared. In the study, the result was that the average of the error squares was more successful than the root of mean square (RMSE) value and the ARIMA model was more successful than the model.

Pekmezci and Dilek [13] ın this study, the performances of cointegration tests, which are frequently used in the literature, were compared for different sample sizes in terms of their empirical power and type I error probabilities. As a result of this study, it was determined that some test applications in testing cointegration in terms of empirical power and type I error probability did not meet.

Ertuğrul and Bekin [14] used time series and artificial neural networks models to estimate some basic food prices in Turkey. As a result, Holt's exponential correction used to estimate wheat and barley prices was determined that box-Jenkins models and their model had similar values in respect of the mean of error squares (MSE), while the estimate for the steel prices was given better estimates.

Kızılkaya [15] used ANN used the ARIMA model to estimate Turkey's inflation and unemployment rates, The period 1923-2014 for unemployment and 1969-2014 for annual inflation have been reviewed and forecasts for the period 2015-2020 have been made.

Koç ve Onacak [16] used the euro purchase rate, US dollar purchase rate, under-the-republic sale price, Stock Exchange Istanbul 100 Index closing price, interest rate applied to TL deposits in banks and Consumer Price Index as input variable. In the study, artificial neural networks were used to forecast estimate the pension investment fund share prices. The analysis reviewed monthly data from January 2003 to October 2017. It has been found that the model of artificial neural networks produces results close to actual values.

2. Materials and Methods

2.1. Dataset

In this study, in January 2016-October 2019, 4 variables were used to estimate the returns of investment funds based on the stock of three separate retirement investment companies, gold and foreign currency. These variables are used in PPI (2003=100), CPI (2003=100), Exchange rate (TL\$), gold exchange. The monthly prices of the monetary market fund of Anatolian life Pension Şti, Ziraat Pension Şti, NN Hayat Pension Company have been studied. In the study, the predictions of the long-term values of pension investment funds were compared with the model of time series and the predictions of the results obtained from artificial neural networks (ANN). The study conducted a time series analysis of artificial neural networks, SPSS 21 with Matlab R2016b. Analytics have been created for each company separately. The logarithm of all input-output data has been taken for use in ANN algorithms and time series analysis.

2.2 Artificial neural networks (ANN)

ANNs can be defined as computer systems inspired by biological neural networks in order to be able to derive and discover new information through learning, which is one of the most basic features of the human brain, without any assistance [17-22].

ANN uses the information obtained from the samples as input, creates their own experiences by processing them, and then they can make similar decisions. The ANN model consists of layers, namely the input layer, the hidden layer, and the output layer, which contain neurons that are in connection with each other. Determining the number of layers in which the network will be formed and the number of neurons in these layers is defined as "network architecture". ANN architecture affects the performance of the network. ANN shows common features with the human brain, such as learning, remembering, and generalizing from experience. A mathematical model for the biological nerve structure was developed by McCulloch and Pitts in 1943, and it was briefly defined as the M-P nerve. This developed model is shown in Figure 2.

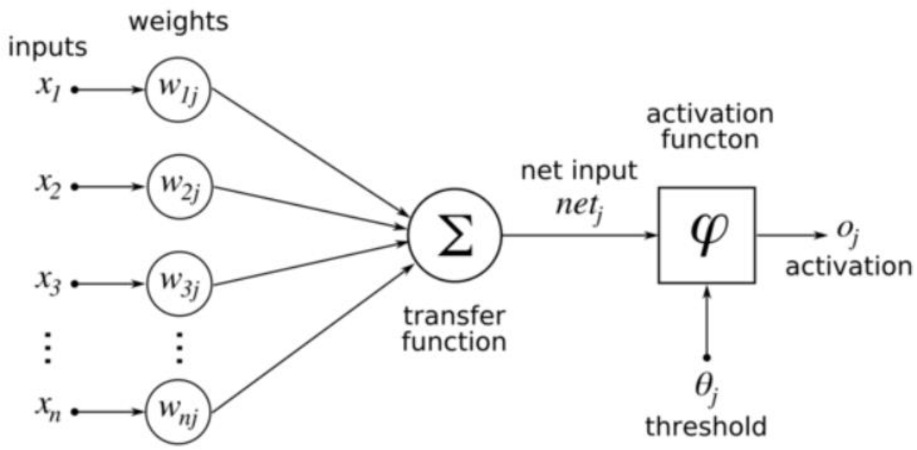

Figure 2. Architectural Structure of Neural Network (McCulloch and Pitts in 1943)

