OPUS
Uluslararası Toplum Araştırmaları Dergisi
International Journal of Society Researches

ISSN:2528-9527
E-ISSN : 2528-9535
Yıl *Year* : 11
Cilt *Volume*:17
Sayı *Issue* :36
Nisan *April* 2021
Makalenin Geliş Tarihi *Received Date*: 23/02/2021
Makalenin Kabul Tarihi *Accepted Date*:30/04/2021

Economic Confidence Index and Economic Growth Relationship: Prediction with Artificial Neural Networks in the Case of Turkey

DOI: 10.26466/opus.885417

*

Emek Aslı Cinel* - Ufuk Yolcu**
* Dr. Öğr. Üyesi, Giresun Üniversitesi İktisadi ve İdari Bilimler Fakültesi
E-Mail: emekasli@yahoo.com **ORCID:** 0000-0002-4201-2427
* Prof. Dr., Giresun Üniversitesi İktisadi ve İdari Bilimler Fakültesi
E-Mail: varyansx@hotmail.com **ORCID:** 0000- 0002- 5188 - 3136

Abstract

It is inadequate to evaluate merely basic macroeconomic indicators to speak of economic growth. Economic growth is also related to external factors. One of these factors is the sentiment of confidence. Economic confidence is associated with expectations. Consumers, producers, savers, and laborers make their economic decisions according to their expectations and affect the economy. In this context, the rise in confidence in the economy positively affects consumption and production decisions, and economic growth is achieved. The study aimed to investigate the relationship between economic confidence and economic growth in Turkey. For this purpose, the economic confidence index data obtained from the official website of TSI over the period 2007-2020 were utilized. The overall situation of the economy was evaluated by considering the data of these index values. As a result of the study, it was observed that the economic growth slowed down in the pessimistic situation where the confidence in the economy decreased, whereas the economic growth boosted in the optimistic situation where the confidence in the economy increased. Moreover, within the scope of this study, both annual and quarterly changes in the Gross Domestic Product, a measurement of economic growth, were predicted with different artificial neural networks (ANNs) over the period 2007 – 2020. Throughout the prediction process, the time-series of economic confidence index with monthly data observed within the same period were included in the inputs of the neural network as the auxiliary variable. The results indicated that artificial neural networks performed successfully in predicting the time-series for economic growth and this situation was based on the relationship between economic growth and economic confidence index.

Keywords: *confidence, economic growth, Turkey, prediction, artificial neural networks.*

OPUS
Uluslararası Toplum Araştırmaları Dergisi
International Journal of Society Researches

ISSN:2528-9527
E-ISSN : 2528-9535
Yıl *Year* : 11
Cilt *Volume*:17
Sayı *Issue* :36
Nisan *April* 2021
Makalenin Geliş Tarihi *Received Date*: 23/02/2021
Makalenin Kabul Tarihi *Accepted Date*:30/04/2021

Ekonomik Güven Endeksi ve Ekonomik Büyüme İlişkisi: Yapay Sinir Ağları ile Türkiye Örneği Öngörüsü

*

Öz

Ekonomik büyümeden söz edebilmek için yalnızca temel makroekonomik göstergeleri değerlendirmek yetersizdir. Ekonomik büyüme aynı zamanda dışsal etkenlerle de ilişkilidir. Bu etkenlerin başında güven duygusu gelmektedir. Ekonomik güven beklentilerle ilişkilidir. Tüketici, üretici, tasarruf ve emek sahipleri ekonomik kararlarını beklentilerine göre almakta ve ekonomiyi etkilemektedir. Bu bağlamda ekonomiye olan güven artışı tüketim ve üretim kararlarını pozitif yönde etkilemekte, ekonomik büyüme gerçekleşmektedir.Çalışmanın amacını Türkiye'de ekonomik güven endeksi ve ekonomik büyüme arasındaki ilişkiyi araştırmak oluşturmaktadır. Bu amaç doğrultusunda TÜİK'in resmi internet sitesinde yer alan 2007-2020 dönemine ait ekonomik güven endeksi verilerinden yararlanılmıştır. Bu endeksteki verilerin değerlerine bakılarak ekonominin genel durumu değerlendirilmiştir. Çalışma sonucunda genel itibarıyla ekonomiye olan güvenin azaldığı kötümser durumda ekonomik büyümenin de yavaşladığı, ekonomiye olan güvenin arttığı iyimser durumda ise ekonomik büyümenin arttığı gözlenmiştir. Ayrıca bu çalışma kapsamında 2007-2020 yılları arasında gözlenen, ekonomik büyümenin bir ölçüsü olan, Gayri Safi Yurtiçi Hâsıla yıllık ve çeyreklik değişim verileri farklı yapay sinir ağları (YSA) ile öngörülmüştür. Öngörü sürecinde aynı dönemde gözlenmiş aylık ekonomik güven endeksi zaman serisi yardımcı değişken olarak sinir ağının girdilerini oluşturmuştur. Elde edilen sonuçlar, yapay sinir ağlarının ekonomik büyümeye ilişkin zaman serilerinin öngörülmesinde başarılı bir performans sergilediği ve bu durumun ekonomik büyüme ile ekonomi güven endeksi arasındaki ilişkiye dayandığını ortaya koymuştur.

Anahtar Kelimeler: *güven endeksi, ekonomik büyüme, Türkiye, öngörü, yapay sinir ağları.*

Introduction

Expectations have always been highly effective on the economic decision-making processes of individuals living in a society. Economic phenomena encountered by individuals within the micro-framework also differentiate macro-decisions such as future investment, consumption, and savings. Therefore, upon considering expectations, individuals would base their decision-making mechanisms on their confidence in the economy.

The experiences of the consumers (micro) and the economic indicator and performance (macro) of the country in which they live would steer the expectations. In this context, the economic confidence index, which is accepted as one of the main indicators of economic crises, and the level of individuals' confidence in the society tend to loom large. The Consumer Confidence Index is being calculated by the Turkish Statistical Institute (TSI) with the Monthly Consumer Tendency Survey and published on its official website. The responses given to the survey questions consisting of sub-domains (Consumer Confidence Index, Real Sector Confidence Index, Retail Sector Confidence Index, Service Sector Confidence Index, and Construction Sector Confidence Index) are used in preparing the Monthly Consumer Tendency Survey. Expectations for the future as well as tendencies to spend and save in the future are measured with financial conditions and overall economic evaluation of the individuals.

Uncertainty in the expectations of economic decision-making units would create differences in consumers' consumption preferences and producers' preferences of production and investment. Fluctuations in production and consumption would lead to changes in basic macroeconomic data such as the gross domestic product (GDP), employment, inflation, and current account deficit. The economy flourishes during periods when uncertainty ceases to exist and confidence in the economy triumphs (Arısoy, 2012, p.305). Financial markets also improve during such a process.

Keynes attributed awareness of economic developments to the characteristics of expectations and confidence in the long-run. In Keynes' analysis, the sensitivity of producers and consumers toward economic developments constitutes the basis of fluctuations in the economy (Ludvigson, 2004, p.29; Aarle and Kappler, 2012, p.44). Therefore, there is a quite close relationship between the basic economic indicators and the economic confidence index.

The basic elements affecting the confidence in Turkey's economy consist of the political stability and the presence of determination, the global economic crises and the unstable structure of assets, efficiency, and consistency of the economic policies in force, as well as the existence of the long-term effective measures (Türkkan, 2001, p.151).

The aim of the study involves revealing the relationship between economic confidence and economic growth in Turkey. To this end, the economic confidence index data obtained from the official website of TSI over the period 2007-2020 are utilized. Upon considering the data in this index, the overall condition of the economy is evaluated and the positive impacts of economic policies implemented to boost social confidence on economic growth are introduced.

