Ege Akademik Bakış

Ege Academic Review

Ekonomi, İşletme, Uluslararası İlişkiler
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Volume 24 • Number 4 • October 2024

Cilt 24 • Sayı 4 • Ekim 2024

Contents

EGE AKADEMİK BAKIŞ / *EGE ACADEMIC REVIEW*

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A Robust Portfolio Construction Using the Bootstrap Method to Extract Multidimensional Uncertainty Sets: An Application on BIST100 Stocks

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ABSTRACT

Asset allocation is a crucial aspect of portfolio management. The primary objective is to maximize the expected return of the portfolio while minimizing investment risk through optimal asset allocation. However, it is impossible to eliminate all investment risks due to factors such as prediction errors, flawed model construction, and uncertainties in parameters. Traditional portfolio theory models address model-based risks but fail to consider parameter uncertainties, resulting in impractical solutions. In this context, robust optimization methods, as opposed to traditional methods, incorporate parameter uncertainties into the mathematical model and construct portfolios by considering worst-case scenarios within uncertainty sets. Therefore, a robust approach ensures that the model solution remains optimal with a high probability, providing protection against model-based risks for investors. In this paper, we present a robust optimization formulation based on Bertsimas and Sim (2004) and combine it with the bootstrap technique to generate optimal portfolios. Our findings demonstrate that as the uncertainty of the models increases, the expected return of the portfolios decreases. However, for moderate levels of uncertainty, the expected return of the robust portfolio is comparable to that of the classical portfolio. Furthermore, the out-of-sample analysis reveals that the robust portfolios outperform the equally weighted portfolio.

Keywords: Robust Optimization, Bootstrap Method, Asset Allocation, Uncertainity Sets.

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INTRODUCTION

Individuals save some of their income and accumulate funds to consume more in the future. The funds accumulated by consumers erode over time due to inflation, which reduces consumers' purchasing power. Consumers, in turn, invest these funds in financial instruments in order to maintain or, if possible, increase their purchasing power. Among many other alternatives, investors invest in the stock market in the hope that their funds will increase in value. However, investing in securities involves a degree of risk due to the nature of the financial markets. These risks may come from investors, sectors or economic cycles. An investment can be exposed to two types of risk: systematic and unsystematic (Marshall 2015). The former is inherent in the market and cannot be eliminated by diversification. The latter is company or security (stock) specific and can be reduced through diversification (Lhabitant 2017; Pilbeam, 2018; Koumou 2020; Zaimovic, Omanovic, and Arnaut-Berilo 2021). In addition to systematic and unsystematic risks, an investor may also face prediction risks based on parameter uncertainties or parameter biases, i.e., a difference between the predicted parameter and its realization (Lauprete, Samarov, and Welsch 2003). Therefore, utilizing classical optimization methods, such as Markowitz's mean-variance model, may result in optimizing an incorrect model with biased parameters, leading to non-optimal solution. In this context, classical methods may not be able to construct the best portfolio that minimizes both model-based and uncertainty-based risks.

Dynamic programming, stochastic programming, and duality analysis are the methods taking parameter uncertainty into account (Gero, and Dudnik 1978; Shapiro, and Philpott 2007; Sheng, Zhu, and Wang 2020; Zakaria et al. 2020; Diwekar, and Diwekar 2020). The difficulty with these methods is that they require detailed information about the distribution of the parameters (Birge, and Louveaux 2011). In practice, however, detailed information about the distribution of the parameters is almost rarely known. Moreover, solving dynamic programming and stochastic programming problems

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This article is a version of the dissertation entitled Robust optimizasyon yöntemi ile portföy analizi: BİST100 hisseleriyle bir uygulama, which was defended at Çukurova University in February 2022. The dissertation is listed in the YÖK Dissertation Centre under the dissertation number 714122.

becomes increasingly difficult as the number of possible scenarios with uncertain parameters increases. Although they have a solid theoretical background, the application of these models is quite limited in the literature. Robust optimization is a new technique compared to the models mentioned above. However, it is widely used in studies as it makes general assumptions about the distributions of the uncertain parameters. Moreover, the mathematical formulation of any robust problem has a linear conjugate and its solution is simple compared to stochastic programming and dynamic programming, even for large problems (Bertsimas, Brown, and Caramanis 2011; Yanıkoğlu, Gorissen, and Den Hertog 2019). Apart from post-solution methods such as duality, dynamic programming, and stochastic programming, robust optimization incorporates the uncertainty of parameters before optimizing the mathematical model (Beck and Ben-Tal, 2009; Gabrel, Murat, and Thiele, 2014). Parameter uncertainty often arises from estimation bias, changes in information flow, and shareholders' future expectations. By accounting for parameter uncertainty and incorporating it into the mathematical model, robust optimization offers several advantages for portfolio management. These include the ability to absorb errors in the mathematical model and within the uncertain sets, as well as providing a solution that remains optimal with a high probability even under the worst possible parameter realizations.

Robust optimization is one of the most widely used methods in portfolio theory (Goldfarb, and Iyengar 2003; Huang et al. 2010; Xidonas, Steuer, and Hassapis 2020). The uncertain parameters are included in the robust portfolio formulation within predetermined convex uncertainty sets. Owing to robust optimization, all possible realizations of the parameters are included in the portfolio optimization, so that the solution remains feasible with high probability. Although several robust models have been utilized to solve optimization problems with uncertain parameters, we have developed a new formulation of robust optimization based on the model proposed by Bertsimas and Sim (2004). While Bertsimas and Sim's formulation accounts for uncertainty in the constraints, the objective function does not consider uncertain parameters. In this paper, we have reorganized their robust formulation and proposed a new one that incorporates uncertain parameters in the objective function. Additionally, we have combined the bootstrap method with the model. It should be noted that there are various techniques available for determining the uncertainty sets of uncertain parameters, but in this study, we have chosen to use the bootstrap method to generate uncertainty sets for the assets analyzed. The bootstrap method is a resampling technique used to make inferences about a population based on an existing sample. In our case, it is used to create convex and symmetric uncertainty sets for the objective function parameters. The extreme values, i.e. the maximum and minimum values of the uncertainty set, were obtained for each stock using the distribution function created by the bootstrap technique.

LITERATURE REVIEW

Although the influential work of Markowitz (1952) laid the foundation for modern portfolio construction theory, the practical application of portfolio management has been disappointing due to difficulties in constructing model inputs. The inputs (expected returns and covariance between assets) for mean-variance optimization must be estimated, either statistically from historical data or pricing model (Tütüncü, and Fabozzi 2014). The uncertainty in the expected returns has a much greater influence on the optimal solution than the covariance matrix (Chopra and Ziemba 1993; and Kallberg and Ziemba 1984; Yam et al., 2016). Therefore, we focus on the uncertainty in the expected returns, assuming that the covariance matrix is known. The emphasis here is not on the risk of returns. Risk, as used in Markowitz's mean-variance model, and uncertainty, which is the difference between the estimated value and the realized value of a parameter, are different concepts. The mean-variance model assumes that asset returns are normally distributed and will continue to be normally distributed in the future. However, returns typically have a fat-tailed distribution with infinite variance (Fama 1965; Mandelbrot 1997; Campbell et al. 2008; Fabozzi et al. 2007; Bhansali 2008; Sheikh, and Qiao 2009; Haas, and Pigorsch, 2009; Stoyanov et al. 2011; Eom, Kaizoji, and Scalas, 2019; Eom 2020). Under the assumption of normality, the ordinary mean estimator is the best linear unbiased estimator (BLUE) and its use in the optimization model is unproblematic. However, in the case of non-normality, robust statistics or models must be used to construct efficient portfolios (Reyna et al. 2005; Kaszuba, 2012; Yang, Couillet, and McKay 2015; Li, Hong, and Wang 2015; Hubert, Debruyne, and Rousseeuw 2018; Bakar, and Rosbi, 2019).