Artificial neural networks are in two classes as feed-forward and feed-back networks based on how they operate. In advanced artificial neural networks, the signals are in one direction, from the input layer to the output layer only. For feedback networks, there is a type of feedback process. In these network structures, the direction of the signal is from the input layer to the output layer.

However, the neurons on a layer can receive signals from themselves, from the neurons on the layer or other layers[21]. In the time series, the three-layer forward feed model is most commonly used. In single-variable time series, the network output is estimated when inputs are past or delayed variables [5]. In use, the learning process is to set the information stored in the weights of the connections generated in the network to perform a desired function. In other words, output is obtained by setting the weight value of the network at the end of the learning process, while initially determining the weight value of the network at random.

Different algorithms are used for learning. These algorithms are divided into two groups, with consultants (supervised) and without consultants (unsupervised). The non-consultative learning algorithm does not specify output variables that correspond to input variables, and weights are adjusted automatically by the network. In the guided learning algorithm, output variables corresponding to input variables are also loaded as information on the network. The network is adjusting the hitch weights so that the difference between network output and target output is minimal. The redistribution algorithm is a learning algorithm that is most commonly used in neural networks using the consulted learning algorithm. It is important to select the learning parameter used in the redistribution algorithm to optimize the performance of the network [18]. The time series analysis uses more back-propagation algorithms.

This study used the reverse-spread algorithm and the model for it is shown in Figure 3.

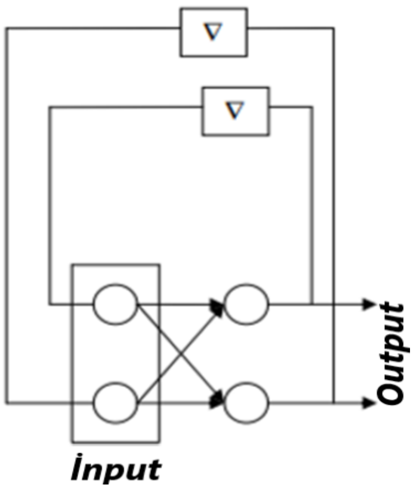

Figure 3. Redistributed network structure.

The developed simplified ANN model is shown in Figure 4.

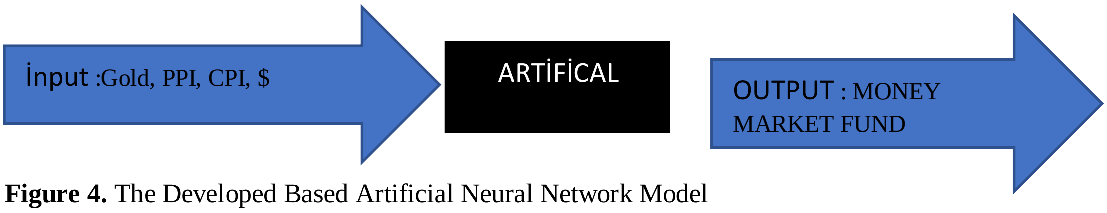

Figure 4. The Developed Based Artificial Neural Network Model

Within a general artificial neural network system, layers are formed by the combination of neurons in the same direction [22]. These layers are the input layer, hidden layer, and output layer. Input variables are made up of the input layer. With the interaction of these input variables, the output variable is formed. Output variables also create the output layer. There is a hidden layer of nerves that is not connected to the external environment. These nerves send signals on the input layer to the output layer with their weight.

2.3. Time series analysis

Time series are often an important practice of statistics and even economies. A time series is a series of measurements that are periodically observed with time intervals. Time series analysis is all over science, but governments are often used to make economic predictions of organizations over economic data.