Besides, the time-series of GDP data with 55 observations obtained over the period 2007:Q1 – 2020:Q3 along with the time-series of the Economic Confidence Index (ECI) monthly data obtained over the same period are analyzed using both feedforward and feedback artificial neural networks via multivariate models.

In the second part of the study, a detailed literature review is introduced. The third part concentrates on the relationship between the ECI and GDP in Turkey. In the fourth part, the predictions of both annual and quarterly percentage change in GDP with artificial neural networks are carried out and the obtained results are evaluated in detail. In the last part, the results are discussed and the perspective for future studies is presented.

Literature Review

Various studies in the literature investigating the relationship between economic confidence index and economic indicators are listed as follows:

Matsusaka and Sbordone (1995) examined the relationship between consumer confidence index and national income over the period 1953-1998 in the USA using the Granger causality and Vector Autoregression (VAR) model. As a result of the study, a causal relationship from the consumer confidence index toward national income was detected, and it was stated that consumer sentiment had a 13-16% impact on national income.

Knack and Keefer (1997) explicated the relationship between the confidence index and economic growth for 29 different economies. It was asserted that a 10% rise in the confidence level would have increased the economic growth by 0.8%.

Zak and Knack (2001) investigated the relationship between confidence indexes and the economic performance of 41 different countries. As a result of the study, the presence of a significant relationship between the confidence index and economic growth was detected.

Utaka (2003) investigated the relationship between consumer confidence index and GDP of Japan over the period 1982-2000 via the Granger causality analysis and VAR model. There was a causal relationship running from the consumer confidence index toward GDP only in the short-run.

Golinelli and Parigi (2004) conducted a research study for the economies of France, Germany, Italy, England, America, Japan, Canada, and Australia utilizing the quarterly data via the VAR model and Toda-Yamamoto (1995) type Granger causality tests. According to the results of the study, consumer confidence was affected by a wide variety of variables and served as crucial guidance in predicting economic performance.

Junoh (2004) conducted a comparative study on the ANN and econometric approaches in order to estimate GDP growth in Malaysia over the period 1995-2000. In the study, knowledge-based economic indicators based on time-series data obtained over the period 1995-2000 were utilized. As a result of the study, it was claimed that ANN aggravated its potential in predicting GDP growth based on knowledge-based economic indicators according to the conventional econometric approach.

Özsağır (2007) evaluated the association between the real sector confidence index and economic growth in Turkey's economy over the period 1988-2005 using the correlation analysis and detected a quite significant correlation coefficient (0.908265). Accordingly, there was a significant relationship between the real sector confidence index and economic growth in Turkey's economy.

Boulila et al. (2008) investigated the relationship between economic growth and social confidence over the period 1980-2000 for various developed and developing countries. In the study, the economies of 35 different developed and developing countries were examined. Accordingly, the study concluded that social confidence significantly and positively affected

economic growth. The rise in social confidence strengthened economic performance along with institutional development.

Düzgün (2008) predicted GDP over the period 1987:Q1 – 2007:Q3 using the ANN and ARIMA (*Autoregressive Integrated Moving Average*) models. The study concluded that the ARIMA model yielded better results than the ANN model.

Çelik et al. (2010), in their research study including the economies of Brazil, China, Mexico, Poland, South Africa, and Turkey, examined the relationship between consumer confidence and economic growth via the Pedroni (1999, 2004), Westerlund (2007) and Westerlund-Edgerton (2007) panels data analyses. Industrial production index and stock market data, which are considered among the determinants of economic growth, were explicated in the study. As a result of the study, it was determined that industrial production index and stock market data were related in the long-run.

Zanin (2010) investigated the relationship between the economic sentiment indicator and economic growth for 6 different EU-member countries' economies. The study emphasized that positive and negative differences in the economic sentiment indicator did not have the same impact on GDP and that the impact might have differed from country to country and over time.

Arısoy (2012) investigated the impacts of both consumer and real sector confidence indexes on employment, stocks, consumption expenditures, and on the level of industrial production (as a determinant of economic growth) using monthly data obtained over the period from January 2005 to January 2012 via the VAR model. As a result of the study, it was explained that the consumer confidence index affected the consumption level, the real sector confidence index affected the industrial production index and the stock market, whereas the confidence indexes were determinants of the real economy.

İbicioğlu et al. (2013) examined the association between foreign exchange rate and consumer confidence index in Turkey utilizing the data obtained over the period 2003:12 - 2011:12 using the Johansen cointegration and Granger causality tests. As a result of the Johansen cointegration test, a cointegration relationship between the exchange rate and the consumer confidence index is detected in the long-run. According to the Granger causality test results, the existence of a unilateral causal relationship from the exchange rate toward the consumer confidence index is revealed.

Gürgür and Kılınç (2015) analyzed the cointegration relationship between consumer confidence index and basic financial and macroeconomic variables for Turkey over the period 2004:01-2015:04 by performing the ARDL Bounds Test. Consumer confidence was affected by the interest rate of consumer loans, unemployment rate, consumer prices, and exchange rate in the short- and long-run. The consumer confidence index is less affected by the exchange rate and consumer prices in the short-run.

Ibrahim et al. (2015) investigated the relationship between the consumer confidence index and GDP for Nigeria. As a result of the study, the consumer confidence index was described as a crucial growth indicator.

Pasarica and Popescu (2015) stated that GDP was either positively or adversely affected by certain non-linear factors such as fiscal policy, exports, agriculture, retail, construction, etc. in emerging economies such as Romania. They argued that their study provided a path between regression models and neural network backpropagation. Neural packages applied in Matlab were utilized for the analysis, and they proved that the correlation between the observed and predicted values exceeded 0.95. They concluded that neural networks had an extremely powerful nature in the GDP modeling and predicting process.

Söyler and Kızılkaya (2015) generated GDP predictions for Turkey's economy using Multiple-Layer Perception (MLP), Recurring Elman Networks, and Radial Basis Function Networks (RBFN). It was seen that the RFTA model with four input layers provided the highest value, and economic growth was predicted for the period between 2013:Q4-2014:Q4 by courtesy of this model. The study concluded that ANN was a successful model in predicting economic growth.

Beşel and Yardımcıoğlu (2016) investigated the relationships of consumer confidence index with the foreign exchange rate, petroleum prices and the unemployment rate in Turkey utilizing the monthly data obtained over the period 2005:01-2014:10 via the Gregory-Hansen cointegration, and Toda-Yamamoto causality tests. According to the results of the study, there was a cointegration relationship among variables, and the consumer confidence index could have only been expressed by exchange rate fluctuations.

Tunalı and Özkan (2016) examined the relationship between the consumer price index and consumer confidence index in Turkey over the period 2004:01-2015:12 using the Johansen cointegration and Granger causality

tests. There was a long-term cointegration relationship between consumer confidence index and consumer price index, and there was a causality running from consumer price index toward consumer confidence index according to the Granger causality test results.

Islam and Mumtaz (2016) analyzed the consumer confidence index using the panel cointegration test for the economies of England, Germany, France, Denmark, and the Netherlands over the period 1996-2012. As a result of the analysis, it was concluded that the consumer confidence index was a determinant of economic growth by influencing the consumption and saving decisions of consumers.

Vrbka (2016) mentioned the importance of artificial intelligence in predicting GDP and used the ANN model to predict the GDP growth of Eurozone countries until the year 2025. As a result of the study, it was concluded that the selected neural structures exhibited satisfactory numerical properties and were equivalent to the observed values of GDP growth.

Chuku et al. (2017) investigated the predictive performance of ANN concerning the Box-Jenkins and structural econometric modeling approaches used in predicting economic time-series in African countries. According to the results obtained from different predictions, it was stated that artificial neural network models performed much better than structural econometric and ARIMA models in predicting the GDP growth in selected border economies, especially when the relevant commodity prices, trade, inflation, and interest rates data were utilized.

