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A STOCHASTIC FRONTIER ANALYSIS OF COST EFFICIENCY IN TURKISH CEMENT INDUSTRY

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Serkan Sengul[1], Yilmaz Koprucu[2], Hakan Yildiz[3]
[1]Yalova University, Yalova, Turkiye.
sengulserkan77@gmail.com , ORCID: 0000-0001-9891-9477
[2]Eskisehir Osmangazi University, Department of Economics, Eskisehir, Turkiye.
ykoprucu@ogu.edu.tr , ORCID: 0000-0002-9539-7957
[3]Istanbul Yeni Yuzyil University, Vocational School, Istanbul, Turkiye.
hakanyildiz2005@gmail.com , ORCID: 0000-0002-3611-2755

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ABSTRACT

Purpose - The main focus of this paper is to measure cost efficiency in Turkish Cement Industry using firm level data over the period 2008-2016. The measurement of cost efficiency in the industry in which there can seem usually competition infringement is of great importance regarding effective allocation of resources. The ineffective allocation of resources can bring about cost inefficiency.
Methodology - In this study, efficiency is measured using a frontier analysis approach, which quantifies efficiency as the gap between the best achievable performance and actual performance. The Stochastic Frontier Analysis (SFA) method is employed to assess cost efficiency of each firm in this manner. By incorporating both statistical error and inefficiency, the SFA method recognizes that deviations from optimal performance can arise from both random errors and inefficiency factors.
Findings- Empirical results show that cost efficiency scores vary between 82% and 93% by different models. The results also indicate a wide range of cost efficiencies across different size cement firms. The lowest cost efficiency score is estimated by TFE, BC95, and PL81 models in 2015.
Conclusion- Average cost efficiency score varies between approximately 93% and 82%, which means that the firms can potentially achieve at least 7% and a maximum of 18% reduction in input costs.

Keywords: Stochastic frontier analysis, cement industry, cost efficiency, efficiency estimation, time-varying, invariant efficiency.
JEL Codes: D24, C51, L61

1. INTRODUCTION

Cement industry is of great importance for Türkiye since construction sector has been an engine of the economy for years. The industry has been sufficiently met domestic and foreign demand, increased revenues of the country through exports. Moreover, the sector offers employment opportunities. According to the October 2022 report of Republic of Türkiye Ministry of Trade, cement is one of the most exported product segments. In the January-October 2022 period, the sector achieved an increase of 14.1% in export revenue with 3.2 billion dollars compared to the same period of the previous year (2.8 billion dollars).[1] While there are 66 enterprises in cement manufacturing in 2020, this sector has provided employment to 19 thousand people in the field of production.[2]

[1]See October foreign trade statistics tables of Republic of Türkiye Ministry of Trade, the table of the most exported 20 product segments.
[2]See Turkish Statistical Institute (TurkStat)-Business Records Statistics and Cement Industry Report (2020) of Republic of Türkiye Ministry of Industry and Technology.

In cement sector, 38% of the total cost is fuel, and %21 is electricity in the process of cement manufacturing in Türkiye. Primary materials and labor costs are 10% and 9% of the total cost, respectively. It is seen that private housing construction have the highest share in cement demand in Türkiye. Türkiye ranks first in Europe in terms of ready mixed concrete production. Although the increasing uncertainties in the Middle East in recent years have negatively affected Türkiye's cement exports, the highest exports are made to the Middle Eastern countries (Çevik, 2016).

Efficiency is basically an indicator of success in achieving the goal. Therefore, a firm is efficient the extent to which it is successful in the field where it is active (Aydın and Kök, 2013). The word of efficiency is used in many fields besides economics and business literature and is defined as "the capacity to achieve maximum return with minimum effort or cost". Economic efficiency is formed of productive efficiency and allocative efficiency including conditions related to Pareto optimum. That's why, the concept of economic efficiency is also defined as allocative efficiency and static efficiency (Kök and Deliktaş, 2003: 43-44). Technical efficiency is the degree to which the output of the related sector is being maximized for a given amount of inputs or the degree to which average production costs are minimized in the long run. Allocative efficiency is the degree to which resources available to the sector are being supplied to the use with the highest expected value (Falkena et. al., 2004). Lovell (1993) states that if the goal of the production is cost minimization, an estimation of cost efficiency is ensured by the ratio of minimum cost to observed cost. And the researcher stresses that a firm is cost efficient if, and only if, it is technically and allocatively efficient.

Our main focus is to measure cost efficiency in Turkish Cement Industry using firm level data over the period 2008-2016. The measurement of cost efficiency in the industry in which there can seem usually competition infringement is of great importance regarding effective allocation of resources. As Abel and Marire (2021) pointed out, the ineffective allocation of resources can bring about cost inefficiency. In addition, the expansion of the related literature is another source of motivation for the study.

This study is organized as follows. Section 2 presents related literature review and Section 3 provides details on the data set and methodology. Section 4 discusses empirical results. Finally, Section 5 provides concluding remarks.

2. LITERATURE REVIEW

The concept of efficiency refers to the relationship between input and output. Efficiency can be classified as technical, allocation, scale and scope efficiency. Technical efficiency refers to whether the input produces the amount of input that it is capable of producing. For example, if a hospital can produce 800 units with an input that has the potential to produce 1000 units of output, then it is 20% inefficient or 80% efficient. Allocative efficiency measures whether the firm chooses the less costly input combination to produce the output. Finally, scale efficiency is used to target the size at which the firm can produce most efficiently (Rosko and Mutter, 2011).

Farrell defined technical efficiency as the ratio of the observed output of the firm to the output at the frontier, which is the maximum output that can be achieved. According to this framework, a hospital can be characterized as technically efficient if it operates above the best practice production frontier of its sector. In the original Farrel study, all observations had the same technology access level (Farrel, 1957). Farrell was the first to use the frontier method in 1957 by determining the efficiency of each firm according to its distance from the best practice production frontier formed by the firms in the sector. Thus, Farrell can be considered the father of boundary analysis.

It is possible to come across many studies in the literature regarding cost efficiency. Within the scope of this study, cost-effectiveness studies, are briefly included in the literature review. Holló and Nagy (2006) try to explain the efficiency differences of banks operating in 25 EU countries and their reasons. Using the stochastic frontier approach (SFA), the X-efficiency (cost-efficiency) of 2459 banks over the period 1999-2003 and the alternative profit-efficiencies were estimated in two different models, controlling for country-specific variables and non-controlling. The authors added environmental variables to the second model to reduce the distorting effect of size and other operational deviations on efficiency estimates. According to the first model, in which environmental factors are not considered, the average cost effectiveness in 25 EU countries was found to be 85%. In addition, it has been observed that the average cost efficiencies in the old EU countries are higher than the cost efficiencies in the new EU countries during the period under consideration. However, a significant catch-up process has emerged over time in the new member states, as their cost-effectiveness has increased significantly and the efficiency gap with the former member states has narrowed. On the other hand, when environmental factors are taken into account, similar results were obtained except for the lower cost-efficiency gaps between the old and new states. According to the results of the snow efficiency model, in which environmental factors are not considered, the authors reached an average of 69% snow efficiency level in all EU countries. Although it is slightly higher in the old member countries, no significant difference has been reached in the average snow efficiency scores between the old and new member countries.

Weill (2007) makes a comparison between banking activities in eastern and western EU countries. The study measures cost-efficiency in 11 Western and 6 Central and Eastern European countries (CCE) between 1996 and 2000. Cost-efficiency results using stochastic frontier analysis show that banks in Western European countries are more efficient than banks in Central and Eastern European countries. According to the author, this result means that there is a cost-efficiency gap between the banking systems in the two regions. Weill (2007) included different environmental factors in the cost model in order to see whether the said deficit was caused by environmental factors. According to the predicted inefficiency effects model, the author concluded that the weak managerial performance especially in Eastern European banks and the efficiency gaps between them and Western European banks are due to differences in risk preferences.

Kasman and Yıldırım (2006) analyzed the cost and profit efficiency of European banks in their studies. Cost and profit efficiencies of 190 commercial banks operating in 8 Eastern and Western European countries between 1995-2002 were obtained with the help of stochastic frontier analysis. In addition, using Battese and Coelli's (1995) single-stage SFA model, the effect of foreign ownership on bank efficiency was examined along with different country-specific variables. According to the results obtained, the average cost inefficiency of banks is 20.7%; the average profit inefficiency was found to be 36.7%. On the other hand, the fact that the cost efficiency of the banking system in the countries included in the sample is higher than the profit efficiency shows that the banks are more effective in controlling their costs rather than making a profit. According to the authors, the cost and profit inefficiencies of banks vary between countries and groups of banks of different sizes. However, foreign banks were found to be more efficient than domestic banks on average. Ekinci (2018) examines the cost efficiency and determinants of 156 commercial banks operating in European Union countries. As far as the study is concerned, cost efficiency of banks falls with the global crisis and European debt crisis.

3. DATA AND METHODOLOGY

3.1. Data

We define total cost as a dependent variable, an output variable and three input prices, the price of capital, wages, and the price of the primary materials and supplies in *Table 1*.

Table 1: Definition of the Variables

Variables	Symbol		Definition
Independent variable	tc	Total cost	Total costs associated with the production
	p_k	Price of capital	Deprecation / tangible fixed assets + interest rates of the government debt securities
Input Prices	p_l	Price of labor	Total personnel expenditure / number of employee
	p_r	Price of primary materials	(Total cost of the primary materials + other production expenses) / cement
Output	q	Quantity of production	Quantity of the cement produced

Summary statistics are also provided for the mean values of the firms' key variables in the *Table 2.* Our quarterly data set covers the period from 2008q1 to 2016q4.

Table 2: Summary Statistics

Variables	Unit	Mean	SD	Min	Max
tc	million tl	33.4	27.5	5.1	93.4
Share of personnel expenses in tc	%	12.2	3.2	7.6	18.5
Share of primary material costs in tc	%	85.4	5.4	76.4	92.7
q	thousand tons	601.8	436.5	114.6	1600.0
Tangible fixed assets	million tl	162.4	117.0	36.8	385.6

3.2. Methodology

Although the stochastic frontier was originally proposed for the estimation of the production functions, it has also been used in exclusive efficiency analyses such as input, profit, and cost. Assuming firms minimize their cost, we can estimate cost efficiency if the price data are available. The general form will be the following.

$$c_{it} \geq c(w_{1it}, w_{2it}, \dots, w_{Nit}, y_{1it}, y_{2it}, \dots, y_{Mit}) \tag{1}$$

where c_{it} is the actual cost of firm i at period t, w_n's are the input prices, y_M denotes the output, and $c(.)$ is a cost function which is non-decreasing and linearly homogeneous in input prices.

If we suppose $c(.)$ has a Cobb-Douglas form, the cost frontier can be written as follows.

$$\ln c_{it} \geq \beta_0 + \sum_{n=1}^{N} \beta_n \ln w_{nit} + \sum_{m=1}^{M} \alpha_m \ln y_{mit} + v_{it} \tag{2}$$

or

$$\ln c_{it} = \beta_0 + \sum_{n=1}^{N} \beta_n \ln w_{nit} + \sum_{m=1}^{M} \alpha_m \ln y_{mit} + v_{it} + u_{it}, \tag{3}$$

where v_{it} accounts for the random errors and u_{it} is a non-negative variable that represents inefficiency. Note that u_{it} has a positive sign in the cost frontier, implying that observed cost increases with inefficiency. In addition, to estimate technical inefficiency in this model, certain distributional assumptions for the error terms are necessary, including half-normal, truncated-normal, exponential, and gamma distributions.

Since cost efficiency is defined as the ratio of best practice (minimum cost) to observed cost, it is given by

$$CE_{it} = \frac{c(.)}{c_{it}}. \tag{4}$$

If we plug the Eq. (3) into Eq. (4), we have

$$CE_i = \frac{\exp(\beta_0 + \sum_{n=1}^{N} \beta_n \ln w_{ni} + \sum_{m=1}^{M} \alpha_m \ln y_{mi}) * \exp(v_i)}{\exp(\beta_0 + \sum_{n=1}^{N} \beta_n \ln w_{ni} + \sum_{m=1}^{M} \alpha_m \ln y_{mi}) * \exp(v_i) * \exp(u_i)} = \exp(-u_i). \tag{5}$$

Hence, we have

$$CE_{it} = \exp(-u_{it}). \tag{6}$$

For detailed explanations and derivations associated with cost frontiers, see Kumbhakar and Lovell (2000) and Coelli et al. (2005).

The stochastic frontier model, initially introduced by Aigner et al. (1977) for cross-sectional data, was later adapted to panel data by Pitt and Lee (1981). Subsequently, various methods have been proposed in the literature to estimate the inefficiency term. Time-invariant models (Pitt and Lee, 1981; Battese and Coelli, 1988) have been developed, along with models that assume time-varying inefficiency (Cornwell et al., 1990; Kumbhakar, 1990; Battese and Coelli, 1992; Lee and Schmidt, 1993; Battese and Coelli, 1995; Greene, 2005). Additionally, there are studies that explore the relationship between the inefficiency parameter and exogenous variables. For the purpose of comparison, we employ some of these methodologies.[3]

[3] sfpanel STATA routine is used.

Considering transcendental cost function (TCF), empirical framework incorporates three inputs (capital, labor, and raw material) and one output (quantity of cement) in cement production. Therefore, TCF, formed by three inputs and one output, is modeled as in *Equation (7)*.

$$\begin{aligned} lnTC_{it} = {} & \alpha_0 + \alpha_1 lnQ + \beta_1 lnPk_{it} + \beta_2 lnPl_{it} + \beta_3 lnPh_{it} + \delta_{11}\frac{1}{2}(lnQ)^2_{it} \\ & + \frac{1}{2}\left(\gamma_{11}(lnPk)^2_{it} + \gamma_{12} lnPk_{it} lnPl_{it} + \gamma_{13} lnPk_{it} lnPh_{it} + \gamma_{21} lnPl_{it} lnPk_{it} + \gamma_{22}(lnPl)^2_{it}\right. \\ & \left. + \gamma_{23} lnPl_{it} lnPh_{it} + \gamma_{31} lnPh_{it} lnPk_{it} + \gamma_{32} lnPh_{it} lnPl_{it} + \gamma_{33}(lnPh)^2_{it}\right) + \rho_{11} lnQ_{it} lnPk_{it} \\ & + \rho_{12} lnQ_{it} lnPl_{it} + \rho_{13} lnQ_{it} lnPh_{it} + v_{it} + u_{it} \end{aligned} \tag{7}$$

where i represents firm and t represents the period. The other variables are as follows. TC: Total cost of sales, Pk: Price of capital (%) [(deprecation/real asset) +deposit interest rate], Pl: Price of labor (expanse of labor/number of personnel), Ph: Price of raw material (expanse of raw material/quantity), Q: Output (Quantity).

The cost function given in *Equation (7)*, is assumed homogeneous of degree one in input prices and symmetric. So, the following constraints are imposed on the model.

$$\begin{gathered} \sum_{i=1}^{n} \beta_i = 1;\ \sum_{i=1}^{n} \gamma_{ij} = 0; j = 1 \dots n;\ \sum_{i=1}^{n} \rho_{ij} = 0; j = 1 \dots n\ (homogeneity) \\ \gamma_{ij} = \gamma_{ji}\,, \qquad \rho_{ij} = \rho_{ji}\,, \qquad i \neq j\ (symmetry) \end{gathered} \tag{8}$$

When we impose the restrictions given in the equation system (6), we get the TCF to be estimated as follows.

$$\begin{aligned} ln\left(\frac{TC}{Pk}\right)_{it} = {} & \alpha_0 + \alpha_1 lnQ_{it} + \beta_2 ln\left(\frac{Pl}{Pk}\right)_{it} + \beta_3 ln\left(\frac{Pr}{Pk}\right)_{it} + \delta_{11}\frac{1}{2}(lnQ)^2_{it} + \gamma_{22}\frac{1}{2}\left(ln\left(\frac{Pl}{Pk}\right)\right)^2_{it} + \gamma_{23} ln\left(\frac{Pl}{Pk}\right)_{it} \\ & * ln\left(\frac{Pr}{Pk}\right)_{it} + \gamma_{33}\frac{1}{2}\left(ln\left(\frac{Pr}{Pk}\right)\right)^2_{it} + \rho_{12} lnQ_{it}\left(ln\left(\frac{Pl}{Pk}\right)\right)_{it} + \rho_{13} lnQ_{it}\left(ln\left(\frac{Pr}{Pk}\right)\right)_{it} + v_{it} + u_{it} \end{aligned} \tag{9}$$

Since the cost efficiency is estimated in terms of this equation, it has an output and three inputs: labor, capital, and primary materials. Therefore, there are three input price such as price of labor, price of capital and price of primary materials. Cement production level is used as an output.