The time series are divided into stationary and non-stationary series according to deviations from the average. If the average and the variance of the time series being examined shows a symmetrical change of the variance, or if the series is free of periodic fluctuations, these series are called static time series. Statistically, stability is important. The statistical results are taken over the series's stagness assumption. If a time series is not static, it is made static using some methods (such as differentiation), then analyzes are performed. In the literature, many economic data can be observed to be non-stable. Therefore, it will be appropriate to review the relevant data that is not static. Non-static time series are reviewed in two sections. One is that the average of the series depends on time, the other is that the series autocorrelation depends on time.

3.Results and Discussion

3.1.The results of the time series

The model and forecast strength set out in the time series analysis of the estimate of money market funds for three separate retirement companies are shown in Table 2 below.

Table 2. Specified Model Results

Companies	**Model**	**MSE**
Anadolu Life AndRetirement	ARIMA(1,1,0)	0.0001
NN Life And Retirement	ARIMA(1,1,1)	0.0000814
Ziraat Life And Retirement	ARIMA (1,0,0)	0.0000780

Prediction accuracy measurements;

MSE (Mean Square Eror) $= \frac{1}{n} \sum c_t^2$

3.2 The results of artificial neural network

The results found by analyzing the multivariate forward diffused artificial nervous network architecture and MATLAB program are shown in Figure 5.

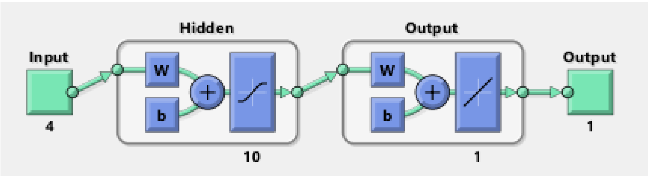

Figure 5. Artificial Neural Networks Model

Artificial Neural Networks Model Results were given in Table 3.

Table 3. Artificial Neural Networks Model Results

Companies	Iteration	MSE
Anadolu Life And Retirement	171	0.0000256
Ziraat Life And Retirement	177	0.0000141
NN Life And Retirement	6	0.0000198

The deviations from the mean are very low compared to the analysis of the time series and are forecasting.