Vergil and Bahtiyar (2017) analyzed the relationship between confidence and economic growth for Turkey's economy besides 28 different countries. The concept of confidence was accepted as an important component of social capital in the study. As a result of the study, it was stated that the level of confidence is one of the indicators affecting economic growth. Keeping the other variables constant, a 1-unit rise in the confidence level led to an 0.045 unit increase in per capita economic growth.

Mazurek and Mielcova (2017), in their research study using the VAR model, stated the existence of a relationship between GDP and consumer confidence index in the long-run and concluded that the changes in the consumer confidence index caused changes in GDP.

Jahn (2018) aimed at predicting the GDP growth rate of 15 industrialized economies over the period 1996-2016. It was stated in the research study

that the ANN model could have yielded much more realistic predictions of GDP growth rates rather than a corresponding linear model. Especially, it was mentioned that ANN models were quite flexible in capturing time trends.

Kasmaoui et al. (2018) investigated the relationship between economic growth and confidence for 14 different countries including Turkey in the Middle East and North Africa (MENA) region utilizing the data obtained over the period 2010-2014. As a result of the study, it was stated that the concept of social confidence had a quite important impact on all countries' economies. It was determined that a 10% rise in the social confidence level aggravates the economic growth by 0.44%. It was stated that providing an atmosphere of confidence was a prerequisite for recovery in the economy.

Aydın and Turan (2019) explicated the relationship between confidence and economic growth for Turkey's economy over the period from January 2007 to March 2019 by performing the EG and RALS cointegration tests. Although there was no relationship between the two variables in the long-run according to the results of the EG test, there was a relationship between the variables according to the RALS-EG test results. According to the test results performed in the study, economic confidence increased growth by 0.4% on average.

Aytekin and Doyar (2019), utilizing the monthly data obtained over the period 2008:01 – 2019:03, examined the relationship of consumer confidence index with the real exchange rate and industrial production for Turkey's economy via the Johansen cointegration and Granger causality tests. The variables were cointegrated in the long-run, a bidirectional causality existed between exchange rate and industrial production, and a unidirectional causality existed from the real exchange rate toward consumer confidence. There was no significant causal relationship between the consumer confidence index and industrial production.

Başarır et al. (2019) examined the relationship between consumer confidence index and macroeconomic/financial variables for Turkey's economy utilizing the data obtained over the period January 2012 - in 2018 using the VAR model. Accordingly, there was a causal relationship from consumer confidence index toward industrial production index; whereas a causality existed from BIST 100, USD, and CPI toward consumer confidence index.

Demirgil (2019) investigated the relationship between the consumer confidence index and the industrial production index utilizing the data obtained over the period 2010-2018 using the ARDL Bounds Test. A 1% rise in the consumer confidence index increased the economic growth by 0.56%.

Çoban and Balıkçıoğlu (2020) examined the relationship of economic growth with confidence, innovation, and RandD expenditures utilizing the obtained from 32 OECD countries over the period 2011-2015. Dynamic panel data analysis was performed in the study. As a result of the study, the impact of confidence, which was seen as social capital, on innovation as well as the impact of innovation on the growth level was found to be significant.

Öztürk (2020) dealt with the relationship between the consumer confidence index and economic growth in Turkey using the VAR method, Granger causality test, and variance decomposition method. As a result of the study, a bidirectional causality exists between the economic confidence index and economic growth, and the basis of the relationship is determined by the real sector confidence index as well as the confidence indexes for the service and construction sectors.

As a result of the literature review, it is observed that the consumer confidence index has been predominantly used in the studies, and some studies included the real sector confidence index and the economic confidence index. Throughout the studies, it is stated that the concept of confidence has significant impacts on economic growth and other macroeconomic indicators.

The Relationship between Economic Confidence Index and GDP in Turkey

Besides the basic macroeconomic indicators, the decisions made by economic decision-making units are also steered by future expectations. Having positive expectations for the future increases the confidence in the economy positively affects production and consumption decisions and boosts economic growth.

The economic confidence index is a composite index that summarizes consumers' and producers' evaluations, expectations, and trends regarding the overall state of the economy. The economic confidence index consists of combining the consumer confidence indicator with the seasonally-adjusted,

normalized, and weighted sub-indexes of the manufacturing industry (real sector), service, retail trade, and construction sectors (TSI, 2020). Upon establishing the economic confidence index, the weights of consumer confidence, manufacturing industry, service, retail trade, and construction sectors are determined as 20%, 40%, 30%, 5%, and 5%, respectively. The performance of the economy is evaluated in accordance with the data values in this index. If the index value is lower than 100, it means that the confidence in the economy decreases, on the contrary, if it is higher than 100, it means that the confidence in the economy increases.

Table 1. Seasonally and calendar adjusted chain-linked GDP volume index and percentage change (The Turkish Statistical Institute (TSI) t.y).

Years	Seasonally and Calendar Adjusted Annual Index Value	Calendar Adjusted Quarterly Index Value	Calendar Adjusted Annual Change (%)	Calendar Adjusted Quarterly Change (%)	Seasonally and Calendar Adjusted Quarterly Index Value	Seasonally and Calendar Adjusted Quarterly Change (%)
2007	104.4	93.7(Q1)	5.1	7.2(Q1)	103.2(Q1)	1.8(Q1)
		100.9(Q2)		3.4(Q2)	103.2(Q2)	0.0(Q2)
		108.8(Q3)		3.8(Q3)	103.8(Q3)	0.6(Q3)
		114.2(Q4)		6.4(Q4)	107.4(Q4)	3.4(Q4)
2008	105.1	99.5(Q1)	0.7	6.2(Q1)	109.6(Q1)	2.1(Q1)
		103.3(Q2)		2.5(Q2)	105.7(Q2)	-3.5(Q2)
		110.1(Q3)		1.2(Q3)	103.8(Q3)	-1.8(Q3)
		107.4(Q4)		-5.9(Q4)	107.4(Q4)	-2.5(Q4)
2009	100.0	85.5(Q1)	-4.8	-14.1(Q1)	95.4(Q1)	-5.7(Q1)
		96.4(Q2)		-6.7(Q2)	99.3(Q2)	4.0(Q2)
		108.7(Q3)		-1.2(Q3)	101.6(Q3)	2.4(Q3)
		109.3(Q4)		1.8(Q4)	103.6(Q4)	2.0(Q4)
2010	108.6	91.4(Q1)	8.6	6.9(Q1)	103.3(Q1)	-0.3(Q1)
		104.2(Q2)		8.0(Q2)	107.3(Q2)	3.8(Q2)
		118.6(Q3)		9.0(Q3)	110.2(Q3)	2.8(Q3)
		120.3(Q4)		10.0(Q4)	113.6(Q4)	3.0(Q4)
2011	120.5	102.1(Q1)	11.0	11.7(Q1)	116.1(Q1)	2.3(Q1)
		115.9(Q2)		11.3(Q2)	119.3(Q2)	2.7(Q2)
		132.0(Q3)		11.4(Q3)	122.5(Q3)	2.7(Q3)
		132.0(Q4)		9.8(Q4)	124.1(Q4)	1.4(Q4)
2012	126.2	108.5(Q1)	4.8	6.3(Q1)	123.0(Q1)	-0.9(Q1)
		122.0(Q2)		5.3(Q2)	125.2(Q2)	1.7(Q2)
		137.2(Q3)		3.9(Q3)	127.4(Q3)	1.8(Q3)
		137.3(Q4)		4.0(Q4)	129.4(Q4)	1.6(Q4)
2013	137.2	118.2(Q1)	8.7	9.0(Q1)	133.2(Q1)	2.9(Q1)
		133.7(Q2)		9.6(Q2)	137.1(Q2)	2.9(Q2)
		149.4(Q3)		8.9(Q3)	139.1(Q3)	1.5(Q3)
		147.5(Q4)		7.5(Q4)	139.4(Q4)	0.2(Q4)
2014	143.9	128.3(Q1)	4.9	8.6(Q1)	143.4(Q1)	2.9(Q1)
		137.7(Q2)		3.0(Q2)	141.1(Q2)	-1.6(Q2)