The expected returns and the variance-covariance matrix estimated from historical data can be a good representation of the past. However, their ability to predict the future is not always perfect. At this point, the reliability of the solution obtained from the robust model increases, because the robust optimization

solves the mathematical model with uncertain parameters (Ben-Tal, and Nemirovski 2002; Fabozzi et al. 2007; Gülpınar, and Hu 2016). Although robust optimization dates back to the study of Sosyter (1973), it received the most attention in the early 2000s (Ghaoui, Oks, and Oustry 2003; Zymler, Rustem, and Kuhn 2011; Qiu et al. 2015; Lee et al. 2020; Xidonas, Steuer, and Hassapis 2020). The logic of the Soyster model is to assume the worst-case realization within uncertainty sets for all assets in the portfolio. This makes it the most conservative of the robust optimization models and therefore the most sensitive to uncertainty. Even if the financial markets exhibit a high degree of uncertainty, it is unlikely that all assets in the portfolio will perform at their worst. Over an investment horizon, some securities will provide lower than expected returns, while others will provide higher than expected returns. The main drawback of the Soyster model is its excessive conservatism with respect to parameter uncertainty. To overcome the problem of conservatism, Ben-Tal and Nemirovski (1998, 1999, 2000) have proposed a new robust model that is less conservative to parameter uncertainties. Compared to Soyster's model, the robust model proposed by Ben-Tal and Nemirovski is less likely to remain feasible due to its lower conservatism. The robust formulation of Ben-Tal and Nemirovski is theoretically convincing, but could not be used by the researchers because of the complications in solving the model. Finally, Bertsimas and Sim (2004) proposed a robust model allowing a trade-off between the value of the objective function and the robustness of the solution (Bertsimas, Pachamanova, and Sim 2004). In addition to the financial studies, the robust optimization formulations have been used in many academic studies, such as production planning and inventory management (Alem, and Morabito 2012; Agra et al. 2018; Rodrigues et al. 2019; Golsefidi, and Jokar 2020), energy storage and planning (Zhang et al. 2018; Zhao et al. 2019; Shen et al. 2020; Moret et al. 2020), supply chain and planning (Bertsimas, and Thiele 2004; Pishvaee, Rabbani, and Torabi 2011; Hahn, and Kuhn 2012), water management and planning (Zeferino, Cunha, and Antunes 2012); finance and portfolio theory (Tütüncü, and Koening 2004; Fabozzi et al. 2007; Quaranta, and Zaffaroni 2008; Gregory, Darby-Dowman, and Mitra 2011; Scutella, and Recchia 2013; Deng et al. 2013; Kapsos, Christofides, and Rustem 2014; Wang, and Cheng 2016; Sengupta, and Kumar 2017; Solares et al. 2019; Dai, and Wang 2019; Dai, and Kang 2021; Georgantas, Doumpos, and Zopounidis 2021).

Carefully defining uncertainty sets is crucial in order to achieve feasible outcomes, although robust optimization effectively reduces the impact of parameter biases. An uncertainty set is a region that encompasses all potential realizations of an uncertain parameter with a specified likelihood. Convexity, symmetry, and closed clusters are required for uncertainty sets. Here, a closed cluster refers to an interval with a finite number of parameter realizations. There are several ways to construct uncertainty sets, including methods proposed by Ben-Tal and Nemirovski (2000), Bertsimas and Brown (2009), Bandi and Bertsimas (2012), Guan and Wang (2013), Bertsimas, Gupta, and Kallus (2018), Zhu et al. (2020), and Daneshvari and Shafaei (2021). However, we chose to use the bootstrap method to create our uncertainty sets due to its statistical advantages.

METHODOLOGY

Robust Optimization

Robust optimization is a technique that takes into account uncertain parameters during the pre-solution phase of mathematical formulation. These parameters can have a range of values within an uncertainty set. The main concept is to define an uncertainty set for potential realizations of the uncertain parameters and then optimize the mathematical model against the worst-case scenarios within the uncertain set. In many optimization problems, the values of the parameters are either unknown or inaccurately predicted at the time of solution. This is a critical factor in the optimization process, as the solution heavily relies on these parameters. It is worth noting that the optimal solution of a linear programming problem occurs at a corner point of the feasible region. However, a potential bias in the parameters can significantly alter the optimization problem and result in an infeasible solution (Ben-Tal and Nemirovski 2000). By incorporating parameter uncertainties into the optimization model, the solution becomes more resistant to prediction bias. It is common for there to be a discrepancy between the actual and predicted values of a parameter in financial data, which is typically based on past information. Discrepancy between prediction and realization of a parameter can lead to uncertainty and risk in portfolio management. To address this issue, robust optimization techniques have been developed. The optimization model of Soyster (1973), Ben-Tal and Nemirovski (2000), and Bertsimas and Sim (2004) are widely cited in the literature. However, the robust model proposed by Bertsimas and Sim (2004) offers distinct advantages, such as the ability to control the level of conservatism through a control parameter and ensuring computational feasibility in both theory

and practice. In this study, we aim to enhance the robust model of Bertsimas and Sim by incorporating uncertainty into the objective function. Our proposed model for portfolio optimization with general constraints is outlined below.

$$\begin{aligned} Z_{max} &= \boldsymbol{\mu}'\boldsymbol{w} - \boldsymbol{\lambda}.\boldsymbol{w}^{t}\boldsymbol{\Sigma}\boldsymbol{w} \\ \boldsymbol{A}\boldsymbol{w} &\leq \boldsymbol{b} \\ \boldsymbol{l} \leq \boldsymbol{w} &\leq \boldsymbol{u} \end{aligned} \tag{1}$$

where $\boldsymbol{\mu}$ is the coefficient vector of the objective function, $\boldsymbol{w}$ is the weight vector, $\boldsymbol{A}$ is a matrix of technology coefficients, $\boldsymbol{b}$ is a vector of right-hand side coefficients, $\boldsymbol{\Sigma}$ is the variance-covariance matrix, $\boldsymbol{\lambda}$ is the risk aversion constant, and $\boldsymbol{l}$ and $\boldsymbol{u}$ are the lower and upper bounds of the weights, respectively. It is assumed that all coefficients in the model are certain or predetermined. However, Bertsimas and Sim (2004) proposed a robust model including uncertain parameters.

$$\begin{aligned} Z_{max} &= \boldsymbol{\mu}'\boldsymbol{w} \\ \sum_j a_{ij}w_j + \max_{\{S_i\cup\{t_i\}|S_i\subseteq J_i,|S_i|=\lfloor\Gamma_i\rfloor,t_i\in J_i\setminus S_i\}} &\left\{\sum_{j\in S_i}\hat{a}_{ij}y_j + (\Gamma_i - \lfloor\Gamma_i\rfloor)\hat{a}_{it_i}y_t\right\} \leq b_i \quad ;\forall i \\ -y_j \leq x_j &\leq y_j \\ \boldsymbol{l} \leq \boldsymbol{x} &\leq \boldsymbol{u} \\ \boldsymbol{y} &\geq \boldsymbol{0} \end{aligned} \tag{2}$$

where w_j is the j^{th} weight of the jth parameter, a_{ij} is the coefficient of the j^{th} certain parameter in the i^{th} constraint, $\hat{a}_{ij}$ is the coefficient of uncertain parameter j in the i^{th} constraint, and b_i is the constant of the right-hand side. The i^{th} constraint contains a sub-optimization model by itself. If w_j^* is the optimal weight of the j^{th} parameter, it is obvious that y_j will be equal to $|w_j^*|$ at the optimal point. If y_j takes a non-zero value, it will be equal to either $-w_j^*$ or w_j^*, because the optimal solution occurs at one of the extreme values. Hence, the constraint in equation (2) can be expressed as:

$$\sum_j a_{ij}w_j + \max_{\{S_i\cup\{t_i\}|S_i\subseteq J_i,|S_i|=\lfloor\Gamma_i\rfloor,t_i\in J_i\setminus S_i\}} \left\{\sum_{j\in S_i}\hat{a}_{ij}|w_j|\right\} \leq b_i \;;\forall i \tag{3}$$

where Γ_i represents the number of uncertain parameters included in the constraint with a possible range of 0 and $\lfloor\Gamma_i\rfloor$. This value corresponds to the maximum number of parameters in the model. The chosen integer in the analysis reflects a trade-off between the risk of uncertainty and the value of the objective function. When Γ_i is equal to 0, the model (2) will be equivalent to the Markowitz mean-variance model, which only includes certain parameters. On the other hand, if Γ_i is equal to $\lfloor\Gamma_i\rfloor$, the objective function will take on a more conservative value. In order to reach the optimal solution for equation (2), the constraint in equation (2) should be expressed as a sub-optimization model:

$$\begin{aligned} \beta_i(\boldsymbol{w}^*,\Gamma_i) = \max &\sum_{j\in J_i}\hat{a}_{ij}|w_j^*|z_{ij} \\ &\textstyle\sum_{j\in J_i} z_{ij} \leq \Gamma_i \\ 0 \leq z_{ij} \leq 1 \quad ; \quad &\forall j \in J_i \end{aligned} \tag{3}$$