4. FINDINGS AND DISCUSSIONS

We estimate translog cost function by using stochastic frontier analysis as in equation (9). Specifically, we utilize the Pitt and Lee (1981) model (PL81) as a time-invariant and half-normal model, the Battese and Coelli (1995) model (BC95) as a time-varying and truncated normal model, and the Greene (2005) model (TFE) as a time-varying and exponential model.[4]

Table 3 summarizes the estimation results obtained for cost efficiency of Turkish cement industry for three different models. According to Table 3, the coefficient of output (lnQ) are positive and statistically significant at 1% in TFE. Additionally, the coefficient of labor price ($ln\frac{p_l}{p_k}$) is positive and significant at 1% in both BC95 and PL81. On the other hand, the price of primary materials ($ln\frac{p_r}{p_k}$) is positive and statistically significant at 5% in only True Fixed Model.

The *lambda* parameter shows the existence of inefficiency in the models. According to the Table 3, all values of *lambda* are statistically significant and it proves the existence of inefficiency.

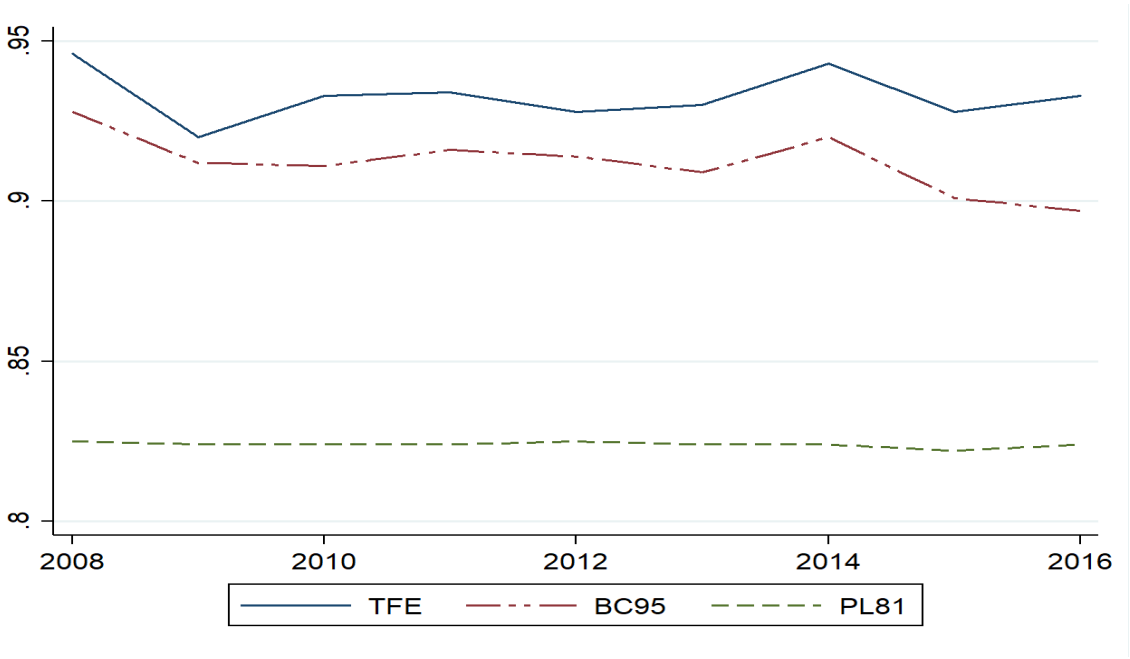
Table 3: Estimation Results of Cost Efficieny

		TFE	BC95	PL81
Variables	**Parameters**	**Coefficient**	**Coefficient**	**Coefficient**
lnQ	α_1	2.310 [0.345]***	14.920 [3.648]***	8.518 [2.598]***
$ln\frac{p_l}{p_k}$	β_2	-0.211 [0.367]	1.394 [0.412]***	2.485 [0.329]***
$ln\frac{p_r}{p_k}$	β_3	1.095 [0.466]**	-0.128 [0.437]	-0.221 [0.351]
$lnQ\left(ln\left(\frac{Pl}{Pk}\right)\right)$	ρ_{12}	-0.107 [0.029]***	1.683 [0.633]***	1.019 [0.448]**
$lnQ\left(ln\left(\frac{Pr}{Pk}\right)\right)$	ρ_{13}	0.146 [0.050]***	0.043 [0.026]*	-0.105 [0.029]***
$0.5(lnQ)^2$	δ_{11}	0.034 [0.031]	0.099 [0.060]*	0.182 [0.027]***
$0.5ln(\frac{Pl}{Pk})^2$	γ_{22}	0.093 [0.043]**	-0.014 [0.026]	0.031 [0.029]
$0.5ln(\frac{Pr}{Pk})^2$	γ_{33}	0.131 [0.053]**	-0.110 [0.048]**	0.086 [0.044]**
$ln\frac{Pl}{Pk}ln\frac{Pr}{Pk}$	γ_{23}	-0.086 [0.052]	0.142 [0.072]**	0.156 [0.050]***
Inefficiency Parameters				
$Sigma\_u$		0.071 [0.008]***	1.932 [0.556]**	0.273 [0.057]***
$Sigma\_v$		0.089 [0.017]***	0.107 [0.013]***	0.118 [0.000]***
$lambda$		0.801 [0.021]***	18.111 [0.562]***	2.312 [0.000]***
Average Cost Efficiency Scores				
2008		0.946	0.928	0.825
2009		0.920	0.912	0.824
2010		0.933	0.911	0.824
2011		0.934	0.916	0.824
2012		0.928	0.914	0.825
2013		0.930	0.909	0.824
2014		0.943	0.920	0.824
2015		0.928	0.901	0.822
2016		0.933	0.897	0.824

Notes: TFE: True Fixed Effects model (Greene, 2005). BC95: Battese and Coelli (1995). PL81: Pitt and Lee (1981). Significance levels: *** 1%, ** 5%, * 10%. Convergence is achieved in all three models.

Our main interest lies with the calculated cost efficiency scores, which are presented towards the bottom of *Table 3*. The cost efficiency scores of the firms in the cement industry varies between 93% and 82% according to the models. Figure 1 also provides an information about the scores.

Figure 1: Average Cost Efficiency Scores



Notes: TFE: True Fixed Effects model (Greene, 2005). BC95: Battese and Coelli (1995). PL81: Pitt and Lee (1981).

In Figure 1, average cost efficiency scores estimated from BC95, TFE, and PL81 are given by years. As seen in the figure, one can infirm that the efficiency scores of TFE model and BC95 model are varies but in parallel to each other. On the other hand the scores of PL81 model are almost stable. In first two models, there is a decline in around 2009 because of 2008 crisis. In 2015, the efficiency score was upward in TFE and BC95 models because both macroprudential policies implemented in the country and the uncertainties in the global capital movements caused the cement sector to shrink (Çevik, 2016).

Possible competition infringement as cartel agreements can be seen in the cement industry. Kulaksizoglu (2004) and Çelen and Günalp (2010) reveal that the cement industry in Türkiye has slowly become more competitive over time. Çalmaşur and Daştan (2015) show that Turkish cement industry has oligopolistic characteristics. Ekinci (2018) points out less competitive markets are more cost efficient than highly competitive markets.

5. CONCLUSION

In this study, we employed the stochastic frontier analysis to measure cost efficiency scores of Turkish cement industry including 14 firms over the period from 2008q1 to 2016q4. We can say that cost efficiency scores above the 80% although it varies by the method we used. Although there are some fluctuations, it can be said that the efficiency followed a nearly horizontal path throughout the period. The results also indicate a wide range of cost efficiencies across different size cement firms. The lowest cost efficiency score is estimated by BC95 and PL81 in 2015. In this year, both macroprudential policies implemented in the country and the uncertainties in the global capital movements caused the cement sector to shrink. Average cost efficiency score varies between approximately 93% and 82%, which means that the firms can potentially achieve at least 7% and a maximum of 18% reduction in input costs.

There may be many reasons for the horizontal efficiency during the period under review. The first of these may be insufficient observations to monitor efficiency changes. Due to the high initial investment to enter the cement sector, new investments may spread over time. This may cause no significant changes to be seen in 9 years. Another factor may be that firms use close technologies in their production process. Relatively higher efficiency scores also support this. Although efficiency-enhancing technologies are accumulated in the capital stock, this accumulation may be similarly experienced in almost all firms.

Although this study makes significant contributions to the potential increase in efficiency in the cement sector, it also has limitations. First, the number of observations may be regarded as inadequate due to the data availability. With more producers making their data available, reaching a deeper understanding of efficiency would be possible. It can also be said that efficiency scores are affected by the analysis method. Therefore, performing comprehensive analyzes will yield more robust results. Finally, in the SFA approach, the influencing factors of efficiency could also be examined. After determining the potential increase in efficiency, exploring which factors play a key role in boosting efficiency would also make significant contributions. This part is left for future work.

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FINANCIAL WELL-BEING AND LIFE SATISFACTION OF INDIVIDUALS DURING THE COVID-19 OUTBREAK

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Zeynep Copur[1], Nuri Dogan[2]
[1]Hacettepe University, Department of Family and Consumer Sciences, Beytepe, Ankara, Turkiye.
copur@hacettepe.edu.tr , ORCID:0000-0002-1456-0522
[2]Hacettepe University, Department of Educational Sciences, Division of Educational Measurement and Evaluation, Beytepe, Ankara, Turkiye.
nuridogan2004@gmail.com , ORCID: 0000-0001-6274-2016

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ABSTRACT

Purpose - This study aims to identify how factors related to financial health, financial ignorance, future prospects, emotional constructs, mental accounting, financial crisis, and household consumptions affect adult population's financial well-being and life satisfaction in Turkey during an ongoing pandemic.

Methodology - The data were collected through an online survey between May 26 and June 15, 2020. The sample of the study consisted of 1333 participants (58.7% women; 41.3% men). Descriptive statistics were calculated regarding the socio-economic variables (frequency, percentage, average, standard deviation, maximum, minimum). Then independent groups *t*-test analyses were conducted to compare the means of the scales by gender. Finally, Linear Regression Model were used to compare the effects of independent variables on three dependent variables (financial well-being measured as financial security/anxiety and life satisfaction).

Findings- The result shows that participants were financially coping during the COVID-19 outbreak. There was a significant difference when comparing mean financial health, spending and saving scores between men and women This study concluded that financial ignorance, financial health, perceptions of the household's future economic outlook and national economic situation, emotional constructs and gender were significantly related to financial well-being. Furthermore, financial health, financial security, perceptions of the future economic outlook of the household economic situation, mental accounting, changes in consumption, emotional constructs, gender, and marital status were predicted life satisfaction.

Conclusion- The findings would be useful for policy makers to maintain the parallel expansion of financial, psychological and welfare measures to improve people's financial well-being and life satisfaction and to strengthen the subjective well-being of individuals to fight against COVID-19. This research will help government and policymakers to maintain their economic and psychological policies and measures to provide relief to individuals during this current and post COVID-19 recovery knowing the psychological and financial situation of the general public.

Keywords: Financial health, financial ignorance, financial well-being, financial anxiety, financial security, life satisfaction.
JEL Codes: A14, D1, D9

1. INTRODUCTION

The COVID-19 outbreak was declared an international public health emergency on January 30, 2020, by the World Health Organization (WHO), causing a great effect on people's lives, families, communities, businesses and economies (Dubey et al., 2020; Mahajan, 2020). This pandemic is the defining global health crisis of our time and the greatest challenge we have faced since World War Two (UNDP-Turkey 2020). As the coronavirus outbreak rapidly spread around the world, it is causing widespread concern, anxiety, anger, depression, panic, insecurity, fear and stress, feelings of loss, and social withdrawal all of which are natural and normal reactions to the changing and uncertain situation that everyone finds themselves in (Brooks et al., 2020; Euart et al., 2020; Kulkarni and Bharati, 2020; Poudel and Subedi, 2020; WHO, 2020; Xiang et al., 2020).

To prevent the spread of this pandemic, governments have taken various measures such as social distancing, lockdowns, closing schools, universities, places of religious worship, and public utilities indefinitely, travel restrictions and home quarantines, imply a slowdown or even a complete stop in production and consumption activities for indefinite time, crumbling markets and potentially leading to the shutdown of businesses, sending millions of employee home (Agrawal et al., 2020; Goodell, 2020; Mahajan, 2020; Nelson et al., 2020). In Turkey, around 10% of both women and men reported quitting their jobs due to health risks (UNDP-Turkey, 2020). According to ECLAC, more than 30 million people could fall into poverty without active policies to protect or substitute income flows to low-income people. This spotlight addresses financial strain as a specific challenge for countries and individuals (Hevia and Neumeyer, 2020; Mogaji, 2020). Moreover, financial difficulty, fear, anxiety and panic has changed usual consumption patterns and created market anomalies; leading to the postponement of consumers' spending decisions (Boost and Meier, 2017; Kaytaz and Gul, 2014; Kulkarni and Bharati, 2020; McKibbin and Fernando, 2020). Panic drives people not to spend unless it is urgent or significantly reduce any unplanned purchase since people tend to save money for their health emergencies (Alonso et al., 2015; Baldwin and Tomiura, 2020; Barua 2020; Hsu et al., 2017). In some countries like US, Canada, UK more consumers reported reducing spending than increasing spending. In other countries like South America, Indonesia, Brazil, more consumers reported increasing spending than decreased (Euart et al., 2020). On the other hand, higher uncertainty leads to higher savings and changes in financial planning (Dietrich et al., 2020). Growing concern related to COVID-19 as individuals worry about immediate health and secondary economic effects (Nelson et al., 2020). For example, Mahajan (2020) concluded that individuals were financially coping during COVID-19 outbreak, and they have liquid savings to manage things for the next 4-5 months. However, the majority of respondents were worried about their financial health. If lockdown continues, it might affect their daily needs as well.

The priority is, of course, to save lives. Nevertheless, the required containment measures to restrict the spread of the coronavirus are causing a dramatic decline in economic activity (Mahajan, 2020). Thus, a global health crisis becomes a global economic crisis (Evans and Over, 2020) and thrust the world into an "economic war." Besides the cost of life and the deep health crisis of the COVID-19 outbreak, the world is sparking fears an impending economic recession and financial uncertainty that will severely impact the financial well-being of large parts of households (Barua, 2020; Evans and Over, 2020; Fujiwara et al., 2020; Nicola et al., 2020; McKibbin and Fernando, 2020; Poudel and Subedi, 2020). The penalty of job or income loss may be devastating for individuals and their families, yet they still have fixed costs to pay and families to feed. Individuals could feel helpless when they are unemployed, financially coping, unable to make ends meet or experience financial emergencies and feel financial insecurity (Mogaji, 2020; Van Aardt et al., 2009). Household financial decision-makers around the world reported their financial situations and countries' current economies were weak, decreases in income and saving, and fear of unemployment and job security concerns held savings to cover less than four months' worth of expenses due to COVID-19 outbreak (Agrawal et al., 2020; Dietrich et al., 2020; Dubey et al., 2020; Euart et al., 2020; Nelson et al., 2020; Ho et al., 2020; WHO, 2020). This transitory no more income or fall in income, coupled with the uncertain situation, will significantly decrease financial well-being and life satisfaction (Hevia and Neumeyer, 2020). Therefore, this study aims to identify how factors related to financial health, financial ignorance, future prospects, emotional constructs, mental accounting, financial crisis, and household consumptions affect adult population's financial well-being and life satisfaction in Turkey during an ongoing pandemic. The following part of the study provides literature on financial well-being and life satisfaction.

2. LİTERATURE REVİEW

2.1. Financial Well-Being

Researchers suggested that mental and psychological state were very important in influencing financial well-being (Simon, 1986; Slovic et al., 2005; Thaler, 1994; Tversky and Kahneman, 1974) and emotional constructs play a major role in financial well-being (Hammond, 2000; Loewenstein, 2000; Mellers and McGraw, 2001; Stern, 2009; Voon and Voon, 2012). With COVID-19 rapidly changing the economy and the way we live, work and consumer behavior, it is no wonder there is an increased level of financial anxiety (Fujiwara et al., 2020). Furthermore, while everyone is facing unprecedented challenges, women were more likely affected the economic, social and psychological consequences of COVID-19 than men. Women have experienced higher loss of jobs and unpaid leave from work (Kalaylıoğlu et al., 2020; UN Women 2020). In Turkey, overall, a higher proportion of men (54%) report employment disruption compared to women (32%) due to the pandemic. Women were nearly twice as likely to switch to working from home compared to men (UNDP-Turkey, 2020).

One of the most important dimensions of financial well-being is how people subjectively feel about their financial situation (Strömbäck et al., 2017). As Rolls (1999) explains, positive feelings improve individuals' ability to problem-solve and make effective decisions and there was a significant negative relationship between stress and financial well-being (Park, 2020). Kim and Garman

(2003) included the individual's perception of their ability to meet expenses and a propensity to worry about debt among other factors as a subjective definition of financial well-being. Thus, financial well-being implies having financial security and financial freedom of choice, in the present and the future (CFPB, 2015).