		154.4(Q3)		3.3(Q3)	144.6(Q3)	2.5(Q3)
		155.2(Q4)		5.2(Q4)	146.5(Q4)	1.3(Q4)
2015	152.5	132.9(Q1)	6.0	3.5(Q1)	149.3(Q1)	1.9(Q1)
		147.6(Q2)		7.2(Q2)	151.6(Q2)	1.5(Q2)
		164.6(Q3)		6.6(Q3)	153.7(Q3)	1.4(Q3)
		165.0(Q4)		6.3(Q4)	155.5(Q4)	1.2(Q4)
2016	157.6	139.0(Q1)	3.3	4.6(Q1)	156.1(Q1)	0.4(Q1)
		154.6(Q2)		4.7(Q2)	158.3(Q2)	1.4(Q2)
		164.4(Q3)		-0.1(Q3)	153.8(Q3)	-2.9(Q3)
		172.4(Q4)		4.4(Q4)	162.2(Q4)	5.5(Q4)
2017	169.3	146.5(Q1)	7.5	5.4(Q1)	164.4(Q1)	1.4(Q1)
		164.4(Q2)		6.3(Q2)	168.2(Q2)	2.3(Q2)
		181.7(Q3)		10.5(Q3)	170.7(Q3)	1.5(Q3)
		184.8(Q4)		7.2(Q4)	174.0(Q4)	1.9(Q4)
2018	174.5	157.5(Q1)	3.1	7.5(Q1)	176.6(Q1)	1.5(Q1)
		174.1(Q2)		5.9(Q2)	177.4(Q2)	0.5(Q2)
		186.6(Q3)		2.7(Q3)	174.6(Q3)	-1.6(Q3)
		179.8(Q4)		-2.7(Q4)	169.4(Q4)	-3.0(Q4)
2019	176.2	153.8(Q1)	1.0	-2.4(Q1)	172.3(Q1)	1.7(Q1)
		171.3(Q2)		-1.6(Q2)	175.8(Q2)	2.1(Q2)
		188.2(Q3)		0.8(Q3)	176.5(Q3)	
		191.4(Q4)		6.4(Q4)	180.1(Q4)	0.4(Q3)
						2.0(Q4)
2020	-	160.1(Q1)	-	4.1(Q1)	180.4(Q1)	0.2(Q1)
		154.4(Q2)		-9.9(Q2)	160.9(Q2)	-10.8(Q2)
		200.4(Q3)		6.5(Q3)	186.0(Q3)	15.6(Q3)

Table 1 presents the seasonally and calendar adjusted chain-linked volume indexes and percentage changes in GDP on both annual and quarterly basis which are utilized in the analyses conducted to predict the relationship between economic confidence index and economic growth rate using the methodology of the neural network. Accordingly, there is an increasing trend in both annual and quarterly index values which are calendar-adjusted over the period 2007-2020. The calendar-adjusted annual rate of change was 5.1% as of 2007, whereas it declined to 1.0% in 2019.

Tablo 2. Monthly economic confidence index (2007-2020). (The Turkish Statistical Institute (TSI), t.y)

Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2007	111.2	108.3	108.4	109.9	104.2	108.1	109.0	111.9	110.9	107.5	106.7	108.0
2008	104.8	101.7	98.0	92.3	90.5	90.1	89.2	92.0	87.3	73.5	60.4	62.0
2009	63.0	66.0	68.4	82.1	91.9	94.2	95.5	95.3	94.5	93.9	93.4	94.3
2010	98.9	98.2	102.5	106.2	103.7	104.1	104.6	106.1	108.4	107.1	109.2	109.6
2011	114.0	112.1	111.6	111.2	111.5	112.2	111.2	108.6	111.2	106.8	107.7	107.3
2012	105.5	107.0	107.0	105.4	106.2	104.4	106.8	104.6	103.9	102.5	103.8	102.7
2013	103.9	105.6	106.6	105.6	107.0	107.1	106.0	106.5	105.0	106.8	107.2	105.2
2014	102.0	100.9	102.5	104.5	104.5	103.8	102.4	102.9	104.9	105.3	101.8	102.6
2015	102.8	102.7	99.8	101.4	101.6	100.7	100.8	100.0	96.5	99.2	104.7	104.0

2016	100.8	97.8	99.7	98.4	100.2	100.5	103.0	98.2	102.6	101.1	102.1	97.4
2017	94.0	98.9	101.8	103.2	104.1	103.8	106.4	108.7	107.4	106.2	103.5	101.7
2018	107.4	106.7	104.5	102.5	99.7	97.2	97.7	91.9	83.1	80.4	85.5	86.7
2019	84.1	84.4	87.0	88.7	82.6	88.4	85.7	90.9	90.1	93.6	95.0	97.2
2020	98.3	98.3	93.1	52.4	62.7	73.5	83.1	85.9	88.5	92.8	89.5	86.4

Table 2 presents monthly economic confidence index data over the period 2007-2020. Economic confidence index data are calculated by TSI using seasonally-adjusted sub-indexes. Although the economic confidence index value was 111.2 in January 2007, it was calculated as 108.0 in December. The economic confidence index value was 98.3 in January 2020, then it decreased to 86.4 in December. The economic confidence index, which was 93.1 in March 2020, has decreased rapidly to 52.4 in April due to the crisis caused by the COVID-19 outbreak. Although the value of the economic confidence index indicates an enhancing trend with the impact of the monetary and fiscal policies implemented since April 2020, upon considering that the adverse impacts of the COVID-19 pandemic on the economy would continue to rise throughout the year 2021, it is predicted that the confidence of producers and consumers in the economy would be plunging in the coming period and economic growth would be slowing down.

Dataset and Methodology

As a measure of economic growth, the Gross Domestic Product (GDP) is closely related to the confidence of the actors that make up the economic environment in the economy, as well as the basic macroeconomic variables. In this regard, it is essential that a model that can be established for the aim of GDP prediction includes only the lagged observed (past period) variables of GDP, but also the observed values of the ECI variable in terms of the model's satisfactory predictive performance. Keeping this in mind, in this study, the GDP time-series data consisting of 55 observations over the period 2007:Q1– 2020:Q3 as well as the monthly ECI time-series observed in the same period are analyzed using both feedforward and feedback artificial neural networks via multivariate models.

For the purpose of time-series prediction, different types of artificial neural networks that do not cover assumptions and limitations such as the stationarity of classical methods, model structure, normal distribution have been widely and effectively used especially within the last few decades. One

of them was multilayer perceptrons proposed by Werbos (1974) in order to solve nonlinear problems, whereas redesigned and developed later by Rumelhart et al. (1986). In this study, multilayer perceptron artificial neural network types such as feedforward neural network (FFNN) and feedback ELMAN neural network (FBeNN) are utilized for the prediction of GDP time-series data. In both neural network architecture structures, the observed values of the GDP time-series data of the previous quarter as well as the observed values including the three months prior to the quarter period which are intended for the prediction of the ECI time-series data are used as inputs. With a more concrete example, upon predicting the GDP value for the third quarter (September) of 2020, the GDP value of the second quarter (June) of 2020, and the ECI values of May, April, and March 2020 would constitute the inputs of the neural networks as observed values. Thus, both FFNN and FBeNN are used in order to establish a multivariate prediction model for each. Output for both neural networks would comprise the prediction of GDP value of the third quarter of 2020.