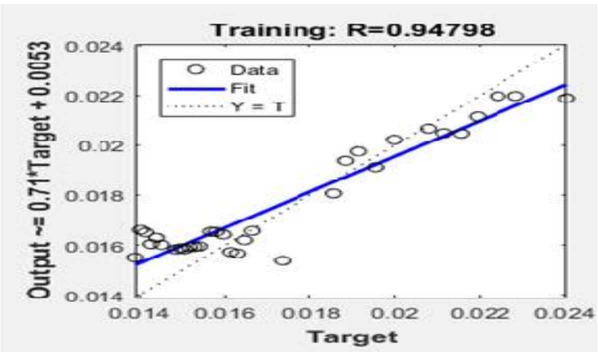

Figure 6: Ziraat Life And Retirement Training And Test Data Regression Result

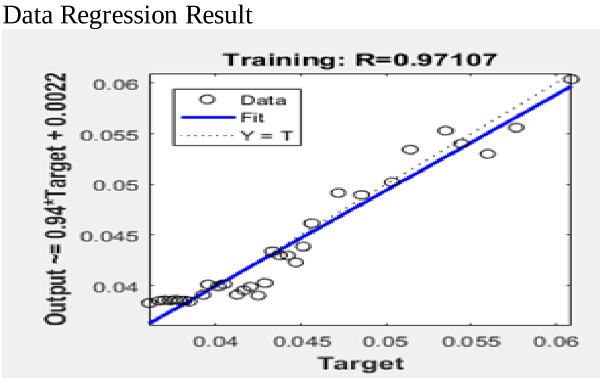

Figure 7. Anadolu Life And Retirement Training And Test Data Regression Result

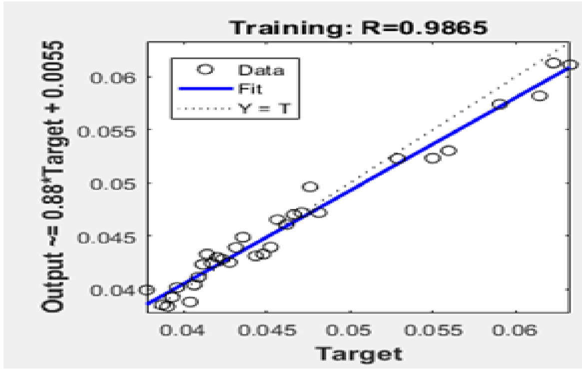

Figure 8..NN Life And Retirement Training And Test Data Regression Result

Prediction and prediction success due to data loss correction in time series analysis are very risky in comparison to the artificial neural network method. MSE values in time series analysis and artificial neural networks have shown superior performance in predicting artificial neural networks compared to Table 4.

Table 4. Forecasting Success Criteria Results

	Time Series Analysis	ANN
	MSE	**MSE**
Anadolu Life And Retirement	0.0001	0.0000256
NN Life And Retirement	0.0000814	0.0000141
Ziraat Life And Retirement	0.0000780	0.0000198

The 5-month estimate (standardized values) obtained by The Time Series and Artificial Neural Networks method of Anadolu Life And Retirement is shown in Table 5.

Table 5. Time Series Analysis And ANN Forecasting

Period	Forecasting With Time Series	Forecasting With ANN
2019-11	0,06243026	0,0564418
2019-12	0,05601761	0,0561455
2020-01	0,05601398	0,0585714
2020-02	0,05874537	0,0594157
2020-03	0,05929718	0,0568943
2020-04	0,05689785	0,0572886
2020-05	0,05775788	0,0585676

4.Conclusion

With uncertainties in the economy, it is important for decision-makers to determine what economic time series will show in the future. In this case, the values that make up the time series are examined and the model installed and the series are asked to forecast the values that they will receive in the future with high performance.

In this study, it is aimed to present a general framework to compare the working processes and forecasting performances of forecasting methods. For this purpose, a linear time series method and nonlinear ANN model were used and the predictive success performances of the two methods were compared by applying them to Private Pension Mutual Funds in Turkey. As a result of the study, it was determined that the prediction performance of ANN was more successful.

It is recommended to use artificial neural networks instead of classical time series analysis in forecasting and forecasting modeling. Those who do the estimation process should use different methods in their work. Thus, the most suitable model for the studied time series is determined. Evaluating the method or model used at each stage may yield better results in case the data set changes.

Acknowledgment

This study is an expanded and revised version of the paper presented orally at the 20th EYI: Twentieth International Econometrics Operations Research and Statistics (EYI) Symposium (12-14 February 2020).

Conflicts of interest

The authors declared no conflict of interests.

References

[1] Emeklilik Gözetim Merkezi, Bireysel-Emeklilik-Nedir? https://www.egm.org.tr/bireysel-emeklilik/bireysel-emeklilik-nedir (2020).

[2] Korkmaz T., Türkiyede'ki Emeklilik Fonlarının Perfonmans Ölçümü ve Fon Yöneticilerinin Zamanlama Yeteneği, *Akdeniz Üniversitesi İ.B.F Dergisi*, (14) (2007) 66-93.

[3] Zor İ., OECD Ülkeleri ve Türkiye Bağlamında Bir Değerlendirme, *Reasürör Dergisi*, 70 (2008) 6-20.

[4] Qi M., Zhang P.G., An Investigation of Model Selection Criteria for Neural Network Time Series Forecasting, *European Journal of Operational Research*, 132 (3) (2001) 666-680.

[5] Eğrioğlu E., Aladağ Ç.H., Yapay Sinir Ağları ve Arıma Modellerin Melez Yaklaşımı ile Zaman Serilerinde Öngörü, İstanbul Üniversitesi VII. Ulusal Ekonometri ve İstatistik Sempozyumu, 26-27 Mayıs 2005, İstanbul.