2.2. Life Satisfaction

Earlier studies indicated that financial well-being is a component of life satisfaction and increased financial well-being can be associated with an increase in life satisfaction (see Gerrans et al., 2014; Joo, 2008; Netemeyer et al., 2018). People are happier when they are financially secure (O'Neill et al., 2005). The existing literature concluded that besides financial well-being and financial situation (e.g. income) there are many different factors that contribute to life satisfaction. For example, being employed and healthy have been shown to influence greater life satisfaction (Dolan et al., 2008). A major study by University College London (UCL) surveyed 74.000 participants at the start of the lockdown, asking how adults feel about the lockdown, feelings of well-being, and psychological health. They reported that levels of life satisfaction were lower than at the same time last year (Fujiwara et al. 2020). Previous research also has shown that life events such as losing or changing jobs, reduction in hours of employment, death and illness can have effects on financial well-being and life satisfaction (Luhmann et al., 2012). Studies confirmed that lower scores in all well-being measures and higher anxiety and psychological distress during the COVID-19 outbreak. COVID-19 was associated with a statistically significant decrease in life satisfaction and higher levels of anxiety and greater psychological distress (Brooks et al., 2020; Dietrich et al., 2020; Poudel and Subedi, 2020; Xiang et al., 2020). COVID-19 impacted people's subjective well-being levels negatively included health impacts (e.g. risk and fear of being infected by COVID-19), economic impacts (e.g. job and income loss, concerns about the future economy), and social impacts (e.g. self-isolation, working from home). Moreover, the negative relationship between COVID-19 and life satisfaction was statistically significantly worse for women than for men (Agrawal et al., 2020; Fujiwara et al., 2020).

COVID-19 outbreak impact on individuals, families and economies in such a deeply negative way. Thus, it is interesting to assess its impact on financial well-being and life satisfaction at an individual level especially for emerging economies. During a COVID-19 outbreak, the economic conditions become very uncertain and depressing, as there is neither enough information nor a definitive treatment to the COVID-19 at hand. In this study, as well as demographic characteristics, future prospects, financial crisis, emotional constructs, mental accounting, financial ignorance and financial health were considered as stressful life occurrences, and they have important predictors of financial well-being and life satisfaction during periods of COVID-19 outbreak.

3. DATA AND METHODOLOGY

3.1. Data Collection and Sample

Data were collected from the participants through an online survey between May 26 and June 15, 2020 using convenience sampling method. The survey was developed using the free software Google Forms. Participants were contacted via email and telephone, a link to a self-report questionnaire was sent by e-mail or made public on other online platforms (Facebook and WhatsApp). Participants could contact the researchers via email or phone at any time.

Consent to participate in this study was obtained from each respondent and the study consists of individuals of 18 years and older living in Turkey. According to Turkey's 2019 address-based population registration system, the population that is 18 years old and above is 56.645.598 (TUIK, 2020). The sample for this study totaled 1333 participants in different regions of the country. Turkey recorded the first case of the disease on March 11, 2020. Since then, the cases have increased steadily and significantly. As of February 16, 2021, according to the Ministry of Health (2021), a total of 2.602.034 COVID-19 cases, 2.489.624 recovered, and 27.652 deaths have been reported. Table 1 presents the sample profile. More than half (58.7%) of the participants were women and about 41.3 % of them were men. The average age of the participants was 39.7 (*SD*=10.49) years. 65.7% of the respondents in the sample indicated being married. Further, 58.4% of the participants had a college degree and 36.8% of the participants were currently working at home during the Covid-19 pandemic. The average monthly income for respondents in the sample was ₺7812.56 (Turkish Lira, TL) (*SD*=7121.91) (1 USD = 6.95 TL in June 2020). The sample may not be representative to of the general population. When comparing to this sample profile with the population of Turkey (49.9% women, 50.1% men; *M*=32 age; 47.4% married, 52.6% single; 56% less than high school, 44% high school or more; monthly income *M*=5779,08 TL) (TUIK 2020) demographic characteristics of sample are not similar to the overall sample, but it is still meaningful sample to represent various socioeconomic backgrounds (Table 1).

Table 1: Distribution of the Participants by Socioeconomic Variables

Variables and Categories		Full sample (N=1333)		Women (n=782)		Men (n=551)	
		N	%	n	%	n	%
Gender	Women	782	58.7				
	Men	551	41.3				
Marital Status	Married	876	65.7	458	34.3	418	31.4
	Single	457	34.3	324	24.3	133	10.0
Working status during the COVID-19 outbreak	Always at home	490	36.8	344	25.8	146	11.0
	Always at workplace	164	12.3	75	5.6	89	6.7
	Flexible	361	27.1	162	12.2	199	14.9
	Not working	309	23.2	196	14.7	113	8.5
	Other	9	.7	5	.4	4	.3
Education	Literate/primary sch	8	.6	5	.4	3	.2
	Middle school	9	.7	3	.2	6	.5
	High school	67	5.0	39	2.9	28	2.1
	Associate degree	74	5.6	34	2.6	40	3.0
	Undergraduate	778	58.4	487	36.5	291	21.8
	Master degree	250	18.8	130	9.8	120	9.0
	Doctorate	147	11.0	84	6.3	63	4.7
	Min/Max	**M**	**SD**	**M**	**SD**	**M**	**SD**
Age	18-89	39.67	10.50	38.6	10.48	41.2	10.33
Monthly inc.(TL)	0-250000	10479,510	75842.50	8130,87	30873.71	13626,32	110358.42
Perceived income	1-5	3.13	.858	3.06	.83	3.22	.88

3.2. Measurement of Variables

3.2.1. Dependent Variables

Financial well-being: In this study, we measured subjective financial well-being using two separate scales (Barrafrem et al., 2020b; Strömbäck et al., 2017): The Financial Anxiety Scale (Fünfgeld and Wang, 2009; Strömbäck et al., 2017) and the Financial Security Scale (Strömbäck et al., 2017).

The Financial anxiety scale (FAS): Financial anxiety has been defined as a subjective feeling that individuals have an uneasy and unhealthy attitude toward engaging with, and managing their finances effectively (Burchell, 2003; Shapiro and Burchell, 2012). To measure anxiety related to financial decisions, we adopted four items from Fünfgeld and Wang (2009). We asked respondents to indicate, on a five-point Likert scale where 1 indicates "strongly disagree" and 5 indicates "strongly agree," their agreement or disagreement with four statements. A sample item is "*After making a decision, I am anxious whether I was right or wrong*." A higher FAS score indicated that the individual felt more anxiety related to financial matters.

The Financial security scale (FSS): Financial security indicates a perceived security in one's current and future financial situation. The three items included measuring financial security. Individuals were asked to state to what degree they agreed with three statements on a five-point Likert scale where 1 indicates "strongly disagree" and 5 indicates "strongly agree." A sample item is "*I feel secure in my current financial situation.*" A higher FSS score indicated that the individual experienced a higher level of security concerning his/her financial situation.

Cronbach's alpha was calculated and showed a reliability coefficient of .69 (FAS) and .85 (FSS). The results of Confirmatory Factor Analysis (CFA), based on maximum likelihood estimation, confirmed that the two scales for subjective financial well-being measured different underlying constructs (Chi-Square =144;673: p<.01; GFI=.97; AGFI=.94; CFI=.96; TLI=.93; RMSE=.087; RMR=.07). A person can feel quite comfortable with their financial situation but still feel anxiety about financial matters (e.g. Lind et al. 2020). We define higher subjective financial well-being as high financial security values and low values of financial anxiety (Barrafrem et al. 2020b).

Satisfaction with life scale (SWLS): The life satisfaction is a conscious cognitive judgment of one's life in which the criteria for judgment are up to the person (Pavot and Diener, 1993). It was measured by a commonly used scale developed by Diener et al. (1985). This scale was developed as a measure of the critical component of subjective well-being. A sample item is, "*In most ways my life is close to my ideal*." Responses were included "strongly disagree" (1) to "strongly agree" (5). Higher scores indicate a higher level of satisfaction with their life. The total satisfaction with life score for our sample ranged from 5 to 25. Cronbach alpha internal consistency reliability was .88 for this scale. The results of CFA, based on maximum likelihood estimation, results provide sufficient evidence that the scale is one- dimensional (Chi-Square =37.572: p<.01; GFI=.99; AGFI=.95; CFI=.99; TLI=.97; RMSEA=.093; RMR=.019).

3.2.2. Independent Variables

Financial ignorance: Financial Homo Ignorans (FHI) scale summarizes individual differences in financial behavioral ignorance. Behavioral ignorance was defined as a tendency to neglect relevant aspects of the decisions (Barrafrem et al, 2020a). To measure financial ignorance, we used the Turkish version of the Financial Homo Ignorans scale developed by Barrafrem et al., (2020a). The instruments measures four different types of ignorance tendencies: i) decision avoidance (e.g. saving money), ii) information avoidance (e.g. the total debt left to pay), iii) aggregation bias (e.g. how multiple small loans become large debts), and iv) motivated reasoning (e.g. focus only on the positive aspects of a specific loan neglecting the fine print (Barrafrem et al., 2020a). Individuals were asked to state to what degree they agreed with twelve statements on a five-point Likert scale ranging from "1= strongly disagree" to "5 = strongly agree." Sample items include: "*I avoid making decisions about my current financial situation,*" "*I would rather not know how much I spent last month.*" According to the results of CFA, based on maximum likelihood estimation, there is strong validity evidence for the four-component structure. (Chi-Square =316.487: p< .01; GFI=.96; AGFI=.94; CFI=.96; TLI=.95; RMSEA=.063; RMR=.078). The Cronbach's alpha of the complete scale is .83. pointing to the high reliability of the scale. In the current study internal consistency with the Cronbach's α values were .86 for decision avoidance, .90 for information avoidance, .82 for aggregation bias, .59 for motivated reasoning.

Financial health: Financial health was examined by using eight indicators of financial health prescribed by Financial Health Network, Chicago 2020 and Mahajan, 2020. FHNC has defined four components of financial health: Spend, Save, Borrow, and Plan. These components reflect individuals daily financial activities. The FHNC Financial Health Score provides a holistic, moment-in-time snapshot of an individual's financial health. The score is based on eight multiple-choice survey questions that correspond to FHNC's eight financial health indicators. Every individual who responds to the eight questions outlined in the survey guide will receive one FHNC Financial Health Score and four sub-scores that align with the four components of financial health (Spend, Save, Borrow, Plan). Financial health scores and sub-scores below 40 are considered "Vulnerable," scores from 40 to 79 are considered "Coping," and scores 80 and above are considered "Healthy." According to the results of CFA, based on maximum likelihood estimation, there are strong validity evidence for the 4-component structure (Chi-Square =77.156: p< .01; GFI=.99; AGFI=.98; CFI=.89; TLI=.79; RMSEA=.058; RMR=.098). Cronbach alpha internal consistency reliability was .71 for this scale.

Assess the near future economic situation; Assess the near future economic situation measures individuals' expectations for the future changes in the economic situation using three questions asking about their opinion on how the COVID-19 outbreak will have affected: (1) one's household economic situation, (2) country's economic situation, and (3) world's economic situation in six months from now compared to today (Barrafrem et al., 2020a). Respondents answered on a five-point Likert scale ranging from "it will be a lot worse than today=1" to "it will be a lot better than today=5." Since there are 3 items in this variable, CFA was not performed (Çokluk et al., 2010). As a result of the exploratory factor analysis (EFA), it was determined that it is a one-dimensional structure. EFA results showed that the first eigenvalue was 2,258 and explained 75% of the total variance. However, in the analyzes, three items within the scope of the future variable were considered separately. The Cronbach's alpha in our study was .83.

Emotional constructs: For the emotional factor, we adopted three items from Voon and Voon (2012) including uneasiness, anxiety and fear. Participants were asked to "Here are some statements about the COVID-19 outbreak. To what extent do you agree with each? "You feel uneasy," "You feel worried or anxious," "You feel fearful" with a five-point Likert scale ranging from "1=Very much

disagree" to "5=Very much agree." The lower score (1) indicates "not affected by COVID-19 outbreak" and the highest score (5) denotes "very much affected."

Mental accounting: Mental accounting refers to one's ability to subjectively frame transactions in their mind involving current and expected income decline or wealth. It was measured by the "Relative to before the COVID-19 outbreak, did any change happen to you on the following aspects? "Future expected or perceived income," Current income" and "Wealth" question, with a five-point response ranging from "Reduced=1" to "Increased=5" developed by Voon and Voon (2012). The higher score indicating higher income (and wealth). A score of 3 means "no change." The results of CFA, based on maximum likelihood estimation, on emotional structure and mental accounting variables measured with the same scale provide strong evidence for the two-component structure (Chi-Square =53.555: p< .01; GFI=.99; AGFI=.97; CFI=.99; TLI=.98; RMSEA=.065; RMR=.032). In the current study internal consistency with the Cronbach's α values were .89 for the emotional construct, .76 for mental accounting.

Financial crisis: To measure the financial crisis at an individual level, the current study used three items, two of the items were borrowed from Voon and Voon (2012). Financial crisis including, Employment decline, Retrenchment/Layoff, and Unpaid leave. Participants were asked to indicate that on a five-point Likert scale "1= No influence" to "5 = Large influence" to what degree they were affected by the above items when evaluating the COVID-19 outbreak. The higher the score, the more affected one is. Since there are 3 items in the financial crisis variable, CFA was not performed (Çokluk et al., 2010). As a result of the EFA, it was determined that it is a one-dimensional structure. The factor loading of each item ranged between .930 and .963. All 3 items had positive loading on the factor. EFA results showed that the first eigenvalue was 2,659 and explained 89% of the total variance. In our study, Cronbach's alpha was .94.

Household consumption: To measure how the COVID-19 outbreak affected household consumption, we adopted an item from Voon and Voon (2012). Participants were asked to indicate that on a five-point Likert scale ranged from 1= reduced to 5 = increased, compared to before the COVID-19 outbreak, what degree did their current consumption change. The higher the score, the more their consumption was affected.

Socio-economic and subjective variables: This study involved information about the participants' characteristics such as age, gender, education level, marital status, working status during COVID-19 outbreak, household's monthly income and perceived income. These characteristics were selected according to research literature and their potential effects on the results. Descriptive statistics on dependent variables were clustered according to personal characteristics.

Research Questions

Based on previous researches, we approached this study with several guiding research objectives:

Gender affect

1. to determine difference between women's and men's financial anxiety, financial security, life satisfaction, financial ignorance, financial health, future prospects, emotional construct, mental accounting, financial crisis and household consumption scores,

Financial security underlying variables

2. to determine whether financial health, financial ignorance, future prospects, emotional construct, mental accounting, financial crisis, household consumptions, perceived income, and socioeconomic variables are associated with financial security,

Financial anxiety underlying variables

3. to determine whether financial health, financial ignorance, future prospects, emotional construct, mental accounting, financial crisis, household consumptions, perceived income, and socioeconomic variables are associated with financial anxiety,

Life Satisfaction underlying variables

4. to determine whether financial security, financial anxiety, financial health, financial ignorance, future prospects, emotional construct, mental accounting, financial crisis, household consumptions, perceived income, and socioeconomic variables associated with life satisfaction.

3.3. Data Analysis

Descriptive statistics were calculated regarding the socio-economic variables (frequency, percentage, average, standard deviation, maximum, minimum). To find an answer to the first research question, independent groups *t*-test analyses were conducted to compare the means of the scales by gender. Before the independent group's *t*-test analysis, the data fit for the normal distribution

and the equality of the variances of the gender groups were checked. According to the analysis results, it was determined that the scores for men and women for all independent variables were normally distributed. The Levene test examined the homogeneity of group variances. While calculating the *t* values, the method following Levene test results was used (Kirk, 2008; Pituch and Stevens, 2016).

Linear regression model and enter method were used to answer the second, third and fourth research problem. To compare the effects of independent variables on three dependent variables (financial well-being measured as financial security/anxiety and life satisfaction), all independent variables were taken into the regression equation simultaneously. For regression analysis, it was checked whether the data provided the regression analysis assumptions. For the test of assumptions, correlations between variables, Mahalanobis distances for variables, variance influence factor values for variables, Durbin-Watson statistics were examined. As a result of the analysis, the data provide multivariate normality. There is no multicollinearity between variables. It was determined that there is no autocorrelation related to the variables and there is a linear relationship between the variables (Çokluk et al., 2010; Kirk, 2008).

4. FINDINGS AND DISCUSSIONS

Bivariate comparisons by gender for dependent and independent variables are summarized in Table 2. Averages and standard deviations are given separately for men and women and the full sample. The participants' average score was higher on the financial anxiety (*M* = 3.14; *SD* = .76). Women (*M*=3.21; *SD*=.72) respondents were more worry about their financial situation than men (*M*=3.05; *SD*=.80) (*p*<.01) during on ongoing pandemic. As expected, this paper shows that participants' financial anxiety was found to be higher during the COVID-19 break and is in line with prior studies (Lind et al. 2020). Women felt more anxious about financial matters than men.