The FFNN, in general, consists of three layers. These are the input layer, hidden layer(s), and output layer. Each layer is a collection of units called nerve cells (neurons). Neurons are connected to each other by weights and there is no connection among the neurons of the same layer. The connections represented by weights among the neurons of different layers are forward and unidirectional. The FFNN architecture used in this study is illustrated in Figure 1.

The FFNN, in general, consists of three layers. These are the input layer, hidden layer(s), and output layer. Each layer is a collection of units called nerve cells (neurons). Neurons are connected to each other by weights and there is no connection among the neurons of the same layer. The connections represented by weights among the neurons of different layers are forward and unidirectional. The FFNN architecture used in this study is illustrated in Figure 1.

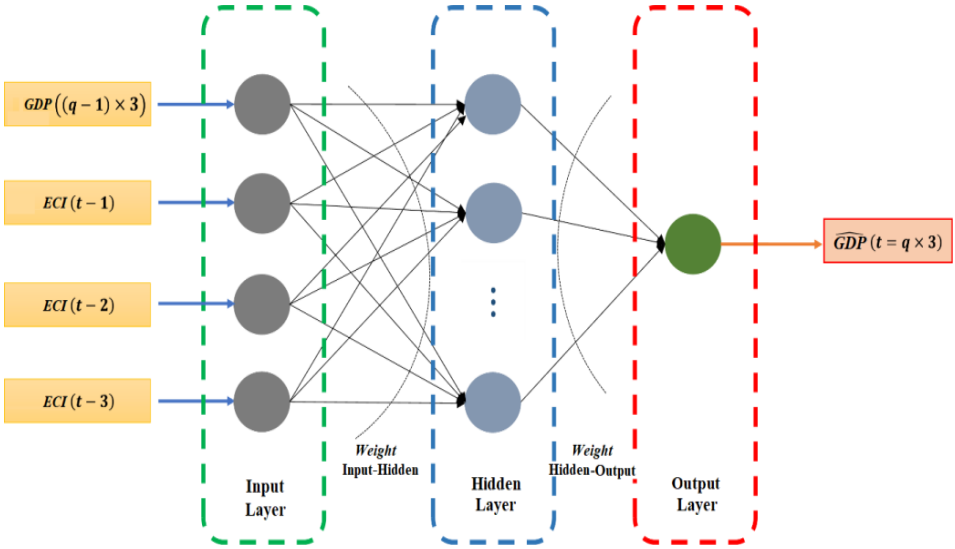

Figure 1. FFNN Architectural Structure

In this study, FBeNN, having the simplest structure among the feedback artificial neural network types proposed by Elman (1990), is another type of neural network used for GDP prediction. FBeNN includes the input-hidden and output layers as well as the context layer that indicates the hidden layer outputs as input to the network and feedback mechanism. Thus, the neural network performs its learning with more information. The architecture structure of an FBeNN is illustrated in Figure 2.

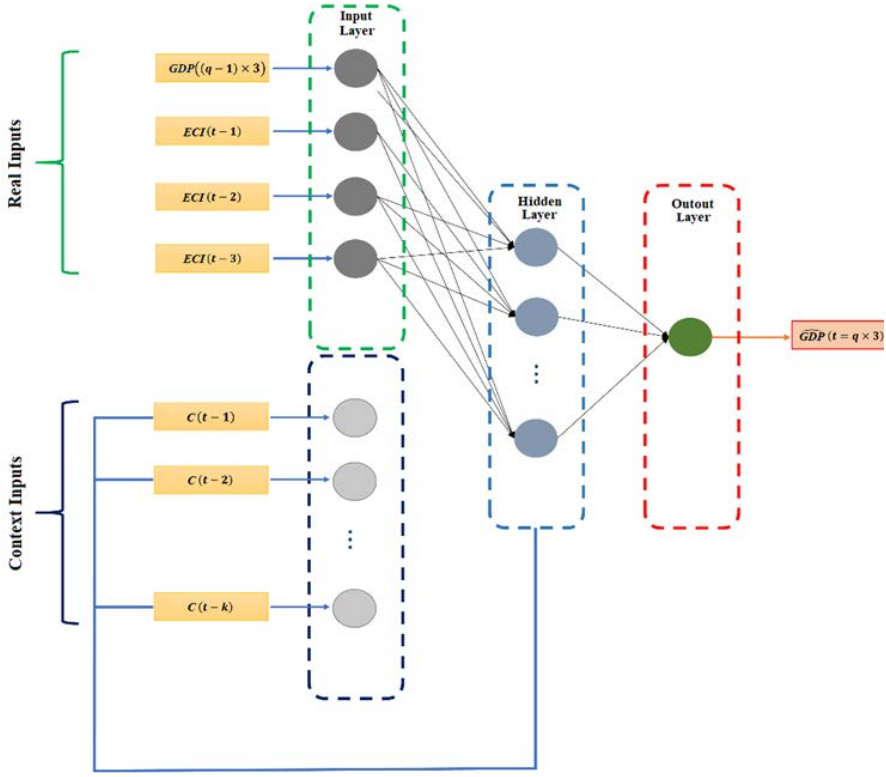

Figure 2. FBeNN Architectural Structure

With neural networks, two distinct time-series predictions for each quarter, which consist of both annual (compared to the same quarter of the previous year) and quarterly (compared to the previous quarter) percentage changes in GDP are generated. Thus, the predictions of both annual and quarterly percentage changes in GDP are realized. The first 51 observations regarding GDP are used in training neural networks, whereas the observations of the last four quarters are used for prediction to evaluate the performance of neural networks.

The time-series of both annual and quarterly percentage changes in GDP consisting of 55 observations over the period 2007:Q1 – 2020:Q3 in Turkey are illustrated in Figures 3 and 4, respectively.

Figure 3. Annual Percentage Change in GDP

Figure 4. Quarterly Percentage Change in GDP

In the prediction process, the sigmoid (logistic) activation function given in Equation (1) is used in the hidden layers of both neural networks, while the linear activation function given in Equation (2) is used in the output layers of the networks besides the sigmoid activation function. Thus, 4 different neural networks are used for GDP prediction.

$$f(x) = \frac{1}{1+exp(-x)} \quad (1)$$

$$f(x) = x \quad (2)$$

In each neural network, a single hidden layer is used and the obtained results are evaluated according to the hidden layer unit numbers ranging between 1-12. For each neural network, the number of input layer units is 4, and the number of output layer units is 1. Three of the inputs are composed of the previous period's ECI values, whereas one is composed of the previous quarter's GDP value. The Levenberg-Marquardt (LM) (Levenberg, 1944) learning algorithm is used as the learning algorithm. As a performance criterion, the error criterion "root mean square error" (*RMSE*) presented by Equation (3) is selected.

$$RMSE = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Predicted_t - Observed_t)^2} \quad (3)$$

The findings regarding prediction performances reveal in the best architectures by 4 different neural networks for the prediction of the annual and quarterly change in GDP are summarized in Table 1.