The solution to model (2) is achieved in two steps: the first step is to solve the sub-optimization model (3), and the second step is to use the solution of model (3) to solve model (2). However, the uncertainty in returns have much more impact on feasible solution than uncertainty in the constraints. By integrating uncertainty into objective function, we develop a robust formulation based on the model of Bertsimas and Sim (2004). The objective of the proposed model is the Sharpe ratio[1] .

$$\begin{aligned} Z_{max} = \frac{\max\left(\sum_{i=1}^{\kappa}\mu_i w_i + \min_{\{S_i\cup\{t_i\}|S_i\subseteq J_i,|S_i|=\lfloor\Gamma_i\rfloor,t_i\in J_i\setminus S_i\}}\left\{\sum_{j\in S_i}\tilde{\mu}_j|w_j|\right\}\right) - R_f}{\sqrt{\mathrm{Var}[R_p]}} \\ \boldsymbol{A}\boldsymbol{w} \leq \boldsymbol{b} \\ \boldsymbol{l} \leq \boldsymbol{w} \leq \boldsymbol{u} \end{aligned} \tag{4}$$

where $\tilde{\mu}_j$ is return vector of the uncertain parameters, Γ_i is the number of uncertain parameter in model, and R_f is the risk-free rate. To optimize the objective, the numerator must be maximized while the denominator must be minimized. The numerator of the objective function contains two nested optimization problems: the inner one is a minimization problem, while the outer one is a maximization problem. The denominator is the portfolio's variance, which is a measure of the portfolio's risk. The model can incorporate conventional constraints, such as transaction cost constraints, minimum and maximum limit constraints, and others. These constraints do not involve uncertain parameters.

[1] The Sharpe ratio is proposed by Sharpe (1966) and formulated as $\frac{\mathrm{E}[R_p]-R_f}{\sqrt{\mathrm{Var}[R_p]}}$; where $\mathrm{E}[R_p]$ is the expected return of portfolio, R_f is the risk free rate, and $\mathrm{Var}[R_p]$ is the variance of portfolio. $\mathrm{E}[R_p] = \mu^{t}w$ and $\mathrm{Var}[R_p] = w^{t}\Sigma w$, where Σ is the covariance matrix of returns.

Bootstrap Method

Determining the appropriate uncertainty set or interval is crucial for the success of robust optimization. Poorly determined uncertainty sets can lead to unreliable solutions for optimization problems. Therefore, well-determined uncertainty sets result in reliable and feasible worst-case solutions. In this context, we use the bootstrap technique to determine appropriate intervals for the assets used in the analysis. The bootstrap is a procedure for repeating samples in order to derive statistics on population parameters. This method uses the resampling procedure to create new samples from the existing sample, with the aim of obtaining a good representation of the population parameters. Assuming that a series consists of a random sample from an unknown probability distribution F, bootstrapping can be used to predict a representative probability distribution of the series, represented as $\hat{F}$. To obtain $\hat{F}$, multiple samples are taken from the realized sample through resampling. There may be a bias between the predicted distribution $\hat{F}$ and the population distribution F, as well as between θ and $\hat{\theta}$, which are unknown population parameters and estimated parameters derived from the resampling procedure, respectively. However, in practice, the bias between θ and $\hat{\theta}$ is usually negligible due to the superior statistical properties of the method.

The distribution function of a random variable X with observed values $X_1, X_2, \ldots\ldots, X_n$ is denoted by F. However, the distribution of X is usually unknown. Fortunately, the empirical distribution $\hat{F}$ can be obtained from random samples $\boldsymbol{x_i} = (x_{i1}, \ldots x_{ik})$ from X, where $k<n$. The estimated parameter $\hat{\theta}$ derived from $\hat{F}$ can be used as a representation of the population parameter θ. By resampling $\boldsymbol{x_i} = (x_{i1}, \ldots x_{ik})$ for $i = 1,2,\ldots,\xi$, we can obtain ξ new samples from X. This allows us to create $\hat{\theta}$ based on ξ subsamples drawn from X using the resampling process. The confidence interval for θ can then be calculated using the estimated parameter $\hat{\theta}$, by taking into account the probability distribution of $\hat{\theta} - \theta$. Let s_α represent the α-percentile of the distribution of $\hat{\theta} - \theta$. A confidence interval for can be calculated using the following statement:

$$P\left(s_{\alpha/2} \le \hat{\theta} - \theta \le s_{1-\alpha/2}\right) = 1 - \alpha$$

or

$$\hat{\theta} - s_{1-\alpha/2} \le \theta \le \hat{\theta} - s_{\alpha/2}$$

The equation above states that the probability of containing the unknown parameter $\hat{\theta}$ is equal to 1-α. However, in order to use this interval, the distribution of $\hat{\theta} - \theta$ must be known. It is more common to use the distribution of the studentized estimator $(\hat{\theta} - \theta)/\hat{se}$, where $\hat{se}$ is the standard error of the estimator $\hat{\theta}$. This random variable often follows an approximate t-distribution with $df = n - p$ degrees of freedom, where p is the total number of unknown parameters to be estimated from the data. If $t_{df,\ \alpha}$ represents the α-percentile of the t-distribution with df degrees of freedom, the following confidence interval can be derived:

$$\hat{\theta} - t_{df;\alpha/2}\hat{se} \le \theta \le \hat{\theta} + t_{df;\alpha/2}\hat{se}$$

According to statistical theory, this interval will contain a population parameter with a probability of . In the context of robust optimization, this confidence interval represents the uncertainty associated with a risky asset used in portfolio optimization (Efron, and Tibshirani 1985; Wehrens, Putter, and Buydens, 2000).

DATA and ANALYSIS

We utilized the developed model to analyze BIST100 shares, with the exception of financial firms. This exclusion was due to the unique calculations involved in their balance sheets and their market-to-book ratio. Typically, investors are drawn to assets with low market-to-book ratios, as this is widely considered a key indicator of whether an asset is undervalued or overvalued in the market. However, financial institutions and banks tend to have very low equity, resulting in consistently low market-to-book ratios compared to manufacturing companies. As a result, the model may give disproportionate weight to the shares of financial institutions and banks. To avoid biased results, financial institutions and banks are typically excluded from financial studies (Fama and French 1992; Fama and French 1993; Azimli 2020). Therefore, our analysis was based on data from 56 assets. We used monthly data from January 2014 to March 2021 for the analysis, with closing prices on the last trading day of each month. Returns were calculated as the percentage change in prices from period t-1 to period t. In terms of the total asset space, 46.42% of shares were from the manufacturing sector, 10.71% from electricity, gas, and water, 10.71% from oil, gas, and chemicals, 8.92% from transportation, storage, and communications, 8.92% from technology, 7.14% from wholesale and retail trade, restaurants and hotels, 5.35% from mining and quarrying, and one share from the construction industry. The mathematical model used for portfolio construction and its constraints are outlined below.

$$Z_{max} = \frac{\mathrm{E}[R_p] - R_f}{\sqrt{\mathrm{Var}[R_p]}}$$

where $\mathrm{E}[R_p] = \max\left(\sum_{i=1}^{\kappa} \mu_i w_i + \min_{\{S_i \cup \{t_i\} | S_i \subseteq J_i, |S_i| = |\Gamma_i|, t_i \in J_i \setminus S_i\}} \left\{\sum_{j \in S_i} \tilde{\mu}_j |w_j|\right\}\right)$ while R_f is the average interest rate of government debt securities and $\mathrm{Var}[R_p]$ is the variance of the portfolio. Here, in order to optimize the expected return, we need to minimize the sub-problem inside the parentheses. This is because the expression inside the parentheses is optimized based on worst-case scenarios, resulting in a negative value for the objective function. Consequently, to maximize the expected return of portfolio, $\left\{\sum_{j \in S_i} \tilde{\mu}_j |w_j|\right\}$ part of $\mathrm{E}[R_p]$ which have zero or negative value must be minimized. Therefore, the objective can be reorganized as follows:

$$Z_{max} = \frac{\max\left(\sum_{i=1}^{\kappa} \mu_i w_i + \min_{\{S_i \cup \{t_i\} | S_i \subseteq J_i, |S_i| = |\Gamma_i|, t_i \in J_i \setminus S_i\}} \left\{\sum_{j \in S_i} \tilde{\mu}_j |w_j|\right\}\right) - R_f}{\sqrt{\mathrm{Var}[R_p]}}$$

Since R_f is constant in the objective function, maximizing the objective is essentially maximizing the ratio of expected return to portfolio risk within the constraints of the model shown in Table below.