The participants' average financial health scores were *M* = 60.43 (*SD* =18.61) (with spend score 71, save score 49, borrow score 76 and plan score 46). There was a significant difference when comparing mean financial health, spending and saving scores between men (FH= 59.31, Spend=69.83, Save=46.22) and women (FH=62.02, Spend=73.82, Save=51.97). Regarding participants' financial health, we found that individuals' overall financial health based on FHNC' score falls under the category of "financially coping." Individuals with scores in this range report healthy outcomes across some, but not all of the eight financial health indicators. It seems that individuals having financial troubles within this tough time. On the other hand, the average score in spend indicator is 71, which indicates that an individual's ability to pay nearly all of their bills on time and spend little less than income. The average score in save indicator (liquid savings and long-term savings) is 49 which indicates that inconsistent with conclusions drawn in prior research (see Baldwin and Tomiura, 2020; Barua, 2020; Kulkarni and Bharati 2020; Mahajan, 2020; Mogaji, 2020), participants did not have satisfactory savings for affording to cover unexpected expense during this tough time, like income or job loss. The average score in borrow indicator is 76, which indicates that having a manageable debt load and ability to credit card payments with little late fees. The average score in the plan or budget indicator is 46, which is the prime reason with saving indicator for getting financial health score in "financially coping" category. Having appropriate insurance allows individuals to be resilient in the face of unexpected expenses, such as medical emergency. Respondents have scored lower in this category, and another component of this indicator i.e plan ahead financially. It indicates that individuals were less future-oriented and interested in improving their current financial situation. Women have significantly displayed less healthy financial behavior on the overall index, spending and saving than men. This result is somewhat consistent with Mahajan' (2020) results. This also explains why although some literature indicates consumers follow 'saving for emergency' during the crisis, participants reported that their daily consumptions increased during the COVID-19 outbreak.

Results of the bivariate analysis test show that expectations about the future economic situation were very pessimistic. As shown in Table 2, the respondents believed that the economic situation will get worse soon than it is now. Women were more likely to believe that economic situation of their country (*M* = 1.76; *SD* = .79) and the world (*M*=1.76; *SD* = .72) will get worse soon than it is now than their counterparts. Literature suggested that individuals who were more pessimistic about their lives were probably more likely to worry about the future (Strömbäck et al., 2017). Our results concluded that expectations about the future economic situation were very pessimistic. Consistent with previous research (see Barrafrem et al., 2020b), participants were more likely to believe that future prospects at the household, national and global economic level would get worse in the future than it is now. Moreover, women reported significantly more pessimistic opinions about their country's economic situation and the world than their counterparts. According to Euart et al.'s research report (2020) also respondents in most countries thought their own and country' economic situation would grow worse.

Participants also reported that their psychological state (uneasiness, anxiety and fear) affected (*M* = 3.86; *SD* = .73) and their mental accounting (expected income etc.) changed (*M* = 2.53; *SD* = .65) during the COVID-19 outbreak. Women' psychological

state (*M*=3.93; *SD*=.73) and mental accounting (*M*=2.57; *SD*=.65) were more affected during the COVID-19 outbreak than men (EC, *M*=3.76; *SD*=.71; MA, *M*=2.49; *SD*=.65). Consistent with previous research (see UNDP-Turkey, 2020), women respondents' average score was higher on psychological state and mental accounting.

The participants reported that their daily consumptions increased during the COVID-19 outbreak (*M* = 3.47; *SD* = .88). Women respondents (*M*=3.55; *SD*=.87) reported significantly higher levels of daily consumptions than their counterparts (*M*=3.35; *SD*=.89) during on ongoing pandemic. Respondent' average score was higher on the financial crisis (employment decline etc.) (*M* = 3.19; *SD* = 1.31) during the COVID-19 outbreak. Concerning financial behavioral ignorance, we found that participants have the approximately average score on the FHI. They tend to ignore some aspects of decision-making (*M*= 2.62; *SD*=.68) during this tough time. Participants experience an average security level (*M* = 2.52; *SD* = .99) concerning their financial situation during an ongoing pandemic. Respondents also have average score (*M* = 2.74; *SD* = .88) on the life satisfaction during the COVID-19 outbreak. We did not find any gender differences in financial security, life satisfaction, financial ignorance and financial crisis (Table 2).

Table 2: Means and Standard Deviations for Dependent and Independent Variables by Gender

Variables		Full sample (N=1333)	Women (n = 782)	Men (n= 551)	Levene F	Test Statistic t
	Min-max	M (SD)	M (SD)	M (SD)		
Financial anxiety	1-5	3.14 (.76)	3.21 (.72)	3.05 (.80)	*p*<.01	3.788***
Financial security	1-5	2.52 (.99)	2.52 (.96)	2.52 (1.03)	*p*>.01	0.111
Satisfaction with life	1-5	2.74 (.88)	2.78 (.86)	2.69 (.89)	*p*>.05	1.876
Financial ignorance	1-5	2.62 (.68)	2.62 (.67)	2.63 (.69)	*p*>.05	-0.298
Financial health	10.6-100	60.43 (18.61)	59.31 (18.34)	62.02 (18.88)	*p*>.05	-2.625**
Spend	17.5-100	71.48 (26.69	69.83 (26.04)	73.82 (27.43)	*p*>.05	-2.693**
Save	12.5-100	48.60 (21.39)	46.22 (20.86)	51.97 (21.68)	*p*>.05	-4.880***
Borrow	12.5-100	75.62 (24.61)	75.50 (25.11)	75.80 (23.90)	*p*>.05	-0.219
Plan	0-100	46.01 (31.09)	45.68 (31.34)	46.48 (30.75)	*p*>.05	-0.461
Future of household	1-5	2.20 (0.89)	2.17 (.84)	2.23 (.96)	*p*<.01	-1.136
Future of country	1-5	1.83 (0.88)	1.76 (.79)	1.93 (.99)	*p*<.01	-3.473 **
Future of world	1-5	1.82 (0.76)	1.76 (.72)	1.92 (.81)	*p*>.05	-3.736***
Emotional construct	1-5	3.86 (.73)	3.93 (.73)	3.76 (.71)	*p*>.05	4.045***
Mental accounting	1-5	2.53 (.65)	2.57 (.65)	2.49 (.65)	p>.05	2.194*
Financial crisis	1-5	3.19 (1.31)	3.14 (1.31)	3.25 (1.31)	p>.05	-1.431
Household consumption	1-5	3.47 (.88)	3.55 (.87)	3.35 (.89)	P>0.05	3.939***

*Note: *p<.05; **p<.01; ***p<.001*

4.1. Multivariate Results

Within the research scope, the linear regression model was used to determine the relationship between psychological, economic and socio-economic variables for the significant effects on financial security, financial anxiety and life satisfaction during the COVID-19 outbreak. Table 3 summarizes the linear regression analysis results for financial security, financial anxiety and life satisfaction. As seen in Table 3, financial health, financial ignorance, future prospect at the household and national economic level, mental accounting and perceived income were positively related to financial security. However, gender and emotional construct

seem to be negatively related to financial security. According to this result, participants with higher levels of financial health, financial ignorance, the optimistic future prospect for household' and country' economic situation, mental accounting and perceived income had significantly higher financial security levels. However, women participants with higher levels of negative emotional construct had significantly lower levels of financial security. When the R^2 value is examined, it is seen that independent variables included in the regression equation can explain 28% of the variability in financial security. If the R^2 value is evaluated as the effect size, independent variables included in the regression equation have a high effect. It can be said that independent variables have practical significance (Table 3).

With regard to financial anxiety, as seen in Table 3, financial ignorance, emotional construct and financial crisis were positively associated with financial anxiety. On the other hand, financial health, future prospect at the household and national economic level and gender were appeared to be negatively associated with financial anxiety. According to this result, participants with higher levels of the negative emotional construct, financial crisis and financial ignorance had significantly higher financial anxiety levels. However, participants with higher levels of financial health, optimistic view of household' and country' economic situation and women had significantly lower financial anxiety levels. When the R^2 value is examined, it is seen that independent variables included in the regression equation can explain 30% of the variability in financial anxiety. If the R^2 value is evaluated as the effect size, independent variables included in the regression equation have a high effect. It can be said that independent variables have practical significance (Table 3).

A possible explanation of this result is that participants with financially healthy knowing how to build financial security now and in the future are not worried about their financial situation. However, inconsistent with an earlier study (Barrafrem et al., 2020a) financial behavioral ignorance was positively related to financial security/anxiety. Participants with higher financial behavioral ignorance feel more secure in their financial situation and worry more about it. Previous studies suggested that individuals who score high on behavioral ignorance were worse at managing their finance, and had lower financial well-being (due to the ignorance of relevant decision aspects). Since, ignorant individuals might perceive their situation to be better than it is (see Barrafrem et al., 2020a). Our results support these claims by showing that participants who were scoring higher financial behavioral ignorance have higher financial security than those were scoring lower financial behavioral ignorance. However, Barrafrem et al. (2020b) reported that lower financial ignorance was related to higher financial security and lower financial anxiety.

Depressed individuals were more prone to pessimistic thoughts about the future and suffer to a greater extent from pessimism bias than non-depressed individuals (Strunk et al., 2006; Strömbäck et al., 2017). We found that individuals who report less gloomy prospects for the future household's economic situation report higher financial security and lower financial anxiety. Also, individuals who have more optimistic views on the nation's economy displayed more financial security and less financial anxiety. This result consistent with previous literature showing that optimism was associated with financial well-being (Barrafrem et al., 2020b; Diener et al., 2010; Gutter and Copur, 2011; Peterson et al., 1988; Scheier and Carver, 2003). More optimistic individuals displayed better financial behavior, were less anxious about financial issues, and were more confident about their financial situation. The perceptions of the future global economic situation's changes were unrelated to subjective well-being (financial security/anxiety).

Literature proposed that emotions play an important role in decision-making (Loewenstein, 2000; Mellers and McGraw, 2001; Hammond, 2000; Stern, 2009). Financial well-being was associated with lower stress and lower depression (Hsu et al., 2017). Consistent with the literature (see Agrawal et al., 2020; Dubey et al., 2020; Poudel and Subedi, 2020; WHO, 2020), we found that negative emotions during the COVID-19 outbreak were associated with higher financial anxiety and lower financial security. Stress level can cause feeling financial insecurity and worrying about the financial situations. This paper reports that individuals who feel anxious during the COVID-19 outbreak were related to lower financial well-being. Hence, psychological changes emanating from the pandemic is of paramount importance in influencing subjective financial well-being. During an ongoing pandemic, individuals may be affected by income decline, job loss threats, investment losses, financial hardships. As a result, they perceive lower financial well-being. Thus, we found that individuals who perceive a decrease in their current and future income or wealth were related to lower security about their financial situation. As expected, the financial crisis was positively associated with financial anxiety. Importantly, household consumption was not robustly linked to financial anxiety/security. Moreover, this study shows that women feel more secure in their financial situation and worry more about it than men. The finding that gender was negatively related to financial security/anxiety somewhat inconsistent with previous studies. This suggests that although women more frequently feel secure in their financial situation, they still feel more anxiety about financial matters. However, Barrafrem et al. (2020b) and Lind et al. (2020) concluded that women feel lower financial security and higher financial anxiety or lower levels of subjective financial well-being than men. Furthermore, Fujiwara et al. (2020) concluded that women's well-being levels were lower than men. Also, respondents who perceived their income higher were feeling more secure than those perceived their

income lower. The finding that perceived income predicts financial security was perhaps not surprising and is in line with prior studies explored income was positively related to financial security and negatively related to financial anxiety (Barrafrem et al., 2020b).

In terms of life satisfaction, as seen in Table 3, financial security, financial health, future prospect for household' economic situation, mental accounting, perceived income and levels of education were positively related to life satisfaction. On the other hand, emotional construct, gender and marital status were negatively associated with life satisfaction. According to this result, respondents who stated higher levels of financial security, financial health, mental accounting, optimistic future prospect for household' economic situation, perceived income and education had significantly higher levels of life satisfaction. However, respondents who stated higher levels of negative emotional construct, women and married or living with a partner had significantly less satisfied with their life. When the R^2 value is examined, it is seen that independent variables included in the regression equation can explain 41% of the variability in life satisfaction. If the R^2 value is evaluated as the effect size, independent variables included in the regression equation have a high effect. It can be said that independent variables have practical significance (Table 3).

Prior research has shown that, COVID-19 was associated with a statistically significant decrease in life satisfaction and happiness and impacted people's self-reported well-being levels (see Fujiwara et al., 2020). Another important finding in our study is that, life satisfaction was predicted by financial security, financial health, perceptions of the future economy of the household economic situation, emotional construct, and mental accounting. Participants who reported optimistic prospects for the future household's economic situation, financially healthy and more secure about financial matters were more satisfied with their lives during the COVID-19 outbreak. The positive relationship between financial well-being and life satisfaction has been explored in prior studies (e.g. Brüggen et al., 2017). Moreover, respondents who perceive an increase in their current and future income or wealth were more satisfied with their life. As expected, respondents who perceived their income higher and have higher education levels were more satisfied with their lives. Our result was consistent with studies suggesting that income positively influences life satisfaction (see Dolan et al., 2008; Özmen et al., 2021; Veenhoven, 1988, 1991) and the lower life satisfaction associated with being single (Özmen et al. 2021). Moreover, men participants with negative emotions during the COVID-19 outbreak were less satisfied with their lives. This result is not in line with previous research showing that life satisfaction statistically significantly worse for women than for men during the COVID-19 outbreak (Fujiwara et al., 2020). Another study, conducted by Gerrans et al (2014), comes to conclusions consistent with this research which revealed that women's life satisfaction scores were significantly higher than men.

Table 3: Linear Regression Models Explaining Financial Security, Financial Anxiety and Life Satisfaction

	Financial Security	**Financial Anxiety**	**Life Satisfaction**
	β (SE)	**β (SE)**	**β (SE)**
Financial security	-	-	.436 ***(.037)
Financial anxiety	-	-	-.026 (.037)
Financial health	.049*** (.005)	-.027*** (.005)	.036*** (.007)
Financial ignorance	.042*** (.009)	.128*** (.009)	-.011 (.013)
Future of household	.573*** (.109)	-.247* (.110)	.478** (.148)
Future of country	.274* (.126)	-.274* (.127)	.064 (.170)
Future of world	-.209 (.127)	.080 (.127)	-.026 (.171)
Emotional construct	-.194*** (.035)	.186*** (.035)	-.231*** (.047)
Mental accounting	.170** (.040)	-.005 (.040)	.142** (.054)
Financial crisis	-.002 (.019)	.060** (.019)	.021 (.026)
Household Consumption	-.071 (.077)	.007 (.082)	.124 (.109)
Gender (0= women)	-.317* (.148)	-.485** (.148)	-.963*** (.199)
Age	.009 (.007)	-.005 (.007)	-.019 (.010)
Perceived income	.249* (.100)	.059 (.100)	.802*** (.134)
Marital status (0= married)	.104 (.164)	-.198 (.164)	-1.209*** (.220)

Working status (0= working)	.026 (.167)	-.107 (.176)	-.095 (.236)
Education	-.016 (.077)	-.008 (.078)	.258* (.104)
(Constant)	2.161* (.833)	8.746*** (.885)	6.491*** (1.232)
R square	0.281***	0.302***	0.409***
F	34.228***	37.805***	53.401***
N	1333	1333	1333

Note: *p<.05, **p<.01, ***p<.001; the numbers in brackets denote robust standard errors.

5. CONCLUSION

This study's objective was to identify how factors related to financial health, financial ignorance, future prospects, emotional constructs, mental accounting, financial crisis, and household consumptions affect people's subjective financial well-being and life satisfaction during an ongoing pandemic using a sample of 1333 adults in Turkey.

This study investigated whether financial health, financial ignorance, future prospects, emotional constructs, mental accounting, financial crisis and daily consumptions were related to subjective financial well-being, measured by combining two facets—financial anxiety and security. The determinants of these two aspects of financial well-being have been a largely neglected area of research during an ongoing pandemic except a study (Barrafrem et al., 2020b); thus, our results make an important contribution. This study highlights numerous factors related to subjective financial well-being and life satisfaction during the COVID-19 outbreak. Based on our findings, financial health, financial behavioral ignorance, perceptions of the household's future economic outlook and national economic situation, emotional construct and gender were significantly related to financial well-being measured as financial security and financial anxiety. Mental accounting and perceived income were positively related to financial security, while the financial crisis was positively related to financial anxiety. Furthermore, financial security, financial health, perceptions of the future economic outlook of the household economic situation, mental accounting, perceived income and education were associated positively. In contrast, emotional construct, being men and single were negatively associated with life satisfaction.

Our results support previous research findings (see Evans and Over, 2020) and show that containing the COVID-19 outbreak is the first step to mitigating the health impacts and the economic impacts. This study explores the role of pandemics in subjective financial well-being and life satisfaction. Our study makes several contributions to the literature. Firstly, we investigate the perceptions of the economic outlook of the household, national, and global economic situation at the onset of the economic slowdown during the COVID-19 outbreak. Second, we use subjective measures of financial well-being, in contrast to previous studies have mostly focused on objective measures. Third, we test for a rigorous set of independent variables that affect financial well-being and life satisfaction. Finally, we examine if the factors differ between genders, and how psychological and financial situation relates to financial well-being and life satisfaction.