[6] Avcı E., Forecasting Daily and Sessional Returns of the ISE-100 Index with Neural Networks Models, *Doğuş Üniversitesi Dergisi*, 8 (2) (2007) 128-142.

[7] Wallace M.P., Neural Networks And their Application to Finance, *Business Intelligence Journal*, (July) (2008) 67-76.

[8] Düzgün R., A Comparison of Artificial Neural Networks and ARIMA Models' Success in GDP Forecast, *Marmara Üniversitesi İ.İ.B.F. Dergisi*, 25 (2) (2008) 165-176.

[9] Nitin N.M., Saxena V. P., Pardasani, K. R., Next Day Stock Forecasting An Application of ANN and ARIMA, The IUP, *International Journal of Theoretical and Applied Finance*, 17 (1) (2011) 70-84.

[10] Irmak S., Köksal C.D., Asilkan Ö., Hastanelerin Gelecekteki Hasta Yoğunluklarının Veri Madenciliği Yöntemleri ile Tahmin Edilmesi, *Uluslararası Alanya İşletme Fakültesi Dergisi*, 4 (1) (2012) 101-114.

[11] Akel V., Karacameydan F., Yatırım Fonları Net Varlık Değerlerinin Yapay Sinir Ağları Yöntemiyle Tahmin Edilmesi, *Anadolu Üniversitesi Sosyal Bilimler Dergisi*, 12 (2012) 87-105.

[12] Keskin Benli Y., Yıldız A., Altın Fiyatının Zaman Serisi Yöntemleri ve Yapay Sinir Ağları ile Öngörüsü, *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi*, 42 (2014) 213-224.

[13] Pekmezci A., Dilek M. (2014). The Comparison of Performances of Widely Used Cointegration Tests, *Communications in Statistics- Simulation and Computation*, 45(6) 2070-2080.

[14] Ertuğrul İ. Bekin A., Türkiye'de Bazı Temel Gıda Fiyatları İçin Yapay Sinir Ağları ve Zaman Serisi Tahmin Modellerinin Karşılaştırmalı Analizi,

Kafkas Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 7 (13) (2016) 253-280.

[15] Kızılkaya O., Türkiye'nin Enflasyon ve İşsizlik Oranının Yapay Sinir Ağları ve Box-Jenkins Yöntemiyle Tahmini *Social Sciences Studies Journal*, 3 (12) (2017) 2197-2207.

[16] Koç S., Onacak D., Yapay Sinir Ağları ile Emeklilik Yatırım Fonu Hisse Senedi Fiyatlarının Tahmini, *Finans Ekonomi ve Sosyal Araştırmalar Dergisi*, 3 (3) (2018) 590-600.

[17] Fausett L., (1994). Fundamentals of Neural Networks. Prentice Hall USA (1994).

[18] Güneri N., Apaydın A., Öğrenci Başarılarının Sınıflandırılmasında Lojistik Regresyon Analizi ve Sinir Ağları Yaklaşımı, *Ticaret ve Turizm Eğitim Fakültesi Dergisi*, 1 (2004) 170-188.

[19] Indro D.C., Jianga C.X., Patuwo B.E., Zhang G.P., Prediction Mutual Fund Performance Using Artificial Neural Networks, Omega, *International Journal of Management Science*, 27 (3) (1999) 373-380.

[20] Öztemel E., Yapay Sinir Ağları. 2. Basım. Papatya Yayıncılık İstanbul (2006).

[21] Tolon M., Güneri Tosunoğlu N., (2008). Tüketici Tatmini Verilerinin Analizi: Yapay Sinir Ağları ve Regresyon Analizi Karşılaştırması, *Gazi Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 10 (2), 247-259.

[22] Çuhadar M., Güngör, İ., Göksu, A., Turizm Talebinin Yapay Sinir Ağları ile Tahmini ve Zaman Serisi Yöntemleri ile Karşılaştırılmalı Analizi: Antalya İline Yönelik Bir Uygulama, *Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*,14 (1) (2009) 99-114.