The first constraint was implemented to ensure that the total weight of the portfolio equaled 1. Constraints 2-7 were utilized to promote portfolio diversification and restrict the upper and lower limits of stocks within each sector. The final constraint was put in place to prevent the weighting of any individual stock from exceeding 5% and to prohibit short selling. These optimization constraints allow for potential losses in one sector to be offset by gains in others, thanks to measures such as sector-specific investment ratios, maximum investment limits, and restrictions on investing in certain sectors.

Above are the descriptive statistics for the assets used in the analysis. The data shows that SASA has the highest monthly return of 6.1285%, while BIZIM has the lowest monthly return of 0.2831%. When conducting mean-variance analysis, it is important to consider the risk and expected return of each asset in order to create a portfolio with minimum risk or maximum expected return. The standard deviation, which represents risk, is a crucial factor in selecting assets for the portfolio. In this case, IPEKE has the highest risk of 17.7770, while

Table 1. The Constraints and Their Definition

#	The Constraint	Definition
1)	$\sum_{i=1}^{N} w_i = 1$	It ensures that the sum of the weights is equal to 1
2)	$\frac{\sum_{i=1}^{N} a_i w_i}{\sum_{i=1}^{N} w_i} \leq 7.00$	It limits the maximum weight of market-to-book ratio of an assets. Here, a_i is the market-to-book ratio of asset i.
3)	$\frac{\sum w_{jm}}{\sum_{i=1}^{N} w_i} \leq 0.35$	It ensures that the total weight of manufacturing stocks in the portfolio does not exceed 35%. Here, $\sum w_{jm}$ is the total weight of assets from manufacturing sector.
4)	$\frac{\sum w_{tp}}{\sum_{i=1}^{N} w_i} \geq 0.05$	It ensures that the total weight of the shares of wholesale, retail, restaurants and hotels is at least 5% of the portfolio. Here, $\sum w_{tp}$ is the total weight of assets from wholesale, retail, restaurants and hotels sector.
5)	$\frac{\sum w_{tk}}{\sum_{i=1}^{N} w_i} \geq 0.20$	It ensures that the total weight of shares in the technology sector is at least 20% of the portfolio. Here, $\sum w_{tk}$ is the total weight of assets from technology sector.
6)	$\frac{\sum w_{km}}{\sum_{i=1}^{N} w_i} \geq 0.10$	It ensures that the total weight of oil, gas and chemical sector stocks is at least 10% of the portfolio. Here, $\sum w_{km}$ is the total weight of assets from oil, gas and chemical sector.
7)	$\frac{\sum w_{ul}}{\sum_{i=1}^{N} w_i} \geq 0.08$	It ensures that the weights of transportation, storage, and communications shares in the portfolio are a maximum of 8%. Here, $\sum w_{ul}$ is the total weight of assets from transportation, storage, and communications sector.
8)	$0 \leq w_i \leq 0.05$	It limits the lower and upper bounds of the weights.

Table 2. Descriptive Statistics

Asset	Mean	Median	Max.	Min.	Std. D.	Skewness	Kurtosis	Jarque-Bera
AEFES	0.315	0.609	22.035	-24.166	8.465	-0.124	3.129	0.280
AKSA	2.427	1.888	31.103	-21.998	9.874	0.199	3.389	1.109
AKSEN	1.968	1.652	32.668	-22.233	10.022	0.376	3.568	3.181
ALKIM	3.007	2.029	23.182	-11.596	7.817	0.342	2.424	2.861
ARCLK	1.571	0.897	23.261	-31.644	9.216	-0.485	4.256	**9.019***
ASELS	2.586	1.641	25.503	-20.456	8.465	-0.074	2.979	0.079
AYGAZ	1.622	1.096	21.423	-24.981	8.158	-0.018	3.651	1.525
BIMAS	1.709	1.171	17.196	-11.749	5.982	0.311	2.760	1.597
BIZIM	0.283	-0.267	35.888	-25.167	10.509	0.256	4.246	**6.506***
BRISA	2.349	1.032	30.124	-20.143	9.987	0.307	3.069	1.366
BRSAN	2.585	1.815	54.002	-28.465	12.266	0.646	5.833	**34.758***
BTCIM	2.291	2.233	82.149	-41.958	15.260	1.444	10.943	**255.988***
BUCIM	1.836	0.756	33.156	-22.400	10.304	0.890	4.351	**17.882***
CCOLA	0.646	0.586	22.181	-25.353	8.797	0.062	3.504	0.966
CEMTS	3.229	2.750	37.764	-25.568	12.050	0.443	3.371	3.304
CIMSA	1.246	0.967	25.073	-35.905	9.375	-0.270	5.306	**20.101***
CLEBI	4.281	2.749	69.586	-32.158	14.624	1.714	9.068	**174.041***
DEVA	3.411	3.150	44.727	-24.525	11.028	0.707	5.772	**34.705***
DOAS	2.387	1.790	45.735	-33.896	14.020	0.705	4.678	**17.225***
EGEEN	4.244	1.958	49.790	-29.515	11.431	0.570	5.043	**19.607***
ENKAI	1.221	0.515	18.704	-10.942	6.006	0.429	3.269	2.893
ERBOS	3.166	2.341	35.783	-23.603	11.662	0.249	2.978	0.894
EREGL	2.773	1.645	30.548	-21.256	10.118	0.027	2.670	0.401
FROTO	2.990	3.705	25.037	-39.001	9.494	-0.774	6.086	**42.720***
GUBRF	3.837	2.271	50.947	-25.983	14.259	1.041	5.117	**31.6035***
HEKTS	4.963	4.006	41.521	-22.704	10.497	0.654	4.822	**18.021***
INDES	3.047	3.259	33.749	-30.772	12.915	-0.185	3.602	1.791
IPEKE	2.089	-1.812	55.667	-57.982	17.777	0.319	4.226	6.847*
KAREL	3.826	2.709	32.030	-37.243	13.810	-0.071	2.818	0.190
KARSN	2.036	1.978	48.168	-40.306	14.769	0.512	5.150	**20.333***
KARTN	2.627	0.147	93.849	-22.629	14.752	3.181	18.956	**1057.307***
KLMSN	2.978	2.427	35.140	-40.042	15.550	-0.274	3.280	1.358
KORDS	2.897	2.236	32.371	-35.452	10.845	0.097	4.524	**8.462***
KOZAA	2.336	-0.129	50.067	-39.256	17.504	0.425	3.269	2.851
KOZAL	2.373	2.971	45.562	-32.918	14.177	-0.014	3.474	0.809
KRDMD	2.692	0.569	45.783	-31.366	13.195	0.342	3.912	**4.653***
LOGO	3.823	2.364	63.517	-23.877	14.398	1.194	5.849	**49.507***
MGROS	1.148	1.503	25.835	-35.742	9.849	-0.426	4.280	**8.475***
NETAS	2.176	0.426	41.985	-25.229	13.531	0.799	4.043	**13.045***
ODAS	2.174	0.879	55.500	-36.546	16.030	0.165	4.224	**5.762***
OTKAR	2.810	2.531	38.295	-35.094	11.682	-0.081	4.676	**10.161***
PETKM	2.408	2.701	21.591	-37.046	9.513	-0.802	5.474	**31.157***
PGSUS	1.404	-0.899	43.807	-45.676	15.560	0.147	3.716	2.147
SASA	6.129	4.796	47.717	-22.159	13.278	0.771	4.148	**13.254***
TATGD	1.932	2.247	27.895	-22.108	11.290	0.080	2.352	1.595
TCELL	0.914	1.632	17.586	-19.947	7.272	-0.404	3.248	2.558

THYAO	0.919	-0.277	24.668	-30.654	11.374	-0.040	2.886	0.069
TMSN	1.743	1.119	48.980	-33.384	12.531	0.449	5.122	19.014*
TOASO	2.034	0.586	30.605	-33.700	8.746	-0.233	6.025	**33.565***
TTKOM	0.629	0.250	25.643	-27.115	8.611	-0.152	4.241	**5.854***
TTRAK	2.186	2.177	36.282	-35.377	11.059	0.117	5.273	**18.702***
TUPRS	1.728	2.397	19.671	-29.395	8.623	-0.353	3.954	**5.045***
ULKER	0.688	0.263	22.655	-19.651	9.180	0.088	2.671	0.500
VESTL	3.593	3.846	40.945	-36.335	15.383	-0.039	3.074	0.041
YATAS	5.007	4.913	38.349	-37.445	14.374	-0.440	3.277	3.049
ZOREN	1.563	1.123	62.390	-22.691	13.076	1.206	7.310	**87.421***