While many countries have reopened their economies, allowing a cautious back to work and economic life, the pandemic seems likely to remain a reality of life for the foreseeable future (Barrafrem, 2020b; Hevia and Neumeyer, 2020). Thus, during this COVID-19 crisis, our results will help government and policymakers to maintain their economic and psychological policies and measures to provide relief to individuals during this current and post COVID-19 recovery knowing the psychological and financial situation of the general public. The findings would be useful for policy makers to maintain the parallel expansion of financial, psychological and welfare measures to improve people's financial well-being and life satisfaction and to strengthen the subjective well-being of individuals to fight against COVID-19. This research also provides the issue facing each one of us is how we manage and react to the stressful situation during the COVID-19 outbreak unfolding so rapidly in our lives and communities (WHO, 2020). Individuals react to the COVID-19 varies depending on their physical, psychological, and socio-economic characteristics, and there might be different practices in line with the course of the pandemic and the measures taken by the countries (Özmen et al., 2021). Individuals with the negative psychological and economic situation will need assistance. Professionals or psychologist could provide need-oriented support services and activities to increase psychological resilience and financial knowledge to those most likely to suffer from the negative effects of the COVID-19 outbreak. These support services may be given any formal or informal arrangements through mass media, social media, telephone or internet. The Government also needs to assess an increase in spending by expanding the various social and economic programs that could target those households most affected by the COVID-19 crisis (Mera, 2020).

Although its contributions to the field explain subjective financial well-being and life satisfaction during the pandemic process, it will be useful to state that this study has some limitations. First, the analyses presented in this paper show the relationship between variables. It is not appropriate to perceive and interpret the relationships between variables as causality. So, we cannot make inferences about causality. For example, although it might seem reasonable to believe that higher financial health leads to better financial security, it may also be that better financial security leads to higher financial health. For the future, we were aimed to deepen the relationships between these constructs. Studies in which researchers manipulate subjective financial well-being and life satisfaction experimentally are also needed to determine causality. The second of the limitations is that the data collection process is carried out online. It may not be possible to say exactly the sample representation that answered our online survey. Those who do not have internet access or have a negative attitude towards answering online surveys, etc., some subgroups are likely not to be included in the sample. Third, the respondents were not a random sample of the country. The sample relied on self-report data that included online connected people with university degrees. Thus, the results of this study cannot be generalized to the population in general. Further research is warranted using broader and more representative samples, especially including a wider range of socioeconomic backgrounds and aspirations.

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ANALYZING THE NEXUS BETWEEN FOREIGN TRADE AND ECONOMIC GROWTH IN DJIBOUTI THROUGH THE APPLICATION OF A VAR MODEL (1989-2021)

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Sadak Mohamud Hassan
Ondokuz Mayis University, Department of Economics, Samsun, Turkiye.
saadaqyare0120@hotmail.com, ORCID: 0000-0001-8581-6575

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ABSTRACT

Purpose- Economic growth and foreign trade are among the most important macroeconomic objectives of all countries in the world. The concept of foreign trade is considered as the engine of economic growth, consisting of imports and exports. Therefore, countries engage in commercial relations with other countries through economic policies tailored to their own economic and political situations. Since there are few studies on the economy of Djibouti, this study investigates the Djiboutian economy using the variables of growth, imports, and exports. The study aims to identify the degree to which foreign trade has affected economic growth in Djibouti, as well as to analyze the short-term and long-term dynamics of this relationship.

Methodology-This study employs a Vector Autoregression (VAR) model to investigate the nexus between foreign trade and economic growth in Djibouti over the period of 1989-2021. The data used in this study is sourced from the Organisation of Islamic Cooperation (OIC) database, which provides extensive information on Djibouti's foreign trade and economic indicators.

Findings- The findings indicate that foreign trade has a strong positive impact on economic growth in Djibouti, underscoring the critical role of foreign trade in driving the country's economic performance.

Conclusion-This study is significant as it adds to the limited literature on the relationship between foreign trade and economic growth in Djibouti, offering policymakers and stakeholders valuable insights into the significance of foreign trade in promoting economic development in the country. These results could guide the development and implementation of policies aimed at promoting and sustaining foreign trade, leading to further growth and development of the Djiboutian economy.

Keywords: Economic growth, foreign trade, VAR Model, Djibouti.
JEL Codes: F10, O41, C31

1. INTRODUCTION

Trade, an important factor in macroeconomics, has been present since the emergence of economics itself. The origin of international trade dates back to 2500 BC, and its nature and scope have expanded significantly over the years(Curtin, P. D. (1984). The theoretical debate on the relationship between foreign trade and economic growth can be traced back to the mid-15th century, when mercantilists emphasized the importance of valuable metals and exports for economic growth. Classical economists later argued that imports could also significantly impact economic growth(Krueger.,(1978). Empirical studies on this relationship gained momentum after the Second World War, particularly with the liberalization of foreign trade. Countries have turned to liberal foreign trade policies to develop their economies, and today, liberalization of foreign trade has become a popular economic policy for both developed and developing countries. In the context of globalization, countries actively seek to reduce trade barriers with the ultimate goal of achieving macroeconomic objectives(.

Foreign trade is a vital component of a country's economic growth and development. International trade allows countries to access goods and services that are not available locally and enables them to specialize in the production of goods and services for which they have a comparative advantage. This specialization and increased production lead to greater economic growth and improved living standards. Additionally, foreign trade helps countries to diversify their economies and reduce their dependence on a single industry or sector.

Foreign trade is an essential driver of economic growth and development, particularly for small, open economies like Djibouti.

Djibouti is a small nation situated in the Horn of Africa, bounded by Eritrea, Ethiopia, and Somalia. The country's populace is about one million, with the majority residing in the capital city of Djibouti. Djibouti has a diverse population comprising Afars, Somalis, and Arabs, and French and Arabic are the official languages, while Somali and Afar are widely spoken.

Djibouti's economy is primarily reliant on services, thanks to its strategic location on the Red Sea, which makes it an important hub for international trade and commerce. The country has one of the busiest ports in Africa, with significant investments in infrastructure and logistics in recent times. Additionally, the country hosts several foreign military bases, contributing to its economy.

Despite Djibouti's strategic location and immense potential for economic growth, it remains one of the world's poorest countries, with a high poverty rate and low levels of human development. The nation faces numerous challenges, including limited access to education and healthcare, environmental degradation, and political instability in the region.

This study aims to analyze the relationship between foreign trade and economic growth in Djibouti, utilizing a Vector Autoregression (VAR) model for the period of 1989-2021.

2. LITERATURE REVIEW

The existing scholarly work on the relationship between international trade and economic growth has presented a range of theoretical explanations. One commonly proposed explanation by researchers studying the effect of exports on economic growth suggests that this relationship is influenced by the productivity and scale effects resulting from increased exports. Conversely, scholars exploring the correlation between imports and economic growth argue that the importation of intermediate and capital goods can lead to appropriate diversification of input types, ultimately reducing investment costs by lowering the relative price of capital. This diversification can have a positive impact on an economy's growth. Overall, numerous studies have been conducted on the link between international trade and economic growth, providing valuable insights into the mechanisms and factors underlying this relationship.

Durbarry et al., (1998) assess the impact of foreign aid on growth for developing countries by using an augmented Fischer-Easterly type model and estimate this using both cross-section and panel data techniques. The results strongly support the view that foreign aid does have some positive impact on growth, conditional on a stable macroeconomic policy environment. They also find that these results vary according to income level, levels of aid allocation and geographical location.

Feeny S (2005) investigates the impact of foreign aid on economic growth in Papua New Guinea using timeseries data for the period 1965 to 1999. He examines whether aid effectiveness is conditional on levels of economic policy and governance using the Autoregressive Distributed Lag (ARDL) approach to cointegration proposed by Pesaran and Shin [1995]. His finding provides that little evidence that aid and its various components have contributed to economic growth in Papua New Guinea. There is some evidence that aid is more effective during periods when the country has undertaken a World Bank Structural Adjustment Program (SAP). An alternative interpretation is that a SAP may be more effective at spurring growth when supported by foreign aid.

Elbeydi and colleagues (2010) conducted an empirical investigation to examine the interdependence between exports and economic growth in Libya over the period spanning from 1980 to 2007. The results of the analysis revealed that income, exports, and relative prices were co-integrated, implying that they move together in the long run. Moreover, the study identified a bidirectional causal relationship between exports and economic growth in the long term. Furthermore, the analysis established that an upsurge in exports contributed to the acceleration of economic growth.

Kumari and Malhotra (2014) explored the connection between exports and economic growth in India from 1980 to 2012 using Johansen cointegration and Granger causality analysis. The results of the analysis indicated that there was no long-term equilibrium relationship between exports and per capita GDP.

The study conducted by Akıncı , Akıncı & Yılmaz (2014)investigates the determinants of financial development in Turkey using a VAR (Vector Autoregression) model. The analysis is based on annual data from the period 1986-2012, aiming to identify the factors that significantly influence financial markets during this timeframe. The findings of the study indicate several important determinants of financial development in Turkey. The first key determinant is national income, which highlights the importance of economic growth in fostering financial development. Higher levels of national income are associated with increased financial development.

Saleem and Sial (2015) conducted research on the relationship between exports and economic growth in Pakistan from 1973 to 2013. They used the ARDL bounds testing approach to examine the short- and long-term relationships and conducted the Granger causality test to investigate the causal relationship between variables. The findings indicated that exports, human capital, and capital formation played a significant role in Pakistan's economic growth. Moreover, the Granger causality analysis showed a bidirectional causal relationship between exports and economic growth in both the short and long run.

Pata (2017) investigated the causal relationship between exports, imports, total foreign trade, and economic growth over the period 1971-2014 by employing the Toda-Yamamoto causality test, generalized impulse-response analysis, and variance decomposition analysis. The analytical results demonstrated that there was a significant and positive unidirectional causal relationship from exports, imports, and foreign trade towards economic growth in the short term

Raza and Ying (2017) assessed the validity of the export-led growth hypothesis in Pakistan from 1967 to 2015 using the Toda-Yamamoto Granger causality analysis. The results showed a unidirectional causal link running from exports to economic growth, from exports to investment, and from economic growth to investment.

Tasew T (2010) examined the impact of foreign aid on investment and economic growth in Ethiopia over the period 1970 to 2009 using multivariate co-integration analysis. The empirical result from the investment equation shows that aid has a significant positive impact on investment in the long run. On the other hand, volatility of aid by creating uncertainty in the flow of aid has a negative influence on domestic capital formation activity. Foreign aid is effective in enhancing growth. However, the aid-policy interaction term has produced a significant negative effect on growth implying that bad policies can constrain aid effectiveness. The growth equation further revealed that rainfall variability has a significant negative impact on economic growth as the economy. His study indicated also that the country has no problem of capacity constraint as to the flow of foreign aid.

3. DATA AND METHODOLOGY

This study aims to analyze the relationship between foreign trade and economic growth in Djibouti, utilizing a Vector Autoregression (VAR) model for the period of 1989-2021. The names of the variables used in the study and their data sources are presented in the table below;

Table 1: Variables of the Study

Variable Name	Description	Source
GDP_Djibout	Gross domestic product of Djibouti	Organisation of Islamic Cooperation (OIC) database
Export__Djibout	Total Export of Djibouti	Organisation of Islamic Cooperation (OIC) database
İmport__Djibout	Total İmport of Djibouti	Organisation of Islamic Cooperation (OIC) database

3.1. Unit Root Analysis

In cases where time series data is non-stationary, standard regression analysis can produce erroneous results. This problem is commonly referred to as "spurious regression" in the literature. Stationarity of a time series implies that it has a constant mean, constant variance, and a covariance that depends on the lagged levels. However, in practice, most time series contain trends and are therefore non-stationary. Therefore, before proceeding with time series analysis, it is essential to conduct unit root tests to determine the stationarity of the variables. Knowing the degree of stationarity through preliminary tests is crucial for subsequent analyses. The most commonly used unit root test in the literature is the Augmented Dickey-Fuller (ADF) test. Depending on whether the series includes a constant and a trend, three ADF models can be established (Enders, 2010).

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=2}^{p} \beta \Delta Y_{t-i+1} + \varepsilon_t \quad (1)$$

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \sum_{i=2}^{p} \beta \Delta Y_{t-i+1} + \varepsilon_t \quad (2)$$

$$\Delta Y_t = \alpha_0 + \alpha_2 t + \gamma Y_{t-1} + \sum_{i=2}^{p} \beta \Delta Y_{t-i+1} + \varepsilon_t \quad (3)$$

In the above models, α_0 represents the constant term, α_1 represents the coefficient on the first lagged difference, α_2 represents the coefficient on the trend, and p represents the lag length. In these models, the null hypothesis (H_0) states that γ=0, indicating that the series is non-stationary and contains a unit root. The alternative hypothesis (H_1) states that γ<0, indicating that the series is stationary and does not contain a unit root. To determine the appropriate lag length in the ADF equation, criteria such as the Akaike Information Criterion (AIC), Schwarz Criterion (SC), or Hannan-Quinn (HQ) criterion can be used. Typically, the lag length with the lowest value according to these criteria is considered as the appropriate lag length.

3.2. VAR Model

The field of econometrics uses VAR (Vector Autoregression) models to reveal the interaction between variables and make forecasts for the future. The VAR modeling approach differs from other models in three main aspects: i) There is no distinction between endogenous and exogenous variables. ii) There are no zero restrictions. iii) There is no strong economic theory guiding the model construction. A VAR model is a set of k time series regressions, where k represents the number of series, and the lagged values of the variables serve as the explanatory variables. A VAR model with two time series or two variables can be represented as follows:

$$Y_t = a_{10} + \sum_{i=1}^{p} a_{11.i} Y_{t-i} + \sum_{i=1}^{p} a_{12.i} X_{t-i} + \varepsilon_{1t} \quad (4)$$

$$X_t = a_{20} + \sum_{i=1}^{p} a_{21.i} Y_{t-i} + \sum_{i=1}^{p} a_{22.i} X_{t-i} + \varepsilon_{2t} \quad (5)$$

Here, Y and X represent the time series variables under investigation, $a_{11.i}, a_{12.i}, a_{21.i}$ and $a_{22.i}$ are the unknown coefficients, p is the lag length, a_{10} ve a_{20} are the constant terms, andε_{1t} and ε_{2t} are the white noise error terms, which have a constant mean, varying variance, are serially uncorrelated, and have probability distributions.

3.3. Granger Causality Test

To conduct the standard "Granger Causality" test based on the VAR model, it is necessary for all variables to be stationary at the same level or at the same and higher degrees. If the stationarity condition is satisfied, the causal relationship can be tested using the standard F-test. The Granger causality test can be performed by estimating the following regression equations:

$$Y_t = a_0 + \sum_{i=1}^{p} \phi_i Y_{t-i} + \sum_{i=1}^{q} \delta_i X_{t-i} + \varepsilon_t \quad (6)$$

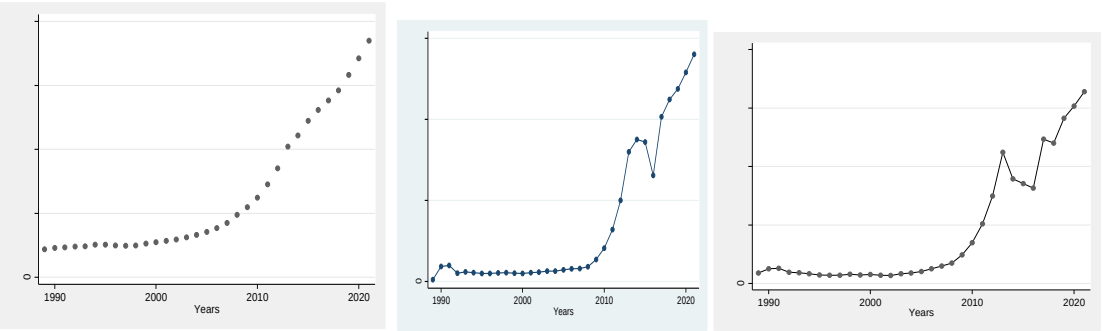
$$X_t = \beta_0 + \sum_{i=1}^{q} \pi_i X_{t-i} + \sum_{i=1}^{q} \lambda_i Y_{t-i} + \mu_t \quad (7)$$

In the above models, p and q represent the optimal lag lengths. In both models, the coefficients of the lagged values of the independent variables are tested to determine if they are equal to zero ($\delta_1 = \delta_2 = \cdots = \delta_i = 0; \lambda_1 = \lambda_2 = \cdots = \lambda_i = 0$) .The F-test is used to test the hypothesis. If the hypothesis is rejected in Equation (6), it is concluded that X is the Granger cause of Y. If the hypothesis is rejected in Equation (7), it is concluded that Y is the Granger cause of X.

4. EMPIRICAL ANALYSIS

This empirical analysis focuses on investigating the nexus between foreign trade and economic growth in Djibouti by utilizing a Vector Autoregressive (VAR) model. The study covers the period from 1989 to 2021, aiming to explore the dynamic interactions and causal relationships between key foreign trade variables, such as exports and imports, and Djibouti's economic growth. By applying the VAR model, this analysis seeks to provide empirical evidence on the short- and long-term effects of changes in foreign trade on the country's economic performance.