Table 3. Prediction results of annual and quarterly changes in GDP / RMSE

		FFNN		FBeNN	
GDP	Dataset	Hidden Layer Activation Function			
		Linear	Sigmoid	Linear	Sigmoid
Annual	Training	0.8103	0.9932	0.6723	**0.3749**
	Test	0.8281	0.9817	**0.7962**	0.9573
Quarterly	Training	0.6812	**0.1948**	0.7405	0.2705
	Test	1.3344	**0.1134**	1.2206	0.2551

Upon considering the results presented in Table 3; regarding the annual percentage changes in GDP of 55 observations over the period 2007:Q1 – 2020:Q3 in Turkey, it is seen that the best prediction results (0.3749 RMSE) of the training dataset consisting of the first 51 observation are produced by FBeNN with hidden layer units in which sigmoid activation function is utilized. Moreover, the highest prediction performance (0.7962 RMSE) for the test dataset consisting of the last 4 observations regarding the annual percentage change in GDP is achieved by FBeNN with hidden layer units in

which the linear activation function is utilized. Regarding the quarterly percentage changes in GDP of 55 observations over the period 2007:Q1 – 2020:Q3 in Turkey, it is seen that good prediction results of both training and test datasets (0.1948 and 0.1134, respectively) are achieved by FFNN with hidden layer units in which sigmoid activation function is utilized. Besides, upon considering both activation functions, it is observed that FBeNN is more successful in predicting the relevant annual percentage change in GDP time-series in both training and test datasets compared to FFNN, whereas the neural networks with hidden layers in which sigmoid activation function is used achieved more successful outputs rather than the neural networks with hidden layer units in which linear activation function is used. On the other hand, each neural network is presumed to generate predictions with fairly low and acceptable errors by utilizing both training and test datasets regarding the time-series of both annual and quarterly percentage changes in GDP. The superior performances of both neural networks in predicting the annual percentage changes in GDP can also be illustrated by the scatter plot diagrams in Figure 5, which include the distribution of both observed and predicted values of GDP.

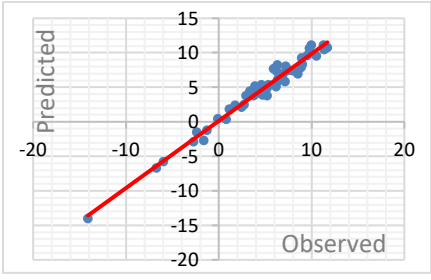

Figure 5.a. GDP annual-Training-FFNN-L

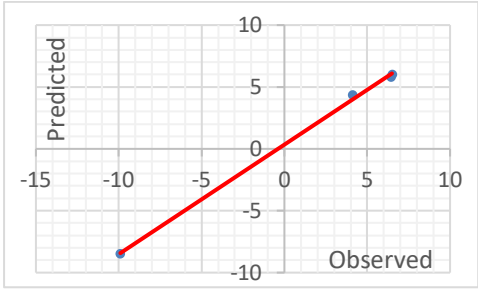

Figure 5.b. GDP annual-Test-FFNN-L

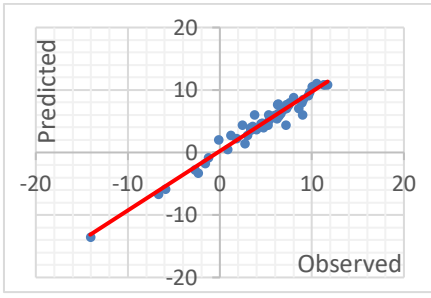

Figure 5.c. GDP annual-Training-FFNN-S

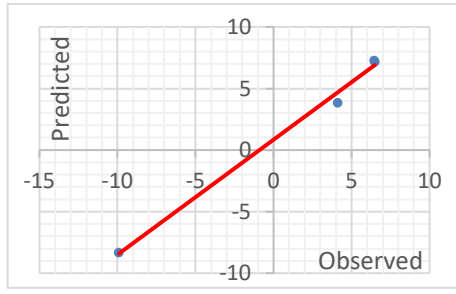

Figure 5.d. GDP annual-Test-FFNN-S

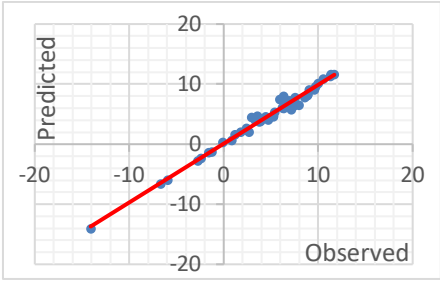

Figure 5.e. GDP annual-Training-FBeNN-L

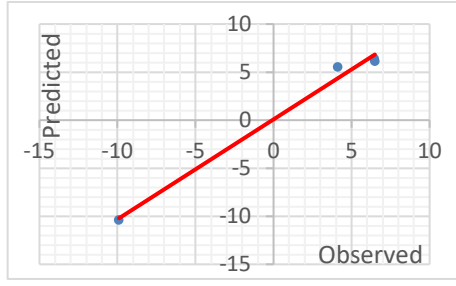

Figure 5.f. GDP annual-Test-FBeNN-L

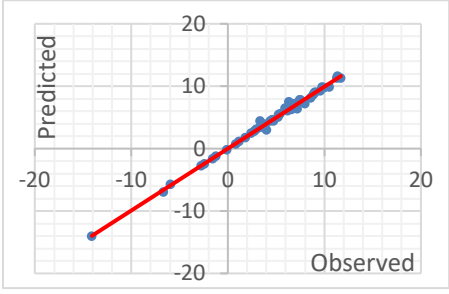

Figure 5.g. GDP annual-Training-FBeNN -S

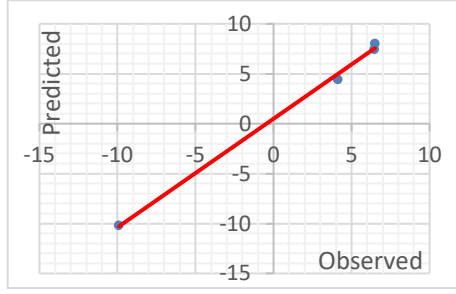

Figure 5.h. GDP annual-Test-FBeNN -S

Figure 5. Observed and Predicted GDP Annual Growth Rates

To achieve satisfactory predictive outcomes, the dispersion of the points in the relevant scatter plot diagrams is expected to be as close to the given line as possible. This situation is an indicator of the convergence of the predicted and observed values. Upon considering Figure 5, it can be claimed

that the relevant points scatter quite close to the determined line, and therefore, the neural networks that are used in predicting the annual percentage change in GDP for both training and test datasets, that is, growth rates compared to the same quarter of the previous year, achieve quite successful and satisfactory outcomes.

Scatter plot diagrams illustrated in Figure 6, which include the distribution of the predicted and observed GDP values, can also be used as another visual proof to demonstrate the successful performance of neural networks in predicting the quarterly percentage changes in GDP.