Table 3. The Uncertainty Sets of the Assets

Asset				**Asset**			
AKSA	[-1.25, 6.11]	[-0.24, 5.09]	[0.34, 4.51]	***KRDMD***	[-2.38, 7.76]	[-0.83, 6.21]	[-0.08, 5.47]
AKSEN	[-1.73, 5.67]	[-0.70, 4.63]	[-0.15, 4.08]	***KAREL***	[-1.38, 9.03]	[0.07, 7.58]	[0.87, 6.78]
ALKIM	[0.07, 5.94]	[0.88, 5.13]	[1.35, 4.66]	***KARSN***	[-3.60, 7 68]	[-2.01, 6.08]	[-1.07, 5.14]
AEFES	[-2.97, 3.60]	[-2.01, 2.64]	[-1.49, 2.12]	***KARTN***	[-1.01, 6. 27]	[-0.05, 5.30]	[0.48, 4.77]
ARCLK	[-2.09, 5.24]	[-0.99, 4.13]	[-0.42, 3.56]	***KLMSN***	[-3.07, 9.03]	[-1.30, 7.26]	[-0.27, 6.23]
ASELS	[-0.74, 5.92]	[0.26, 4.91]	[0.79, 4.39]	***KORDS***	[-1.28, 7.07]	[-0.06, 5.86]	[0.60, 5.19]
AYGAZ	[-1.54, 4.78]	[-0.58, 3.83]	[-0.09, 3.33]	***KOZAL***	[-3.04, 7.79]	[-1.44, 6.19]	[-0.64, 5.38]
BTCIM	[-3.24, 7.83]	[-1.67, 6.26]	[-0.84, 5.43]	***KOZAA***	[-4.29, 8.96]	[-2.42, 7.09]	[-1.34, 6.01]
BIMAS	[-0.53, 3.95]	[0.11, 3.31]	[0.44, 2.97]	***LOGO***	[-0.22, 7.86]	[0.91, 6.74]	[1.52, 6.13]
BIZIM	[-3.74, 4.30]	[-2.55, 3.11]	[-1.93, 2.50]	***MGROS***	[-2.68, 4.98]	[-1.57, 3.87]	[-1.01, 3.31]
BRSAN	[-2.01, 7.18]	[-0.78, 5.95]	[-0.01, 5.18]	***NETAS***	[-2.81, 7.16]	[-1.39, 5.74]	[-0.64, 5.00]
BRISA	[-1.44, 6.14]	[-0.35, 5.05]	[0.24, 4.46]	***ODAS***	[-3.81, 8.16]	[-2.17, 6.52]	[-1.23, 5.58]
BUCIM	[-2.00, 5.67]	[-0.89, 4.57]	[-0.32, 3.99]	***OTKAR***	[-1.72, 7.35]	[-0.36, 5.98]	[0.34, 5.28]
CCOLA	[-2.84, 4.13]	[-1.74, 3.03]	[-1.21, 2.50]	***PGSUS***	[-4.48, 7.29]	[-2.79, 5.59]	[-1.80, 4.61]
CLEBI	[0.23, 8.34]	[1.32, 7.24]	[1.93, 6.63]	***PETKM***	[-1.48, 6.29]	[-0.27, 5.08]	[0.36, 4.45]
CEMTS	[-1.38, 7.83]	[0.06, 6.40]	[0.72, 5.73]	***SASA***	[1.25, 11.00]	[2.63, 9.63]	[3.39, 8.87]
CIMSA	[-2.39, 4.88]	[-1.30, 3.79]	[-0.74, 3.23]	***TATGD***	[-2.34, 6.20]	[-1.13, 4.99]	[-0.46, 4.33]
DEVA	[-0.70, 7.52]	[0.51, 6.31]	[1.13, 5.69]	***TOASO***	[-1.44, 5.51]	[-0.36, 4.43]	[0.16, 3.90]
DOAS	[-2.67, 7.45]	[-1.27, 6.04]	[-0.52, 5.29]	***TCELL***	[-2.00, 3.83]	[-1.12, 2.95]	[-0.66, 2.48]
EGEEN	[-0.05, 8.54]	[1.19, 7.30]	[1.84, 6.64]	***TMSN***	[-3.03, 6.51]	[-1.63, 5.12]	[-0.89, 4.37]
ENKAI	[-1.04, 3.49]	[-0.42, 2.86]	[-0.06, 2.50]	***TUPRS***	[-1.68, 5.14]	[-0.63, 4.09]	[-0.10, 3.55]
ERBOS	[-1.21, 7.55]	[0.06, 6.27]	[0.75, 5.58]	***THYAO***	[-3.47, 5.31]	[-2.19, 4.03]	[-1.53, 3.37]
EREGL	[-1.19, 6.74]	[-0.01, 5.56]	[0.62, 4.92]	***TTKOM***	[-2.73, 3.99]	[-1.70, 2.96]	[-1.19, 2.45]
FROTO	[-0.83, 6.81]	[0.35, 5.63]	[0.94, 5.04]	***TTRAK***	[-2.09, 6.47]	[-0.79, 5.17]	[-0.18, 4.55]
GUBRF	[0.09, 7.58]	[1.13, 6.55]	[1.70, 5.97]	***ULKER***	[-2.91, 4.29]	[-1.84, 3.22]	[-1.29, 2.66]
HEKTS	[1.14, 8.78]	[2.20, 7.73]	[2.76, 7.16]	***VESTL***	[-2.36, 9.54]	[-0.61, 7.80]	[0.33, 6.85]
INDES	[-1.96, 8.05]	[-0.54, 6.64]	[0.27, 5.83]	***YATAS***	[-0.70,10.72]	[1.07, 8.95]	[1.98, 8.03]
IPEKE	[-4.56, 8.73]	[-2.66, 6.84]	[-1.61, 5.79]	***ZOREN***	[-3.08, 6.21]	[-1.81, 4.94]	[-1.10, 4.23]

BIMAS has the lowest risk of 5.9819. Additionally, the distribution of the series is also important in portfolio selection. The coefficients of skewness and kurtosis provide valuable information about the shape of the distribution. It is worth noting that a large proportion of assets do not have a symmetric distribution, as indicated by the coefficients of skewness and kurtosis. The Jarque-Bera test is another indicator of normality, with the null hypothesis being "the series is normally distributed." The results in Table 2 show that 31 out of 56 series are not

normally distributed, which is more than half of the total assets used in the analysis. This proportion increases even further as the frequency of the data increases. Therefore, assuming normality would render the model solutions invalid.

The bootstrap method was used to determine uncertainty intervals, which are presented in Table 3. These intervals were constructed using three alpha values, representing the significance level of the uncertainty sets. The significance levels used were 1%, 5%, and 10%, which are commonly used in statistics for confidence intervals. As the investment in a portfolio was planned for three years, subsamples of 36 observations were created using the bootstrapping procedure. For each asset, 15000 subsamples were drawn to obtain a representative distribution of returns. Once the asset distributions were determined through bootstrapping, the lower and upper bounds of the uncertainty sets were calculated using the first, fifth, and tenth quantiles for each asset. In the case of an alpha is equal to 0.01, corresponding to a 99% confidence level, the lower bounds of the uncertainty sets were generally negative and all upper bounds were positive. This is due to the wide confidence interval. As the confidence level increases, it is expected for the bounds of the confidence intervals to expand. For example, the difference between the boundary values of AKSA at 99%, 95%, and 90% confidence levels were 7.36, 5.48, and 4.85, respectively. A confidence interval of 99% is quite high and means that 99 out of 100 realizations would fall within the interval. Therefore, compared to intervals at lower confidence levels, a larger interval can be expected at a higher confidence level. Asset returns can randomly take on any value within the uncertainty set, including the lower and upper bounds. As robust optimization seeks a feasible solution to the worst-case scenario of assets, it is likely that one of the extreme values will be assumed during model optimization.

Table 4 summarizes the Sharpe ratio, expected returns (%), and portfolio risks in terms of the number of uncertain parameters in the models. The gamma value ranges from zero to 56. The gamma value of zero indicating that the model contains no uncertain variables. The gamma value of 56 corresponds to the most conservative robust formulation, the robust optimization model of Soyster. The confidence levels of the intervals or uncertainty sets are represented by 99%, 95%, and 90%, which are determined by the number of uncertain parameters included in the model. For example, a gamma value of zero would correspond to the classical mean-variance model of Markowitz, while a gamma value of 56 would correspond to the robust optimization model of Soyster.