Figure 1: Graphical Detection of Stationarity



The time series graph exhibits a clear trend, indicating the presence of unit roots in the variables under analysis. Unit roots imply a non-stationary behavior, where the variables show systematic and persistent long-term movements over time. The trend observed in the graph suggests that both foreign trade variables and economic growth in Djibouti have experienced consistent changes and growth throughout the examined period.

Table 2: Results of ADF Unit Root Test (Original Level)

Variables	Test Statistic	1%Critical Value	5%Critical Value	10% Critical Value	p-value for Z(t)
GDP_Djibout	8.055	-3.702	-2.980	-2.624	1.0000
Export__Djibout	1.601	-3.702	-2.980	-2.622	0.9979
İmport__Djibout	1.408	-3.702	-2.980	-2.622	0.9972

The table presents the results of the ADF (Augmented Dickey-Fuller) unit root test in its original level for three variables: GDP_Djibout, Export_Djibout, and Import_Djibout. The ADF test is used to determine whether a time series is stationary or not, and the p-values for the test statistics are shown in the last column.

In the given table, the p-values for the test statistics of all three variables (GDP_Djibout, Export_Djibout, and Import_Djibout) are greater than 0.05. This suggests that we reject can not reject the null hypothesis of a unit root, and the series are non-stationary. Specifically, the p-values are 1.0000, 0.9979, and 0.9972 for GDP_Djibout, Export_Djibout, and Import_Djibout, respectively.

If the variables exhibit non-stationarity in their original levels, differencing can be applied to transform them into stationary time series.

Table 4: Results of ADF Unit Root Test (1st Difference)

Variables	Test Statistic	1%Critical Value	5%Critical Value	10% Critical Value	p-value for Z(t)
D(1)GDP_Djibout	-0.723	-3.709	-2.983	--2.623	0.8406
D(1)Export__Djibout	-4.580	-3.709	-2.983	-2.623	0.0001
D(1)İmport__Djibout)	-5.258	-3.709	-2.983	-2.623	0.0000

Based on the ADF unit root test results for the first difference of the variables, we can conclude that D(Export_Djibout) and D(Import_Djibout) are stationary, while D(GDP_Djibout) is non-stationary.

To make GDP_Djibout stationary, we will take the second difference and also interpret the result.

The second difference of GDP_Djibout will be taken to obtain a stationary series, and the result will be interpreted to determine if the series is stationary.

Table 5: Results of ADF Unit Root Test (Second Difference)

Variables	Test Statistic	1%Critical Value	5%Critical Value	10% Critical Value	p-value for Z(t)
D(2)GDP_Djibout	-7.182	-3.716	-2.986	-2.624	0.0000

According to the ADF unit root test, the second difference of GDP_Djibout yielded a test statistic of -7.182 and a p-value of 0.0000. The test statistic is smaller than the 1% critical value of -3.716, providing evidence that the second difference of GDP_Djibout is stationary at a 1% level of significance. Furthermore, the p-value being less than 0.05 supports the rejection of the null hypothesis of non-stationarity.

Therefore, it is reasonable to assert that the second difference of GDP_Djibout is stationary, which indicates its viability for further analysis.

Table 6: Phillips-Perron Test for Unit Root

Variables	P-value for Z(t)
Original Level	
GDP_Djibout	1.0000
Export__Djibout	0.9986
İmport__Djibout	0.9987
1st Difference	
D(1)GDP_Djibout	0.8893
D(1)Export__Djibout	0.0001
D(1)İmport__Djibout)	0.0000
D(1)GDP_Djibout	
2nd Difference	
D(2)GDP_Djibout	0.0000

The Phillips-Perron test is another commonly used test for checking the stationarity of a time series. The test results in Table 4 show that the original levels of GDP_Djibout, Export_Djibout, and Import_Djibout are non-stationary as their p-values are greater than 0.05. However, the first difference of the data Export_Djibout and Import_Djibout variables are stationary, as evidenced by the p-values being less than 0.05. Furthermore, the second difference of GDP_Djibout is also stationary with a p-value of 0.0000, which is less than 0.05. Therefore, we can conclude that the variables have been made stationary by taking the first and second differences, and they can be used for further analysis.

Table 7: Results of the Lag Length Selection

lag	LL	LR	FPE	AIC	HQIC	SBIC
0	-1589.12	NA	3.1e+49	122.471	122.513	122.616
1	-1566.65	44.953	1.1e+49	121.434	121.602	122.015
2	-1535.14	63.006	2.0e+48	119.703	119.996	120.72
3	-1518.89	32.512	1.3e+48	119.145	119.563	120.597

4	-1494.32	49.142	4.5e+47	117.948	118.491	119.835
5	-1478.05	32.54*	3.5e+47*	117.388*	118.057*	119.711*

The lag length selection suggests that a lag of 5 is the optimal choice based on AIC, HQIC and SBIC

Table 8: Johansen Tests for Cointegration

Rank	Parms	LL	Eigenvalue	Trace Statistic	5% Critical Value
0	39	-1503.6291	-	51.1625	29.68
1	44	-1489.6948	0.65763	23.2940	15.41
2	47	-1478.0874	0.59052	0.0792*	3.76
3	48	-1478.0478	0.00304		

The results of the Johansen tests suggest that there is evidence of cointegration among the variables being analyzed.

Table 9: VAR Model Estimation

Depedent variables	D(2)GDP_Djibout		D(1)Export__Djibout		D(1)İmport__Djibout)	
	Coefficients	P>|z|	Coefficient	P>|z|	Coefficient	P>|z|
D(2)GDP_Djibout	.9112389	0.009	-.1748536	0.262	.1914563	0.375
_cons	3.23e+07	0.000	R-sq = 0.7847 P>chi2 = 0.0000			
D(1)Export__Djibout	6.352807	0.002	.1491466	0.870	-.3044769	0.809
_cons	3.98e+07	0.399	R-sq = 0.9098 P>chi2 = 0.0000			
D(1)İmport__Djibout)	10.6813	0.015	-.408113	0.835	.4338732	0.873
_cons	2.09e+08	0.040	R-sq = 0.7297 P>chi2 = 0.0000			

The results indicate that the lagged values of D(2)GDP_Djibout have a positive and significant effect on itself, while the lagged values of D(1)Export__Djibout and D(1)Import__Djibout have a positive effect, but not significant. Moreover, the R-squared values for Model relatively high, indicating that the model can explain a large portion of the variability in these variables.

The lagged values of D(2)GDP__Djibout have a statistically significant effect on D(1)Export__Djibout, with a coefficient of 6.352807 and a p-value of 0.002. However, the lagged values D(1)Export__Djibout, and D(1)İmport__Djibout do not have a significant effect on D(1)Export__Djibout, as their coefficients have p-values greater than 0.05. The overall model has a high R-squared value of 0.9098, indicating a good fit, and a statistically significant chi-square test with a p-value of 0.0000, indicating that the model is a good fit for the data. For the dependent variable D(1)İmport__Djibout, these results suggest that changes in D(1)Import__Djibout are positively associated with changes in D(2)GDP, changes in D(1)Import__Djibout are not significantly associated with changes in D(1)Export__ Djibout and D(1)İmport__Djibout

Table 10: Correlation Test

lag	chi2	Prob > chi2
1	5.4271	0.79560
2	6.6263	0.67597
3	12.6004	0.18154
4	6.2739	0.71222
5	10.1620	0.33753
6	4.5396	0.87245
7	5.6492	0.77445
8	1.4310	0.99763
9	9.9866	0.35157
10	10.1081	0.34181
11	8.5053	0.48414
12	16.8360	0.05135

The table displays the lag number, the chi-squared test statistic, and the associated p-value. The null hypothesis for the test is that there is no serial correlation in the residuals (i.e., the errors are independently distributed), and the alternative hypothesis is that there is serial correlation.

Looking at the table, we can see that for each lag, the p-value is quite high, indicating that we cannot reject the null hypothesis of no serial correlation in the residuals. Therefore, we can conclude that there is no evidence of serial correlation in the residuals of the VAR model.

Table 11: Jarque-Bera Test for Normality of Residuals

Equation	chi2	df	Prob
D(2)GDP_Djibout	0.014	2	0.99325
D(1)Export__Djibout	5.245	2	0.07261
D(1)İmport__Djibout)	0.153	2	0.92630
ALL	5.412	6	0.49217

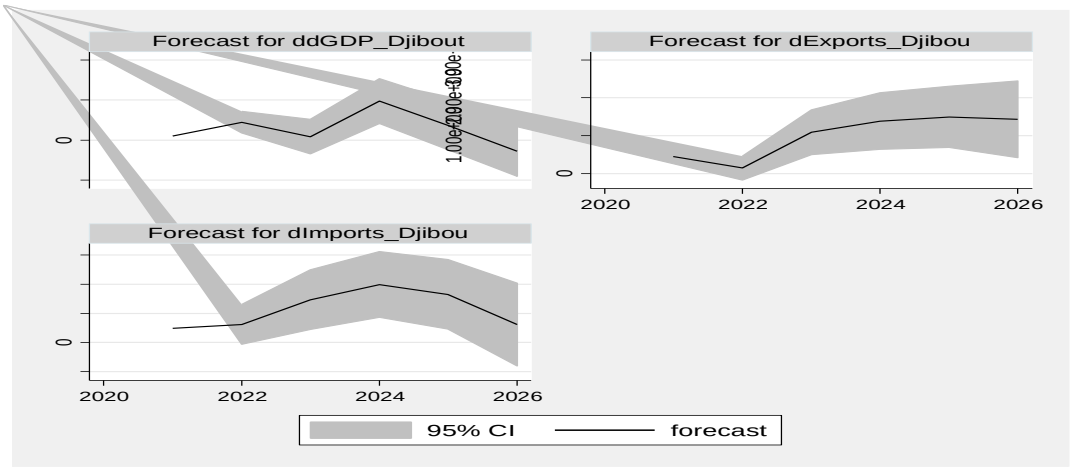
The Jarque-Bera test is a test for normality of residuals. The null hypothesis of the test is that the residuals are normally distributed. However, the p-value of variables greater than 0.05, so we can not reject the null hypothesis of normality for that variable.

Table 12: Granger Causality Wald Tests

Equation	chi2	Prob > chi2
GDP ➡ Export	31.407	0.000
GDP ➡ İmport	31.136	0.000
Export ➡ GDP	21.676	0.001
Export ➡ Export	22.209	0.000
İmport ➡ GDP	20.121	0.001
İmport ➡ Export	15.829	0.007

The Granger causality Wald tests show the results of testing whether one variable Granger-causes the other variable in a VAR model. The test is based on comparing the fit of two VAR models, one with both variables included and the other with the variable of interest excluded. The null hypothesis is that the excluded variable does not Granger-cause the other variable. The results suggest that there are causal relationships between the variables in the model, with the GDP variable being the strongest causal variable.

Figure 2: A VAR Model Forecast for the Next Five Years



Based on the information about the forecasted VAR model for the next five years (2022-2026), the export graph shows an increase, indicating a positive trend in the value of goods and services exported by Djibouti. The GDP graph shows fluctuations, indicating that Djibouti's economic growth may experience varying levels of expansion and contraction during this period. In terms of imports, the graph shows an initial increase followed by a slight decrease. This pattern suggests that Djibouti's imports may initially rise.

5. CONCLUSION

The relationship between foreign trade and economic growth has been a subject of theoretical debate for centuries. Mercantilists emphasized the importance of valuable metals and exports, while classical economists argued that imports could also impact economic growth. Today, empirical evidence suggests that international trade plays a significant role in

promoting economic growth, and policymakers around the world have implemented policies aimed at increasing exports and imports.

The study examining the relationship between foreign trade and economic growth in Djibouti using a VAR model (1989-2021) has provided significant insights into the interdependence of these variables. The results indicate a positive and substantial correlation between foreign trade and economic growth in Djibouti, with exports and imports exerting a considerable influence on GDP, highlighting the critical role of international trade in the country's economic development.

The implications of the study's findings are significant for policymakers and businesses operating in Djibouti. The results suggest that policies aimed at promoting international trade and increasing exports and decreasing imports could significantly contribute to the country's economic growth. The study also underscores the need for further research to explore the complex relationships between foreign trade and economic growth in Djibouti and identify the most effective policies to foster sustainable economic development in the country.

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AN ARTIFICIAL NEURAL NETWORK BASED METHOD FOR COMPANY VALUATION

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Pinar Unal Guner[1], Seyma Nur Unal[2]
[1]Bahcesehir University, Department of International Finance, Istanbul, Turkiye.
pinar.unal@eas.bau.edu.tr, ORCID: 0000-0002-8408-4648
[2]Karabuk University, Department of Economics, Karabuk, Turkiye.
seyma-gnr@hotmail.com, ORCID: 0000-0002-3475-7226

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ABSTRACT

Purpose - Company value is a crucial issue for everyone operating in financial markets. Both firm managers and investors should calculate the value of a firm, and there are many methods available to do so. Calculating valuation methods is challenging due to the multiple parameters and stages that are involved. Due to these reasons, it's possible for managers, owners, investors, and other stakeholders to estimate a company's value inaccurately or with difficulty. The main objective of this essay is to demonstrate how to evaluate a company's value using the NARX model as an alternative to other models.

Methodology – It is estimated that the firm value using an artificial neural network nonlinear external input autoregressive network model for 50 companies operating in the consumer products and industrial products and services sectors in the Euro Stoxx 50 index. The dataset covers the period from 2000 to 2021, and 20 financial ratios were included as input to the model, with FCFF as the output.

Findings- The NARX model with a 20-6-6-1 or 20-10-10-1 network structure provided the best value for both R and MSE at two-time delays. However, the 20-12-12-1 network structure of the NARX model with a time delay of three has a lower error rate after training and the best R value. The model's prediction success rate is 90.82% using the 20-12-12-1 network structure with a time delay of three.

Conclusion- As a result, this model can be used by investors and business managers to value a company. By using this method, businesses may gain access to more precise and unbiased appraisals that can guide resource allocation and strategic decision-making. By including macroeconomic factors that have an impact on the sector and employing a longer time frame, the study could be improved.

Keywords: Company value, company valuation, cash flow to firm, artificial neural networks, nonlinear external input autoregressive network
JEL Codes: C45, C80, G12

1. INTRODUCTION

Valuation is a crucial and complex topic in finance, as the main objective of companies is to maximize company value. Similarly, stakeholders want the companies value and share value to be maximized. Understanding the methods of company valuation is a crucial qualification in the field of corporate finance. The process of valuing a firm and its business units helps to discover sources of economic value generation and destruction inside the organization, which is significant not just in acquisitions and mergers. (Fernandez, 2002).

Bonds, stocks, and other financial instruments are among the assets that businesses buy and sell to obtain money that is more than their cost of capital. Companies create value in this way (Jordan et al., 2012).

Valuation is also an essential requirement for shareholders. Investors should assess the value of a stock before purchasing it to avoid paying more than its value and to determine an investment strategy by identifying undervalued or overvalued assets.

Value evaluation now goes beyond portfolio management and investing. Every step of a company's life cycle requires value. Finding additional funding is crucial for small, privately held enterprises who are thinking about expanding. Depending on their

projected worth for the business, investors will contribute varying amounts of capital. The prices at which businesses are presented to the market in an initial public offering (IPO) when they mature and elect to go public are determined by their valuations. Perceptions of their impact on value will then influence decisions on where to invest, how much to borrow, and how much to return to the owners. (Damodaran, 2011).

Numerous valuation models exist, but there are only two types of valuation: intrinsic and relative. The cash flows you anticipate an asset will produce throughout its lifetime and your level of confidence in those cash flows will determine the intrinsic value of the asset. Assets with strong, consistent cash flows ought to be more valuable than those with low, erratic cash flows. In relative valuation, the market prices of comparable assets are used to determine the worth of an item. So, in order to decide how much to spend for a home, you would consider recent sales of comparable homes in the area. Comparing a stock's valuation to those of other equities in a comparable industry is known as a "peer group". (Damodaran, 2011).

Many methods are used to determine a company's value, including balance sheet-based, relative valuation, and cash flow discounting-based methods. Before starting the valuation, it is necessary to determine what reflects the value of a company. In its simplest form, the value of the company is determined by the cash flow that the company will create over time and the risk-adjusted discount rate.

If we examine the concept of valuation more deeply, we can identify the factors that determine the value of a company, known as value drivers. These include growth in revenues, operating profit margin, investment efficiency level, and cost of capital.

In this study, for determination of company value, the Artificial Neural Networks (ANN) Nonlinear External Input Autoregressive Network Model (NARX) will be used. The Nonlinear Autoregressive Network with exogenous inputs (NARX) is a type of Artificial Neural Network (ANN) architecture that can be used to model complex nonlinear systems, including those with external inputs. (Chen et. al., 1990)

In the NARX model, the network forecasts the following output in the time series using past inputs, past outputs, and any external inputs as inputs. This enables the model to capture the system's nonlinear dynamics while taking into consideration how outside influences may affect the system.