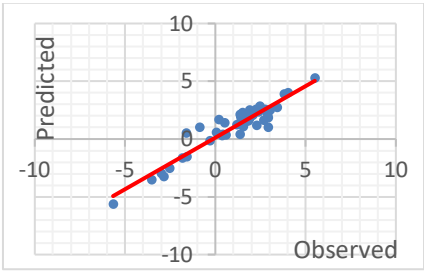

Figure 6.a. GDP quarterly -Training-FFNN-L

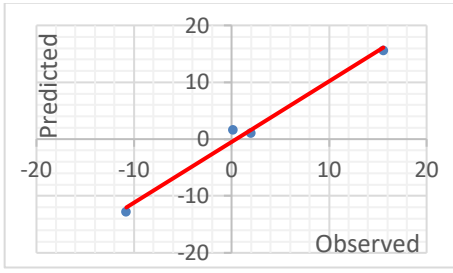

Figure 6.b. GDP quarterly -Test-FFNN-L

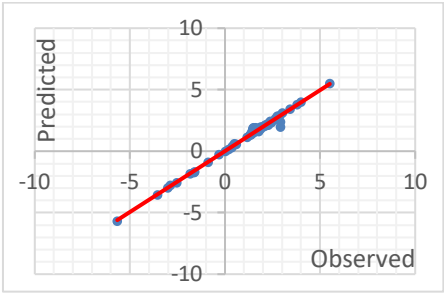

Figure 6.c. GDP quarterly -Training-FFNN-S

Figure 6.d. GDP quarterly -Test-FFNN-S

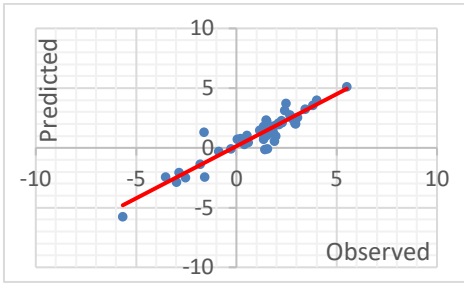

Figure 6.e. GDP quarterly -Training-FBeNN-L

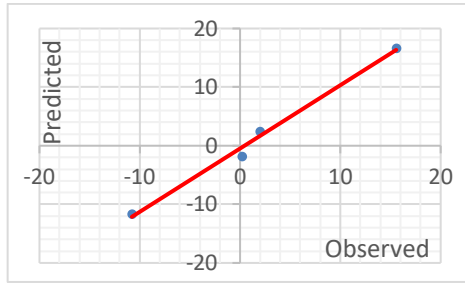

Figure 6.f. GDP quarterly -Test-FBeNN-L

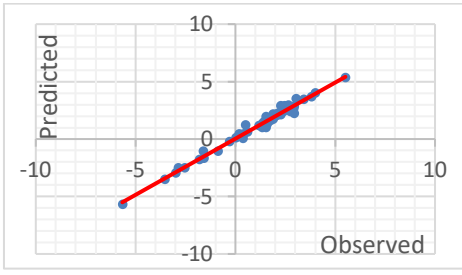

Figure 6.g. GDP quarterly -Training-FBeNN-S

Figure 6.h. GDP quarterly -Test-FBeNN-S

Figure 6. Observed and Predicted GDP Quarterly Growth Rates

Comments made for Figure 5 also apply for Figure 6. Here, the plots formed by the quarterly percentage changes in GDP scattering almost directly above the line pertinent to the predictions generated by both FFNN and FBeNN with hidden layer units in which the sigmoid activation function is used can be presented as proof of extremely successful predictive results. Even in cases where the linear activation function is used in hidden layer units, the relevant plots scattering over the line without significant deviations for both training and test datasets indicate that neural networks generate outcomes with satisfactory predictive accuracy.

Within the scope of this study, another approach that can be used to evaluate the performance of 4 neural network models with different characteristics utilized in predicting both the annual and quarterly percentage changes in GDP is the analysis of a simple linear regression model in which the

predicted and observed values the GDP change rate are used as the independent and dependent variables, respectively, without a constant term. This model can be formulated as shown by Equation (4).

$$Y_t = \beta \hat{Y}_t + \varepsilon_t \quad (4)$$

For satisfactory prediction results, the estimated regression coefficient ($\hat{\boldsymbol{\beta}}$) and the coefficient of determination ($\boldsymbol{R^2}$) for this regression model are expected to be as close to 1 as possible. The obtained findings regarding the analysis of the relevant regression model are summarized in Table 2.

Table 4. Summarized findings of the regression analysis

GDP	Neural Network	$\hat{Y} = \hat{\beta} Y_{predicted}$	95% Confidence Interval for β		R^2
			Lower Bound	Upper Bound	
Annual	FFNN-L	$\hat{Y}$ = 1.007179 $Y_{predicted}$	0.974003	1.040354	0.985633
	FFNN-S	$\hat{Y}$ = 1.006253 $Y_{predicted}$	0.965544	1.046963	0.978485
	FBeNN-L	$\hat{Y}$ = 0.997006 $Y_{predicted}$	0.969430	1.024583	0.989827
	FBeNN-S	$\hat{Y}$= 0.994008 $Y_{predicted}$	0.976239	1.011777	0.995725
Quarterly	FFNN-L	$\hat{Y}$= 0.958621 $Y_{predicted}$	0.901333	1.015910	0.954217
	FFNN-S	$\hat{Y}$= 1.000406 $Y_{predicted}$	0.985261	1.015551	0.996931
	FBeNN-L	$\hat{Y}$= 0.953167 $Y_{predicted}$	0.893433	1.012902	0.949881
	FBeNN-S	$\hat{Y}$= 1.002075 $Y_{predicted}$	0.980547	1.023603	0.993838

The findings that are summarized in Table 4 can be taken into consideration from different aspects. First of all, the regression coefficients of the regression models regarding the predicted and observed values of both annual and quarterly percentage changes in GDP for each neural network model are quite close to 1 as expected, which is proof of the high level of harmony between the predicted and observed values, meaning, the superior prediction accuracy. Secondly, in favor of this finding, based on the confidence intervals established for the relevant regression coefficients, it can be said that these coefficients are 1 within a 95% confidence interval, hence, indicating high predictive accuracy. Furthermore, the expected high (as close to 1 as possible) level of a linear relationship between the predicted and observed percentage changes in GDP is revealed by the fact that the coefficients calculated for the regression models are quite close to 1. In the light of all these findings, prediction models which are generated by using different neural networks and taking into account the economic relations between GDP and ECI achieve quite successful and satisfactory outcomes.

Discussion and Conclusion

GDP, as a measure of economic growth, can be expressed as the total value of the final production of goods and services in a given period, the total expenditure made to purchase the outputs of the production, and thus the total income earned by all factors of production. In this respect, GDP contains basic information regarding the size and strength of an economy. This study aims to predict calendar (yearly) and seasonally (quarterly) adjusted chain-linked changes in the GDP volume index as a measure of economic growth. At this point, based on the fact that economic growth in the light of basic economic indicators is closely associated with the confidence of the actors that constitute the economic domain in the economy, past observations of the GDP, as well as the past period values of the ECI, are used as model inputs in the prediction model to be established. In the analysis of the established prediction model, feedforward and feedback artificial neural networks utilizing different activation functions are used as predictive tools. In this context, the economic growth data consisting of both annual and quarterly changes with 55 observations over the period 2007:Q1–2020:Q3 are analyzed along with the monthly ECI data obtained over the same period using 4 different tools of neural network prediction via multivariate models. Upon evaluating the analysis results, it is seen that neural network models utilizing the sigmoid activation function, especially in hidden layer units, yield a superior prediction accuracy, as well as the other models that also exhibit quite satisfactory and successful predictive performance.

One of the main reasons for successfully predicting growth rates with neural networks involves the fact that neural networks, which are used as prediction tools, utilize the ECI data as inputs for the three months that have been observed before the relevant quarter during the analysis. Such a success, which emerged with the use of confidence in the economy as an auxiliary variable in predicting growth rates, can also be considered as proof of the relationship between these two economic variables. In short, the economic growth of the country is closely associated with the level of confidence in the economy, and by using confidence level information, future growth rates can be successfully predicted through an appropriate prediction tool.

In future studies, it would be reasonable to concentrate on hybrid prediction models in which the inputs of different neural network types determined by classical time-series prediction models which may be used to predict changes in GDP can be.

Kaynakça / References

Aarle, B. and Kappler, M. (2012). Economic sentiment shocks and fluctuations in economic activity in the Euro area and the USA. *Intereconomics: Review of European Economic Policy, 47*(1), 44-51.

Arısoy İ. (2012). Türkiye ekonomisinde iktisadi güven endeksleri ve seçilmiş makro değişkenler arasındaki. İlişkilerin VAR analizi. *Maliye Dergisi,* 162, 305-315.

Aydın, M. and Turan, Y. E. (2019). Türkiye'de ekonomik güven büyümeyi etkiliyor mu? RALS birim kök ve eşbütünleşme yaklaşımı. *Ekoist: Journal of Econometrics and Statistics,* 32, 1-16.