As the number of uncertain parameters included in the model increased, the expected return and Sharpe ratio decreased. This relationship was observed at different levels of uncertainty, with the Sharpe ratio decreasing by more than 20% at a 99% confidence level when the number of uncertain parameters increased from 1 to 2. However, the decrease in Sharpe ratio was minimal when the number of uncertain parameters was between 2 and 10. As the number of uncertain parameters continued to increase from 15 to 56, the Sharpe ratio decreased significantly, and for models with 45 or more uncertain parameters, it even took on a negative value. This suggests that the risk-free interest rate was higher than the expected return of the portfolio. The expected returns of the portfolios also followed a similar trend as the Sharpe ratio. The model without any uncertain parameters had an expected return of 52%, which remained almost unchanged when one uncertain parameter was included. At different confidence levels (99%, 95%, and 90%), the expected returns were 52.095%, 51.59%, and 51.59%, respectively.

In terms of risk, the variance of the portfolio, which represents investment risk, tended to decrease as the number of uncertain parameters included in the model increased. This was in line with expectations, as robust optimization takes into account parameter uncertainties before the solution, thereby reducing some of the investment risk. However, this reduction in risk came at the cost of sacrificing some of the expected return. As the level of uncertainty increased, the solution space of the optimization model became smaller. This inverse relationship between expected return and uncertainty is referred to as the "price of robustness" by Bertsimas and Sim (2004). It is important to note that a gamma value of zero (indicating no uncertain parameters) or the maximum value of 56 (indicating all uncertain parameters) is not expected in practice. In reality, the assets in a portfolio fall somewhere between these two extremes. Some sectors may perform below the expected return, while others may perform above it. This highlights the importance of diversification in a portfolio, as investing in assets from different sectors and with different characteristics can help mitigate the impact of underperforming assets.

Figure 1 illustrates the relationship between the Sharpe ratio and portfolio risk in relation to the uncertain parameters included in the models. The dashed line represents portfolio risk, while the straight line represents the Sharpe ratio. The figure suggests that as the number of uncertain parameters increases, the Sharpe ratio

Table 4. The Expected Return Of Portfolio, The Risk Of Portfolio, and The Sharpe Ratio

	Sharpe Ratio				Sharpe Ratio		
Gama=0	0.01812	%52.090	25.66250				
Gama=1				***Gama=4***			
99%	0.01810	%52.095	25.69165	***99%***	0.01490	%41.232	23.93431
95%	0.01682	%51.590	27.34654	***95%***	0.01490	%41.233	23.93460
90%	0.01683	%51.590	27.33443	***90%***	0.01503	%40.878	23.48085
Gama=2				***Gama=5***			
99%	0.01447	%41.352	24.72033	***99%***	0.01500	%40.877	23.52785
95%	0.01448	%41.352	24.70964	***95%***	0.01491	%40.910	23.69429
90%	0.01460	%41.336	24.48440	***90%***	0.01494	%40.907	23.64958
Gama=3				***Gama=6***			
99%	0.01448	%41.342	24.69349	***99%***	0.01497	%40.888	23.58361
95%	0.01496	%41.207	23.81680	***95%***	0.01489	%40.912	23.73513
90%	0.01506	%41.159	23.61990	***90%***	0.01494	%40.914	23.65005
Gama=7				***Gama =10***			
99%	0.01451	%39.445	23.33683	***99%***	0.01389	%37.804	23.19995
95%	0.01482	%39.752	23.04991	***95%***	0.01455	%39.869	23.55889
90%	0.01445	%39.595	23.53577	***90%***	0.01451	%39.430	23.32053
Gama =8				***Gama =15***			
99%	0.01459	%39.606	23.31754	***99%***	0.01258	%31.950	20.95607
95%	0.01623	%39.690	21.01095	***95%***	0.01382	%32.230	19.28916
90%	0.01623	%39.693	21.01858	***90%***	0.01425	%32.031	18.55739
Gama =9				***Gama =20***			
99%	0.01556	%39.800	21.99614	***99%***	0.01116	%29.720	21.62301
95%	0.01515	%40.000	22.71826	***95%***	0.01272	%29.790	19.03467
90%	0.01478	%39.674	23.07072	***90%***	0.01323	%31.510	19.60297
Gama=25				***Gama=45***			
99%	0.01094	%24.713	17.48019	***99%***	0.00156	%08.758	20.37770
95%	0.01221	%29.008	19.19222	***95%***	-0.00100	%3.330	22.50142
90%	0.01308	%29.662	18.40892	***90%***	0.00703	%20.133	20.70634
Gama=30				***Gama=50***			
99%	0.00827	%22.543	20.49859	***99%***	-0.00462	-%4.218	21.19801
95%	0.00984	%24.842	19.56484	***95%***	0.00343	%12.725	20.82131
90%	0.01081	%27.116	19.92363	***90%***	0.00099	%7.779	22.17366
Gama=35				***Gama=56***			
99%	0.00768	%21.013	20.10443	***99%***	-0.00720	-%9.667	21.17044
95%	0.00864	%23.427	20.64725	***95%***	-0.00577	-%10.000	27.01822
90%	0.00981	%25.708	20.51236	***90%***	-0.00175	%1.618	22.60142
Gama=40							
99%	0.00141	%8.471	20.45621				
95%	0.00492	%15.811	20.78953				
90%	0.00671	%19.545	20.80928				

decreases. For instance, when the model contains no uncertainty, the ratio is 0.017, but it drops to almost -0.003 when the optimization model includes 56 uncertain parameters. Similarly, the trend of portfolio risk follows that of the Sharpe ratio, until the point where 25 uncertain parameters are present in the models. Beyond this point, the trend of risk slightly increases with the number of uncertain parameters. Interestingly, both portfolio

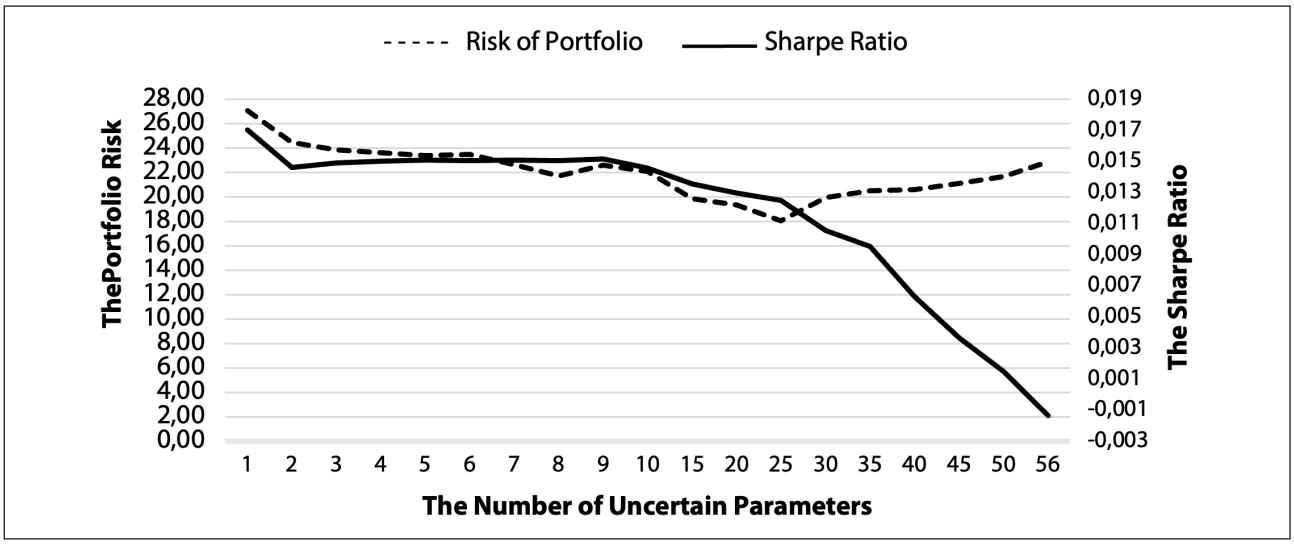

Figure 1: The Sharpe Ratio and the Risk of Portfolios Concerning Uncertain Parameters

risk and Sharpe ratio remain relatively stable when the number of uncertain parameters ranges from 2 to 10, indicating the robustness of the optimization solution. This suggests that solving the portfolio optimization problem with 2 uncertain parameters may be feasible for models with up to 10 uncertain parameters. However, for models with more than 10 uncertain parameters, a decrease in Sharpe ratio and an increase in risk can be expected due to the increased uncertainty in the models.