A NARX model's architecture usually consists of two key parts: a set of neurons that take in input from the outside world and a feedback loop that links the network's output to its input. The feedback loop allows the network to learn from its own predictions and correct any errors in its output, while the external input neurons enable the network to take into account any additional information that may be relevant to the system being modelled. (Narendra & Parthasarathy, 1990)

NARX models are commonly used in time series prediction, control systems, and signal processing applications, where it is often necessary to model complex, nonlinear systems that exhibit dynamic behavior. They are a powerful instrument for simulating and forecasting complex systems, and they have been effectively used in a variety of disciplines, including engineering, economics, and finance.

The ability of a NARX model to capture the nonlinear dynamics of the financial system, which can be challenging to model using conventional linear models, is one potential benefit of using a NARX model to forecast company value. The NARX model has the potential to offer more accurate and reliable predictions than simpler models because it considers both past inputs and past outputs as well as any external inputs that might influence the company's value.

The NARX model also has the benefit of being adaptable over time to shifting market circumstances. The model can adapt its parameters in reaction to changes in the underlying system because it takes feedback from its own predictions into account. This is particularly crucial in volatile or rapidly changing markets.

This article's main goal is to use the NARX model to calculate a company's value. Calculating valuation methods can be challenging due to the multiple parameters and stages that are involved. Due to these factors, it's possible for managers, owners, investors, and other stakeholders to estimate a company's value inaccurately or with difficulty. The NARX model will be used to evaluate the company's value in this study, and the variables will be chosen by taking into account the aforementioned value drivers and the benefits listed above. With this method, managers, shareholders, or investors can more correctly estimate the company's value without having to rely on intricate valuation models and minimize risk.

2. LITERATURE REVIEW

Komo, Chang, and Ko (1994) employed two neural network models to predict the stock market. Specifically, they applied these models to the Dow Jones Industrial Index and achieved an 80% success rate in their predictions. Rather, A.M. (2011) used an ANN

to predict stock prices. He utilized data from 02-01-2007 until 22-03-2010 for several companies, including TCS, BHEL, Wipro, Axis Bank, Maruti, and Tata Steel. He found that utilizing artificial neural network methods helped to minimize prediction errors.

Wilimowska and Krzytoszek (2013) stated in their introduction that FCFF is considered the company value method in their study and is estimated with artificial neural network, as it is considered the most valid method that reflects the true value of the company. However, FCFF calculation is complex and requires a lot of data, which is why there are few studies in the literature taking it into account. In their study, Wilimowska and Krzysztoszek focused on estimating company value with ANN and presented value drivers that should be considered in the process of company valuation. They used 12 factors as input and 2 factors, namely FCFF and net assets, as output. The estimated company value with the determined value drivers was found to be close to the real value.

Adebiyi et al. (2014) conducted a study to estimate share prices using the ANN method. Adewumi and Ayo compared the forecasting performance of ARIMA and ANN models using published stock data from the New York Stock Exchange. They found that both models achieved good forecast performance, but the ANN model outperformed the ARIMA model.

Patel and Yalamalle (2014) aimed to use artificial neural network techniques to predict the stock price of companies listed under the LIX15 index of the National Stock Exchange (NSE). Their results showed satisfactory output with a median normalized error of 0.05995, median correct direction percentage of 51.06, and median standard deviation of 6.39825.

Persio and Honchar (2016) presented an Artificial Neural Network (ANN) approach to predict stock market indices and considered the S&P500 historical time series. They showed that neural networks are able to predict financial time series.

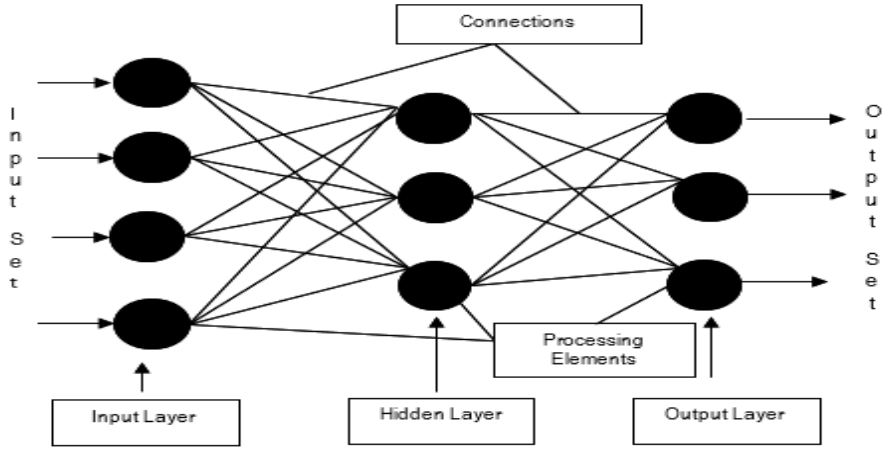
Many conventional and contemporary methodologies are employed to determine company value when we look at the pertinent literature. Husain et al.'s (2020) goal was to empirically demonstrate the modeling of the company's value based on the profitability ratio connected with dividend policy in different manufacturing industries and sub-sectors of automotive components listed in the Indonesia Stock Exchange (BEI) from 2014–2018. (Husain et al., 2020). The research used a Price-to-Book worth (PBV) method to calculate the company's worth. The Profitability Ratio and Dividend Policy did not appear to have a major impact on the Company's Value, nevertheless.

3. DATA AND METHODOLOGY

3.1. Artificial Neural Networks (Ann) Nonlinear External Input Autoregressive Network Model (Narx)

Artificial neural networks (ANNs) are made up of individual neurons organized and linked in a certain fashion determined by their design, just like biological role models. When data is supplied to the network during the learning process, special training algorithms attempt to make the network conform to the goal data by altering the weights of the connections between neurons. (Samarasighe, 2006). Figure 1 shows the architecture of an artificial neural network.

Figure 1: Artificial Neural Network Architecture



Artificial neurons come together to form an artificial neural network, and this formation is not random. Neurons are generally organized into three layers and run in parallel in each layer to create the network. These layers are as follows:

Input layer: Processing elements in this layer receive information from the outside world and transfer it to hidden layers. In some networks, there is no computing done at the input layer.

Hidden layers: The information from the input layer is processed and sent to the output layer through hidden layers. Multiple hidden layers can exist in a network.

An artificial neural network's output layer has processing components that analyze the data from the hidden layer and produce the output the network is supposed to produce for the input set given from the input layer. The finished product is then released to the public. (Oztemel, 2020).

In summary, the structure of a NARX network is typically represented in the form of "input-hidden-output" units, where the input and output units are connected to the hidden units. The input layer takes in the time series data, and the output layer produces the predicted output. The hidden layer(s) are where the non-linear relationships are modelled.

A wide range of nonlinear problems may be represented using artificial neural networks (ANNs), which are flexible computer architectures. ANNs have a significant advantage over other forms of nonlinear models since they are universal approximators and can precisely estimate a broad variety of functions. Their power comes from the simultaneous processing of information from the data. (Zhang, 2003).

Recurrent neural networks (RNNs) with a particular feature known as nonlinear autoregressive networks with exogenous input (NARX) employ a global feedback loop between the output and input layers. They are thus particularly well suited for modeling nonlinear systems. As a standard tool for time series analysis, the linear autoregressive model with exogenous input (ARX) and neural networks can be used to create NARX (Wunsch et al., 2018). The autoregressive with exogenous inputs (ARX) model in time series analysis serves as the foundation for the artificial neural network (ANN) known as NARX. It has been shown that NARX works well for modeling nonlinear systems. (Menezes & Barreto, 2008)

The NARX model is defined by the following equations 1: (Lin et al., 1998)

$$y(t) = f(y(t-1), y(t-2), ..., y(t-n), u(t-1), u(t-2), ..., u(t-m)) \quad (1)$$

where y(t) is the output at time t, f is a nonlinear function, y(t-1), y(t-2), ..., y(t-n) are the previous output values, and u(t-1), u(t-2), ..., u(t-m) are the external inputs.

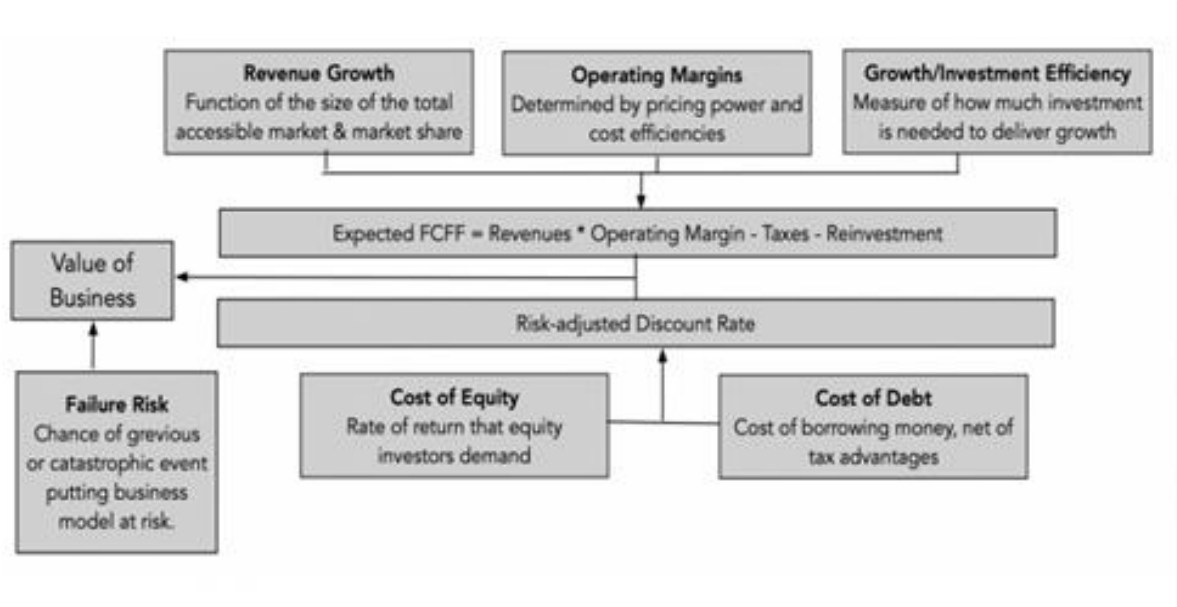
The capacity of a NARX model to capture the nonlinear dynamics of the financial system, which can be challenging to represent using conventional linear models, is one possible benefit of employing a NARX model to estimate business value. By taking into account both past inputs and past outputs, as well as any external inputs that may affect the company's value, the NARX model can potentially provide more accurate and reliable predictions than simpler models.

Another advantage of the NARX model is its ability to adapt to changing market conditions over time. Because the model incorporates feedback from its own predictions, it can adjust its parameters in response to changes in the underlying system, which can be especially important in volatile or rapidly changing markets.

3.2. Variables

The study examined companies in the Euro Stoxx 50 index, which is a stock index comprising the 50 largest companies operating in various sectors within the European Union. Company value estimation will be made using the Artificial Neural Networks NARX method. The inputs to be used in the method have been selected based on the value drivers shown in Figure 2. Twenty inputs have been determined that will help us estimate the value of the company. The output variable to be used to check the validity of the model is the free cash flow of the company.

Figure 2: The Drivers of Value



Note: Cornell, B. and Damodaran, A., Valuing ESG: Doing Good or Sounding Good? (March 20, 2020). NYU Stern School of Business

In this study, Free cash flow to the firm (FCFF) will be considered as output. The FCFF is an important and generally accepted scientific method in determining the true value of the company because the cash flows to be generated in the future depend on factors such as the company's organizational structure, human resources, brand value, goodwill, and intellectual capital (Ozturk, 2009).

The free cash flow to firm is the cash available to all of the company's stakeholders (including debt and equity holders) after all operating expenses, taxes, and capital expenditures have been paid. The FCFF is calculated as follows (Damodaran, 2011a):

FCFF= EBIT * (1-tax rate) + Depreciation and Amortization - Capital Expenditures - Change in Net Working Capital (2)

Where EBIT is earnings before interest and taxes, tax rate is corporate tax rate, depreciation and amortization are non-cash expenses, capital expenditures are the amount of money invested in long-term assets, change in net working capital is the change in the difference between current assets and current liabilities over a period of time.

The model's inputs and outputs are shown in Table 1.

Table 1. Inputs and Outputs of the Model

OUTPUT	**INPUT**				
Free Cash Flow to Firm	Sales Growth	ROA	Total Assets	Profit margin	Leverage Ratio
	Net Income	ROE	Total Liabilities	Cash Ratio	WACC
	EBIT	ROC	Gross Margin	Current Ratio	Cost of Equity
	EBITDA Margin	ROIC	Sustainable Growth Rate	Quick Ratio	Cost of Debt

Sales growth, which is the increase in sales and services revenues produced by an organization after deducting sales returns, allowances, discounts, and sales-based taxes, is one of the variables used to assess the firm value. The cost of items sold, general expenditures, taxes, and interest are subtracted from sales to produce net income, on the other hand. Ebitda margin, which is the portion of total sales income that a business keeps after paying the direct costs related to producing the goods and services it sells, is another factor. Ebit stands for earnings before interest expenses and income taxes. The return on assets (ROA) ratio measures a company's profitability in relation to its total assets as a percentage. It provides insight into how well management is utilizing its resources to produce profits. Return on equity (ROE), which is also represented as a percentage, is a metric of a company's profitability that shows how much profit a business makes with the money shareholders have contributed. The

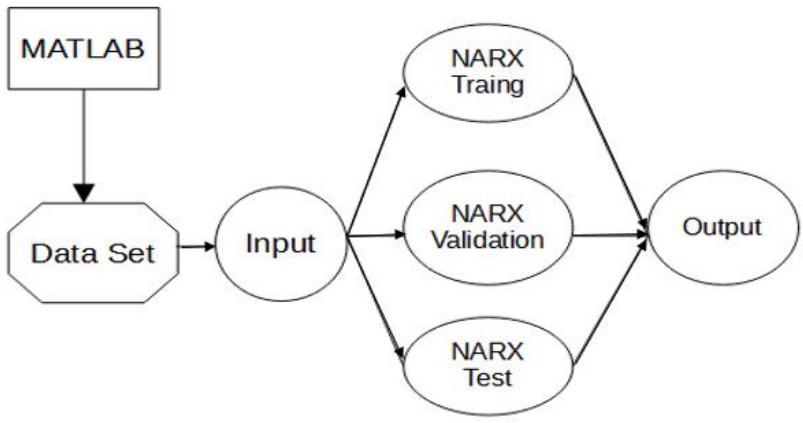
percentage return an investment delivers for capital contributors is measured by a metric known as return on capital (ROC). It reveals how successfully a business converts capital into profits. Return on invested capital (ROIC) measures how well a business utilizes the equity and debt sources of capital that are used to fund its operations. The initial and ending balances of Total Invested Capital are averaged to determine Average Invested Capital. Total liabilities are the sum of all short-term and long-term obligations recorded on the balance sheet, whereas total assets are the sum of all short-term and long-term assets. Gross margin is the fraction of total sales income that a company retains after all direct costs associated with producing the goods and services it sells have been paid. Maximum rate of growth that a business can maintain without having to raise more equity or debt is known as sustainable growth rate. The profitability of an organization is gauged by its profit margin, which is the ratio of net income to sales stated as a percentage The cash ratio—calculated as cash and cash equivalents divided by current liabilities—measures the company's liquidity by demonstrating its capacity to settle short-term debt with cash. The current ratio, which is determined by dividing current assets by current liabilities, assesses the company's capacity to settle short-term debts with its available resources. The quick ratio, which is computed as cash and equivalents, marketable securities, and accounts receivable divided by current liabilities, demonstrates the company's capacity to settle its short-term debts using its assets that are readily convertible into cash. The leverage ratio gauges a company's capacity to fulfill its commitments. The term "weighted average cost of capital" (WACC) describes the weighted cost of all capital used by the business to finance its assets. The rate of return that investors need to invest in a company's stock is known as the cost of equity. The return a business gives to its creditors and debt holders is known as the cost of debt. The term "free cash flow to the firm" (FCFF), also known as "operating free cash flow" (OFCF), refers to the amount of cash generated by a business's activities that is accessible to all capital sources within the capital structure of the company.

3.3. Model Structure

The research data used in this study consists of annual historical data taken from the Euro Stoxx 50 index. The Euro Stoxx 50 index is a stock market index that tracks the performance of 50 of the largest companies in the Eurozone. The index is chosen because they are designed to provide a broad-based representation of the Eurozone economy, with the goal of tracking the performance of the region's most important and influential companies. The period from 2000 to 2021 and all data were taken from the Bloomberg Database.

For analysis, 20 indicators were chosen, and the entire dataset was split into 70% training, 15% test, and 15% validation datasets, as shown in Figure 2. The program randomly separated the dataset into three parts, with 70% for training, 15% for validation, and 15% for testing, in order to achieve the best result. The MATLAB program and NARX (Nonlinear autoregressive with external input) method were used for the prediction model and all algorithms. The designed ANN model is presented in Figure 3.