Aytekin, İ. and Doyar, B. V. (2019). Türkiye'de döviz kuru dalgalanmalarının sanayi üretimi ve tüketici güveni üzerindeki etkisi: 2008-2019. *Uluslararası Bilimsel Araştırmalar Kongresi,* Gölbaşı - Adıyaman, 913-923.

Başarır, Ç., Bicil, İ. M. and Yılmaz, Ö. (2019). The relationship between selected financial and macroeconomic variables with consumer confidence ındex. *Journal of Yaşar University,* 14, 173-183.

Beşel, F. and Yardımcıoğlu, F. (2016). Tüketici güven endeksi ile makro değişkenler arasındaki ilişki, *Uluslararası Politik, Ekonomik ve Sosyal Araştırmalar Kongresi Bildiriler Kitabı*, 475-487.

Boulila, G., Bousrih, L. and Trabelsi, M. (2008). Social capital and economic growth: empirical investigations on the transmission channels. *International Economic Journal, 22*(3), 399-417.

Chuku, C., Oduor, J. and Simpasa, A. (2017). Intelligent forecasting of economic growth for African Economies: Artificial neural networks versus time series and structural econometric models. *Washington Research Program on Forecasting*, 1-28.

Çelik, S., Aslanoğlu, E. and Uzun, S. (2010). Determinants of consumer confidence in emerging economies: a panel cointegration analysis. Topics in *Middle Eastern and African Economies,* 12, 1-19.

Çoban, H. and Balıkçıoğlu, E. (2020). Güven, inovasyon ve ekonomik büyüme ilişkisi. *Maliye Araştırmaları Dergisi,* 6(3), 1-16.

Demirgil, B. (2019). Ekonomik büyümede güven faktörünün etkisi: Türkiye örneği. *Avrasya Sosyal ve Ekonomi Araştırmaları Dergisi, 6*(3), 155-163.

Düzgün, R. (2008). A comparison of artificial neural networks and ARIMA models success in GDP forecast. *Marmara Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 25*(2), 165-176.

Elman, J. (1990). Finding structure in time. *Cognitive Science,* 14, 179-211.

Golinelli, R., and Parigi, G. (2004). Consumer sentiment and economic activity. *Journal of Business Cycle Measurement and Analysis,* 2, 147-170.

Gürgür, T. and Kılınç, Z. (2015). What drives the consumer confidence in Turkey? *Research Notes in Economics,* 17, 1-13.

İbicioğlu, M., Kapusuzoğlu, A. and Karan, M. (2013). Türkiye'deki tüketici güven endeksi ile döviz kuru arasındaki ilişkinin ampirik analizi. *İşletme Araştırmaları Dergisi, 5*(1), 5-16.

Ibrahim, A., Bawa, S., Abdullahi, I.S., Digigu, C. E. and Mainasara, S. (2015). Consumer confidence indicators and economic fluctuations in Nigeria. *CBN Journal of Applied Statistics, 6*(1), 285-300.

Islam, T. and Mumtaz, M. (2016). Consumer confidence index and economic growth: an empirical analysis of EU countries. *EuroEconomica, 2*(35), 17-22.

Jahn, M. (2018). Artificial neural network regression models: predicting GDP growth. *Hamburg Institute of International Economics,* 185, 1-15.

Junoh, M. Z. H. M. (2004). Predicting GDP growth in Malaysia using knowledge – based economy indicators: a comparison between neural network and econometric approach. *Sunway College Journal,* 1, 39- 50.

Kasmaqui, K., Mughal, M. and Bouoiyour, J. (2018). Does trust influence economic growth? evidence from the Arab world. *Economics Bulletin, 38*(2), 880-891.

Knack, S. and Keefer, P. (1997). Does social capital have an economic payoff ?. *Quarterly Journal of Economics,* 112, 1251-1288.

Levenberg, K. (1944). A method for the solution of certain non-linear problems in least squares. *The Quarterly of Applied Mathematics, 2*(2), 164-168.

Ludvigson, S.C. (2004), Consumer confidence and consumer spending. *Journal of Economic Perspectives,* 18, 29–50.

Matsusaka, J. and Sbordone, A. (1995). Consumer confidence and economic fluctuations. *Economic Inquiry,* 33(2), 296-318.

Mazurek, J. and Mielcova, E. (2017). Is consumer confidence index a suitable predictor of future economic growth? an evidence from the USA. *E+M: Ekonomie a Management, 20*(2), 30-46.

Özsağır, A. (2007). Ekonomide güven faktörü. *Elektronik Sosyal Bilimler Dergisi,* 6, 46-62.

Öztürk, M. (2020). Türkiye'de güven endeksleri ve ekonomik büyüme ilişkisi. Article in *The Journal of Turk-Islam World Social Studies, 7*(25), 59-79.

Pasarica, A. E. and Popescu, M. (2015). Prediction of the GDP of Romania using neural networks. *Interdisciplinary Approaches Between Traditional and Modern Methods Nord 1 International Conference,* Romania.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple repressors. *Oxford Bulletin of Economics and Statistics,* 61, 653–678.

Pedroni, P. (2004). Panel cointegration; asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory, 20*(3), 597-625.

Rumelhart, E., Hinton, G. and Williams, R. (1986). Learning Internal Representations by Error Propagation in: The M.I.T. Press. Cambridge, 318–362.

Söyler, H. and Kızılkaya, O. (2015). Türkiye'nin GSYH tahmini için yapay sinir ağları model performanslarının karşılaştırılması. *Cumhuriyet Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 16*(1), 45-58.

Toda, H. and Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics, 66*(1-2), 225-250.

TSI (2020). *Statictics data protal.* Retrieved from https://data.tuik.gov.tr/Kategori/GetKategori?p=ekonomik-guven-117anddil=1 on 01.30.2020.

Tunalı, H. and Özkan, İ. (2016). Türkiye'de tüketici güven endeksi ve tüketici fiyat endeksi arasındaki ilişkinin ampirik analizi. *İktisat Politikası Araştırmaları Dergisi, 3*(2), 53-66.

Türkan, E. (2001). Türkiye'de 2001 krizi ve güven faktörü. *Yeni Türkiye Dergisi, Ekonomik Kriz Özel Sayısı, 7*(41). 1.

Utaka, A. (2003). Confidence and real economy- the Japanese case. *Applied Economics,* 35(3), 337-342.

Vergil, H. and Bahtiyar, B. (2017). Ekonomik büyüme farklılıklarının açıklanmasında sosyal sermayenin etkisi: güven düzeyi üzerinden karşılaştırmalı bir analiz. *Uluslararası Yönetim İktisat ve İşletme Dergisi, 13*(3), 673-686.

Vrbka, J. (2016). Predicting future GDP development by means of artificial intelligence. *Littera Scripta, 9*(3), 154-167.

Werbos, P.J. (1974). *The roots of backpropagation.* John Wiley and Sons, New York.

Westerlund, J. (2007). Testing for error correction in panel data. *Oxford Bulletin of Economics and Statistics, 69*(6), 709-748.

Westerlund, J. and Edgerton, D. (2007). A panel bootstrap cointegration test. *Economics Letters, 97*(3), 185-190.

Zak, P. and Knack, S. (2001). Trust and growth. *Economic Journal Royal Economic Society, 111*(470), 295-321.

Zanin, L. (2010). The relationship between changes in the economic sentiment indicator and real GDP growth: A time-varying coeffcient approach. *Economics Bulletin, 30*(1), 837-846.

Kaynakça Bilgisi / Citation Information

Cinel, E.A. ve Yolcu, U. (2021). Economic confidence index and economic growth relationship: Prediction with Artificial neural networks in the case of Turkey. *OPUS–International Journal of Society Researches, 17*(36),2490-2517. DOI: 10.26466/opus.885417