Figure 2 illustrates the relationship between the Sharpe ratio and expected returns of different models, based on the number of uncertain parameters in each model. As the number of uncertain parameters increases, the expected returns of the models decrease. This is reflected in the numerator of the Sharpe ratio, which includes the expected return of the portfolio. Interestingly, the decrease in expected return is more significant than the decrease in the Sharpe ratio when going from one uncertain parameter to two. This suggests that the impact of risk on the Sharpe ratio is greater than the impact of return when additional uncertain parameters are added to the model. As the number of uncertain parameters increases from two to ten, there is a gradual decline in expected returns. However, when there are more than ten uncertain parameters, the expected returns of the portfolios decrease even further and eventually become negative.

Figure 3 shows the portfolio efficient frontiers obtained by robust optimization. The efficient frontiers were computed from the constructed efficient portfolios with 95% confidence intervals for each gamma representing the uncertain parameters in the models. The efficient frontiers of , , , , , and almost overlapped, and the efficient frontier of was slightly below the first frontier. The efficient frontier of the portfolios gradually decreases as model uncertainty increases. This means that the efficient frontier of models with more uncertain parameters is lower than that of models with less uncertain parameters. The figure illustrates this by showing a decrease in expected return from almost 62% to almost 18%, depending on the level of uncertainty in the models. As investors' risk appetite increases, the expected return of the portfolios also increases, but at a decreasing rate. However, there comes a point where it is impossible to further increase the expected return for a given level of risk. At this point, there is no reason for the investor to take on more risk. The efficient frontier represents a combination of all the portfolios in which investors have invested, and it is technically impossible to achieve a higher return than this frontier. Therefore, investors should choose a portfolio on the efficient frontier based on their risk tolerance. Expected returns of a portfolio reflect the performance of the portfolio during a specific analysis period. However, investors interest in portfolio performance in a real investment process, because the expected return of a portfolio is not necessarily the same as the return achieved at the end of an investment period. Therefore, the average appreciation of an investment is often more important than the expected return of a portfolio. As a result, theoretically constructed portfolios are expected to generate a higher return than the average market returns in the investment process.

Table 5 displays the average annual returns of two portfolios: one constructed using robust optimization and the other using an equally weighted approach with 56 assets. These figures cover a seven-year period from November 2014 to February 2021, deliberately chosen to include the Covid-19 pandemic and demonstrate the robustness of the robust optimization solution. The results align with the expected return

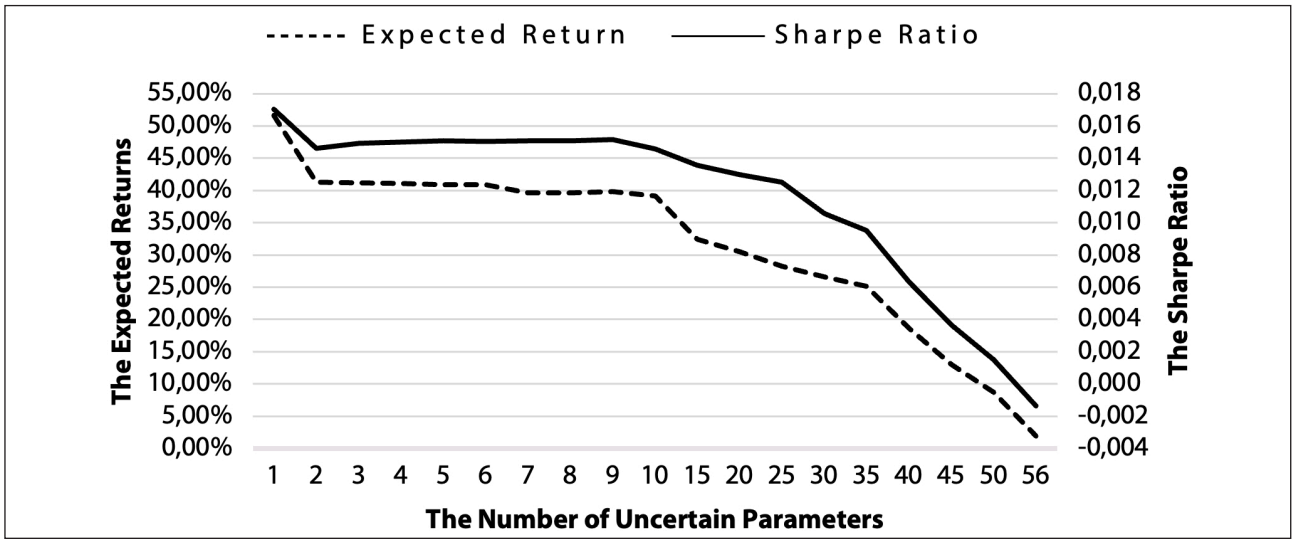

Figure 2: The Sharpe Ratio and the Expected Returns

and Sharpe ratio, as illustrated in Figures 1 and 2. As the number of uncertain parameters in the model increases, the average annual returns of the invested portfolio naturally decrease. For instance, the model without any uncertain parameters (corresponding to Markowitz's classical mean-variance model) yielded an average annual return of 51.64%. However, when an additional uncertain parameter (Gamma) was introduced and increased by two, the average annual return of the invested portfolio significantly decreased. In comparison, the average annual return of the market index during the same period was 44.60%. This suggests that portfolios without uncertainty provided approximately 7% more return than the market or equally weighted portfolio. However, if an investor aims to minimize risk, they may have to sacrifice some potential return. As the number of uncertain parameters in the model increases, the average annual returns of the portfolios decrease. For instance, when the number of uncertain parameters was 1, 2, 15, and 56, the average annual returns of the portfolios were 53.80%, 41.74%, 27.19%, and 24.82%, respectively. Notably, the average annual return of the model with two uncertain parameters was lower than that of the model without uncertainty, while the portfolios with one uncertain parameter provided approximately 9% more return than the equally weighted portfolio. Finally, the portfolios with the maximum number