Figure 3: Designed ANN Model

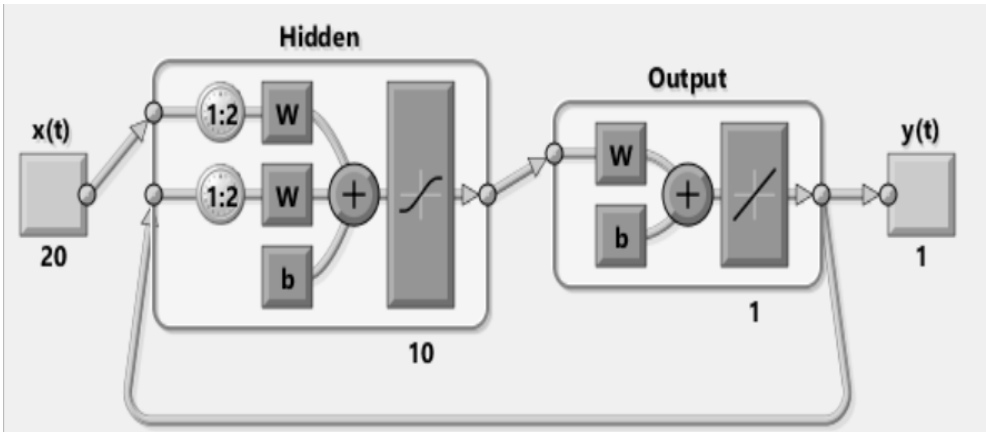


Since the collected data has different values with different scales, it is necessary to adjust and normalize the time series at the beginning of the modelling. The data normalization range is chosen to be [0,1], and the equation for data normalization is given as:

$$zi = [xi - \min(x)] / [\max(x) - \min(x)] \quad (3)$$

The NARX structure is depicted in Figure 4. The 1:2 expressions in the hidden layer structure show how many days ago the value was given as the input parameter. This value varies according to the application and data type. In this study, a comparison was made using different ANN layer numbers and delay values.

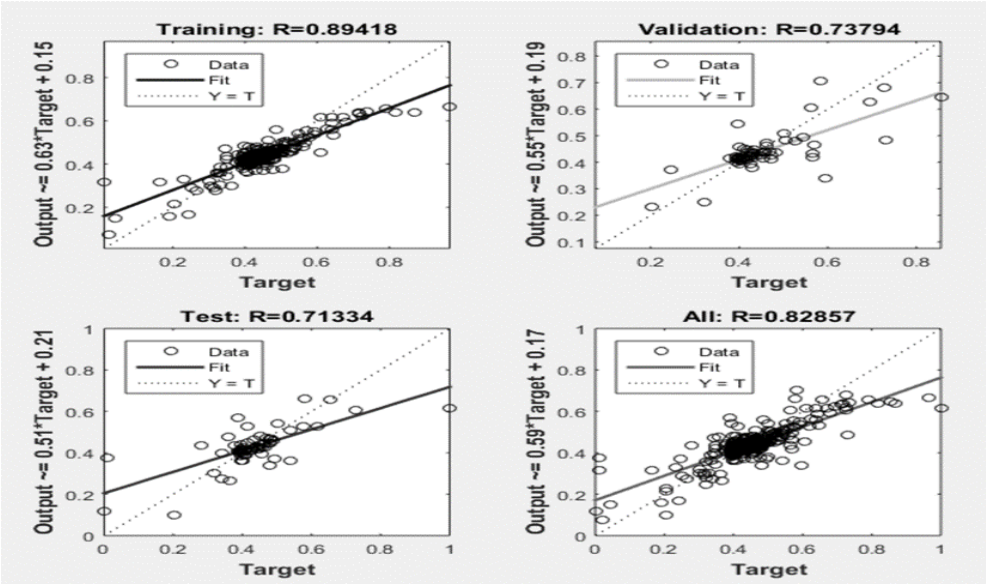
Figure 4: NARX Network Structure



5. EXPERIMENTAL RESULTS

The performance analysis of the ANN model, which has 20 inputs and 1 output, is presented in Table 2. Different hidden layer numbers were tested to reduce the error and achieve best R value, and the results are shown for training, validation, and testing. The main evaluation criterion is for the test data, while validation and training are used to train the model. The best values for both the correlation coefficient (R) and mean squared error (MSE) with 2-time delays were obtained with a 20-6-6-1 or 20-10-10-1 network structure. The R curves for the 20-6-6-1 structure with two hidden layers and six neurons in each layer are presented in Figure 4. The 20-6-6-1 NARX network has 20 input units, 6 hidden units in the first hidden layer, 6 hidden units in the second hidden layer, and 1 output unit. This means that the network takes in a 20-dimensional input time series, processes it through two hidden layers of 6 neurons each, and produces a single output prediction.

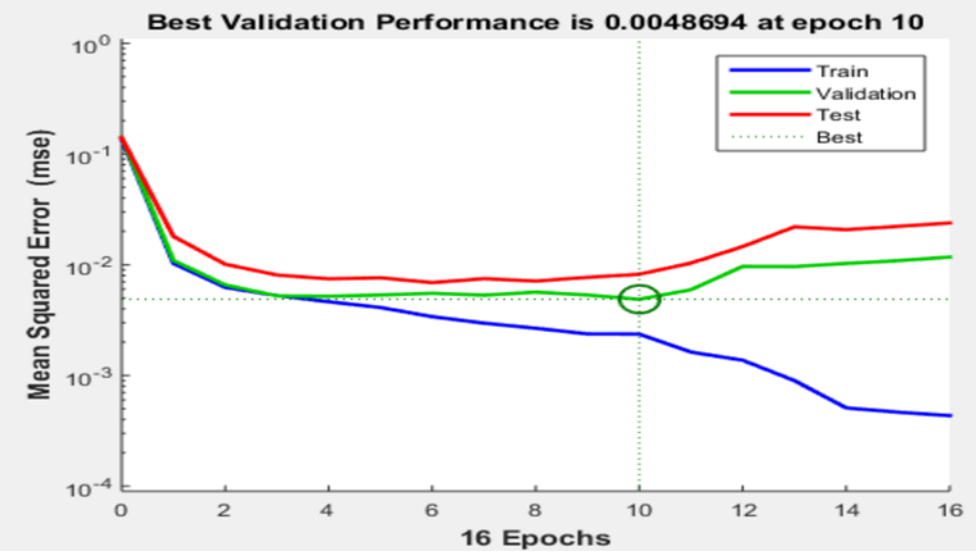
Figure 5: Evaluation of ANN performance with R



The NARX neural network model was created, and the success of training, validation, and test sets was evaluated using regression analysis. The correlation coefficient (R) measures the correlation between outcomes and goals, with a value of 1 indicating a close relationship, and 0 indicating a random relationship. As seen in Figure 5, the values between outputs and targets are very close to 1. The general correlation coefficient of the dataset was 0.82857.

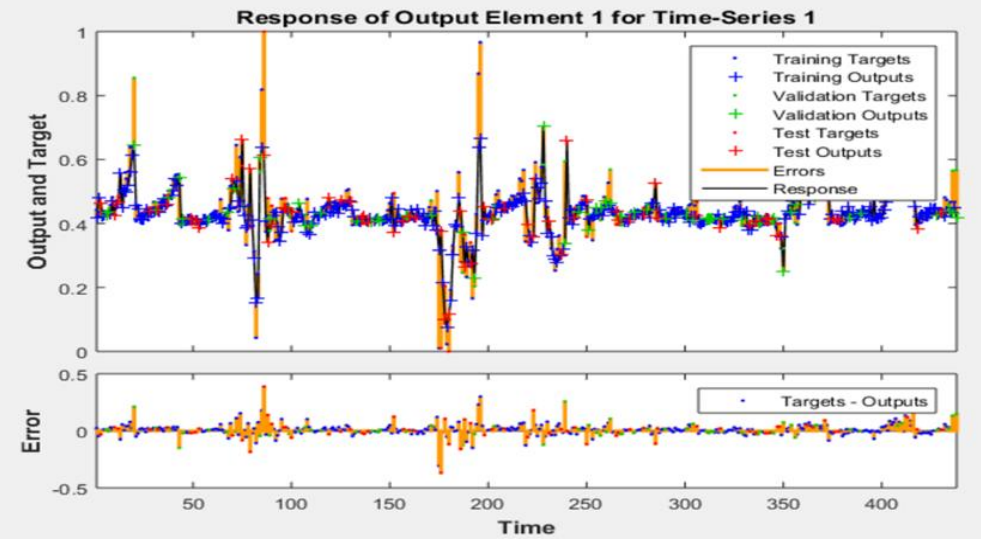
Figure 6 shows the output graph that displays the training structure of the NARX neural network at the end of 16 iterations. The figure indicates the states of the 16 iterations of the training process with respect to the periods. It is observed that the target function reaches the minimum lower point in 16 iterations with a value of 0.0048694. However, starting from the 10th iteration of the 16-iteration training, the validation of the network performance began to deteriorate.

Figure 6: Performance Chart



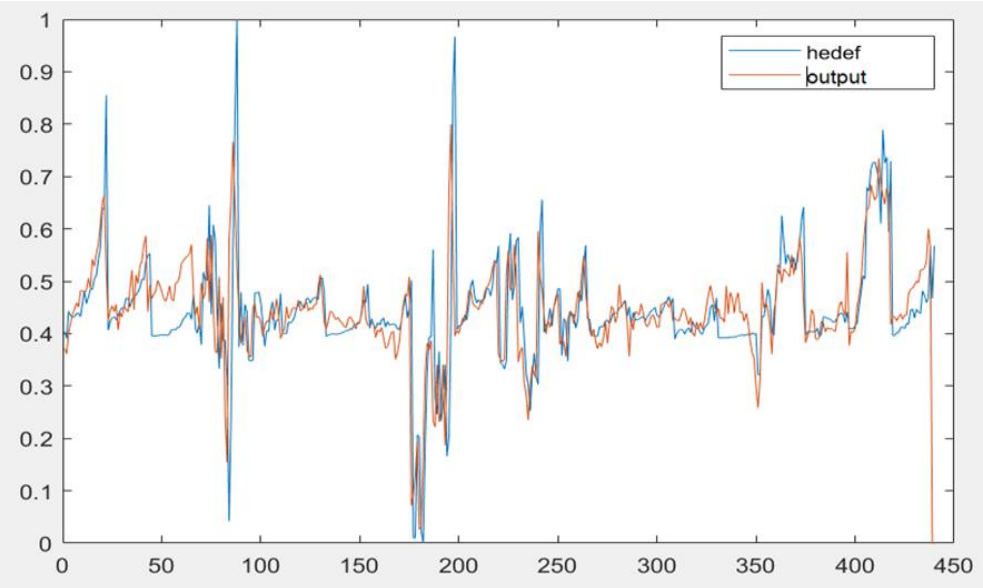
ANN Regression performance graph is shown in Figure 7. The Response Plot chart displays the time variable on the horizontal axis and the Target variable on the vertical axis. The Neural Network responses are synchronized with the calculated system responses.

Figure 7: ANN Regression Performance Chart



In Figure 8, a graph comparing the estimated values with the model and the actual values is presented. Table 2 contains the necessary data for the interpretation of the graph. The table 2 shows the results of different time delays with different layer numbers in 2. According to the analysis results, the best value for both R and MSE at 2-time delays was obtained with a 20-6-6-1 or a 20-10-10-1 network structure. The best value for both R and MSE at 3-time delays was obtained with a 20-12-12-1 network. Overall, it is seen that the 20-12-12-1 network structure with 3-time delays is the best model as a result of the training. It has a minimum mean square error of 0.0017 and a prediction success rate of 90.82%.

Figure 8: Actual and Estimated Values After the Training Phase



The results of different time delays with different layer numbers are presented in Table 2. At the table, time delay refers to the number of time steps used in the input data. For example, a time delay of 20-6-1 means that the input data includes 20-time steps, with 6 inputs and 1 output. Data Structure refers to the structure of the input data. For example, 20-6-1 means that there are 20-time steps, 6 inputs, and 1 output.

R value refers to the correlation coefficient, which measures the strength and direction of the relationship between the predicted values and the actual values. R formula is shown in Equation 4:

$$R= \frac{\sum_{i=1}^{n}(x_j-x)\,(y_j-y)}{\sqrt{\sum_{i=1}^{n}(x_j-x)^2}\sqrt{(y_j-y)^2}} \quad (4)$$

MSE value refers to the mean squared error, which measures the average squared difference between the predicted values and the actual values. The MSE formula is shown in Equation 5, and the:

$e_j=y_t-\hat{y}_t$
y_j= The value realized in period j,
$\hat{y}_j$= The predictive value calculated for period j,
n= the estimated number of periods,
e_j= To show the prediction error in the j period.

$$MSE=\frac{1}{n}\sum_{j=1}^{n} e_j^2 \quad (5)$$

The table 2 is divided into three sections for each time delay: Training, Validation, and Test. The Validation and Test parts show the model's performance on new data that it has never seen before, while the Training section displays the model's performance on the data used to train it.

Table 2: Performance Results

Time Delay	Data Structure	20-6-1		20-10-1		20-6-6-1		20-10-10-1		20-12-12-1	
		R	MSE	R	MSE	R	MSE	R	MSE	R	MSE
2	Training	0.8337	0.0037	0.8062	0.0035	0.8941	0.0024	0.9003	0.0022	0.8939	0.0021
	Validation	0.7273	0.0058	0.5659	0.0129	0.7379	0.0049	0.6205	0.0085	0.7843	0.0048
	Test	0.5599	0.0100	0.8131	0.0040	0.7133	0.0082	0.5792	0.0047	0.5706	0.0081
3	Training	0.8273	0.0040	0.8562	0.0065	0.7921	0.0046	0.8582	0.0064	0.9082	0.0017
	Validation	0.7143	0.0071	0.7408	0.0082	0.6885	0.0093	0.5524	0.0110	0.6822	0.0091
	Test	0.7645	0.0052	0.6430	0.0065	0.8356	0.0039	0.5986	0.0097	0.5021	0.0204

5. CONCLUSION

In order to maximize value, companies and investors must understand the notion of company value. Every stage of a company's life cycle, such as setting the stock price in initial public offerings, figuring out the cost of borrowing, and mergers and acquisitions, depends on valuation. Investors must also use the company's value to establish their investment strategy, enabling them to pay for shares based on their value. However, determining company value is challenging, and numerous methods are used to calculate it. This study uses the FCFF as an output. It is one of the most important and widely accepted methods for reflecting a company's real value.

In this study, the NARX-ANN method and the FCFF methodology were used to calculate the real value of the company. The NARX-ANN method combines financial data and takes into account non-linear correlations. So that the value of the company is determined more precisely and comprehensively.

The results of the study show how well the FCFF model captures the intrinsic value of the company. All important points, such as free cash flows, cost of capital, and growth potential, are taken into account in the FCFF calculation. And the valuation process has been significantly improved using the NARX-ANN methodology because it captures the dynamic nature of financial data and allows for non-linear relationships.

The strength of the study is that it works with FCFF valuation, which takes into account many important factors such as industry dynamics and company-specific variables, and the ability to capture the impact of these variables on the company's value using the NARX-ANN methodology. Especially in dynamic and uncertain market conditions, this comprehensive approach reduces reliance on simple assumptions and provides a more robust valuation framework. In addition, the NARX-ANN model learns and adapts to changing market conditions faster, which strengthens its forecasting ability.

The study aims to estimate the value of a company using the ANN Narx method with financial variables that have been selected based on the value drivers. The model includes 20 financial variables as input and FCFF as output, and the study was conducted with 50 companies in the Euro Stoxx 50 index. The Narx neural network estimates the FCFF output value with input values, and the trained artificial neural network realizes the estimation of the company value. As a result, the best value for both R and MSE at 2-time delays in the NARX model was obtained with the 20-6-6-1 or 20-10-10-1 network structure. On the other hand, as we are looking for the structure that performs best with our model and the training results show, the 20-12-12-1 network structure of the NARX model with a 3-time delay is the best, has a lower error rate resulting from training, and has the best R value.

Table 2 shows the performance of a NARX model with a time delay of 20-12-12-1 on a training, validation, and test dataset. The R and MSE values for each dataset are provided. The R values indicate a positive correlation between the predicted and actual values, while the MSE values indicate the degree of error between the predicted and actual values.

The results suggest that the NARX model performs well on the training dataset, with R values of 0.8939 and 0.9082 and MSE values of 0.0021 and 0.0017 for time delays 2 and 3, respectively. This suggests that the model is able to accurately capture the patterns in the training data. The model's overall prediction accuracy with a 20-12-12-1 network structure and a 3-time delay is 90.82%.

As a result, the NARX-ANN method combined with the FCFF valuation approach provides an all-encompassing framework for company valuation. This method takes into account all the factors and non-linear connections that affect the company's value and accommodates external influences, thus providing a more precise and comprehensive assessment of a company's intrinsic value. The model is a useful tool for investors, analysts, and decision-makers seeking a strong and forward-looking company

valuation approach as financial markets continue to evolve and become more complex. By including macroeconomic factors that have an impact on the sector and employing a longer time frame, the study could be extended.

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