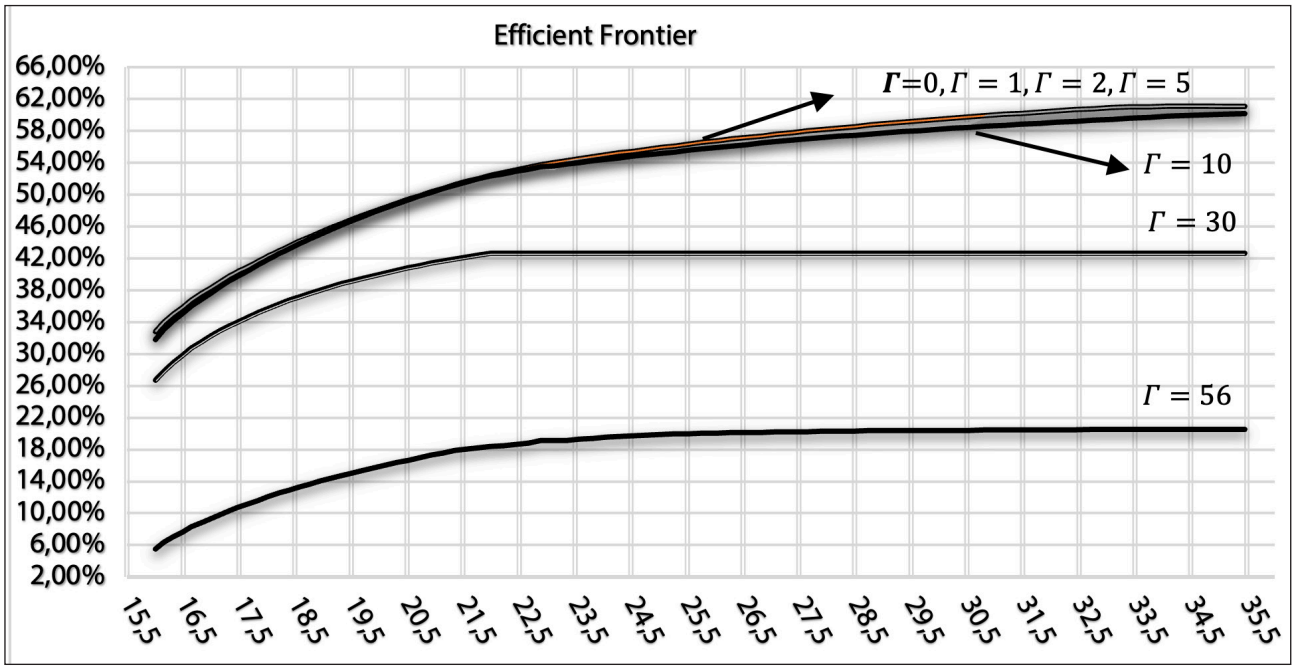

Figure 3: The Efficient Frontier of Portfolios Based on Uncertain Parameters

Table 5. The Average Annual Return of Portfolios and The Equally Weighted Index

#	The Constraint	Definition
1)	$\sum_{i=1}^{N} w_i = 1$	It ensures that the sum of the weights is equal to 1
2)	$\frac{\sum_{i=1}^{N} a_i w_i}{\sum_{i=1}^{N} w_i} \leq 7.00$	It limits the maximum weight of market-to-book ratio of an assets. Here, a_i is the market-to-book ratio of asset i.
3)	$\frac{\sum w_{jm}}{\sum_{i=1}^{N} w_i} \leq 0.35$	It ensures that the total weight of manufacturing stocks in the portfolio does not exceed 35%. Here, $\sum w_{jm}$ is the total weight of assets from manufacturing sector.
4)	$\frac{\sum w_{tp}}{\sum_{i=1}^{N} w_i} \geq 0.05$	It ensures that the total weight of the shares of wholesale, retail, restaurants and hotels is at least 5% of the portfolio. Here, $\sum w_{tp}$ is the total weight of assets from wholesale, retail, restaurants and hotels sector.
5)	$\frac{\sum w_{tk}}{\sum_{i=1}^{N} w_i} \geq 0.20$	It ensures that the total weight of shares in the technology sector is at least 20% of the portfolio. Here, $\sum w_{tk}$ is the total weight of assets from technology sector.
6)	$\frac{\sum w_{km}}{\sum_{i=1}^{N} w_i} \geq 0.10$	It ensures that the total weight of oil, gas and chemical sector stocks is at least 10% of the portfolio. Here, $\sum w_{km}$ is the total weight of assets from oil, gas and chemical sector.
7)	$\frac{\sum w_{ul}}{\sum_{i=1}^{N} w_i} \geq 0.08$	It ensures that the weights of transportation, storage, and communications shares in the portfolio are a maximum of 8%. Here, $\sum w_{ul}$ is the total weight of assets from transportation, storage, and communications sector.
8)	$0 \leq w_i \leq 0.05$	It limits the lower and upper bounds of the weights.

Note: AARP is the abbreviation for Average Annual Return of Portfolios.

of uncertain parameters had a 19.78% lower return than the equally weighted portfolio. It is worth mentioning that both portfolios with zero and 56 uncertain parameters are theoretically possible, but their realization is rare. In practice, portfolios with a number of uncertain parameters between these two extremes are more common. Therefore, calculating the number of assets with lower returns than the target index and incorporating this information into the investment process can assist investors in determining the appropriate number of uncertain parameters to include in their portfolio.

CONCLUSION

Modern portfolio theory aims to maximize returns and minimize risk in line with investor expectations. However, achieving both objectives in one model can be challenging. This is due to the volatility of securities and the difficulty in accurately predicting expected returns. Assuming that predicted values are precise and certain can invalidate the solution, as these values may contain errors. Instead, it is more realistic to consider a range of possible values for the predicted returns. This approach eliminates computational errors and biases within certain limits, while still ensuring a high probability of a successful optimization. The robust optimization model used in this paper combines the advantages of the bootstrap method, which allows for inferences to be made about the population, increasing the reliability of the model solution. The use of well-established uncertainty sets is crucial in ensuring the reliability of the model solution. By incorporating the bootstrap method, we are able to control both the uncertainty levels and the confidence levels of the uncertainty sets. This is the main advantage of the model proposed in this paper. The analysis includes uncertainty sets for three different confidence levels: 99%, 95%, and 90%. Additionally, the number of uncertain parameters is gradually increased from zero to 56, resulting in 58 different portfolio optimizations. This allows investors or researchers to select a model that meets their expectations and use the weights of the model for their investments. For example, a risk-sensitive investor may choose a portfolio with a high probability level for the uncertainty quantities and a high number of

uncertain parameters, while a less risk-sensitive investor may prefer a portfolio with a lower probability level and fewer uncertain parameters. The portfolios constructed in this paper offer a flexible range of options for investors.

The results indicate that investors must make a trade-off between the stability of their portfolio and the expected return. If an investor wants to ensure that their portfolio remains feasible under all possible market conditions, they may have to sacrifice some of their expected return. However, the portfolio is still expected to outperform the market or target index. The study covers the period from January 2014 to March 2021, and during this time, the recommended portfolios had an average return higher than the market return. From April 1, 2021 to September 31, 2021, the average return of the model portfolios was 173.54%, 176.01%, and 173.16% at confidence levels of 99%, 95%, and 90% respectively. In comparison, the BIST100 increased by 69.7871%, BIST50 increased by 59.67%, BIST30 increased by 41.19%, and the equally weighted portfolio increased by 167.10%. These results demonstrate that the model portfolios consistently achieved higher returns than the index returns at all confidence levels. This shows that portfolios created using robust optimization not only provided high returns but also remained feasible under all possible market conditions. It is worth noting that extreme cases, where there are either zero or 56 uncertain parameters, are not expected in practical situations due to the diversification of the portfolio. Additionally, the robust formulation of the portfolios resulted in resistance to extreme fluctuations during the pandemic period and maintained high out-of-sample valuation rates. The robust models used in the analysis, which account for parameter uncertainty, produced optimal solutions that remained feasible with a high probability. In other words, portfolios created using robust optimization are not significantly affected by potential market fluctuations.

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Are Electric Vehicles Discharging Tax Revenues? The Türkiye Case

Doğan BAKIRTAŞ[1] , Metin NAZLIOĞLU[2] , Hasan YAZAR[3]

ABSTRACT

Türkiye, in tandem with global trends, is witnessing a significant uptick in electric vehicle (EV) sales, prompting concerns about substantial impacts on traditional tax revenues derived from fuel-related products and the automotive sector. Data from the Automotive Distributors Association in Türkiye highlights a noteworthy increase in the EV market share from 0.03 percent (155 units) in 2020 to 4.8 percent (28,931 units) between January and August 2023. This study, utilizing forecasting methodologies such as the Exponential Smoothing Model and Holt's Exponential Smoothing, projects total vehicle numbers for 2025 and 2030. Employing the Total Cost of Ownership model, encompassing registration, motor vehicle tax, fuel/charging costs, and maintenance, the research compares tax revenues from electric and internal combustion engine vehicles. The findings underscore an imminent government challenge, anticipating tax revenue losses of approximately $567.5 million for 2025 and $1.9 billion for 2030.

Keywords: Electric Vehicles (EVs); Tax Revenues; Total Cost of Ownership Model (TCO).

JEL Classification Codes: H20, H21, Q58

Referencing Style: APA 7

INTRODUCTION

Electric vehicles (EVs) hold a significantly advantageous position when compared to internal combustion engine vehicles (ICEVs), primarily due to their higher efficiency, greater environmental friendliness, and reduced energy consumption. This advantage has also been reflected in recent years in the sales figures of vehicles. When viewed globally, EV sales in 2021 doubled to reach 6.6 million units compared to the previous year. According to sales figures for the first quarter of 2022, it is observed that they reached 2 million units, indicating a 75% increase compared to the same quarter of the previous year (IEA, 2022).

The 2023 report of the International Energy Agency (IEA) states that the global transition to EVs has brought about a change in tax revenues generated from gasoline and diesel, amounting to $11 billion. However, the widespread adoption of EVs usage has generated $2 billion in tax revenue. Consequently, the net tax revenue loss amounts to $9 billion. Despite China having the largest stock of EVs, the highest tax revenue loss has been experienced in Europe due to the high rates of taxes applied to petroleum products *(for example, fuel tax rates in Germany are ten times higher than those in China)*. The report estimates that tax revenue losses globally will reach around $60-70 billion by 2030.

The assumption that the increase in EV sales will result in a decrease in governments' revenue from fuel taxes, which holds a significant share among their income sources, is supported by research findings in the literature (Table 1). Governments find themselves in a situation where, on one hand, they strive to achieve sustainability goals by considering environmental factors, and on the other hand, they face a significant loss of revenue.

In Türkiye, EV sales are steadily increasing as well. The growing sales pose a risk of eroding the significant revenue source of the central government budget, which is generated from fuel tax revenue. Therefore, the study aims to assess possible revenue loss due to the rapid increase in sales of EVs in Turkish automotive market compared to ICEVs. This study focuses on how the proliferation of electric vehicles would affect the

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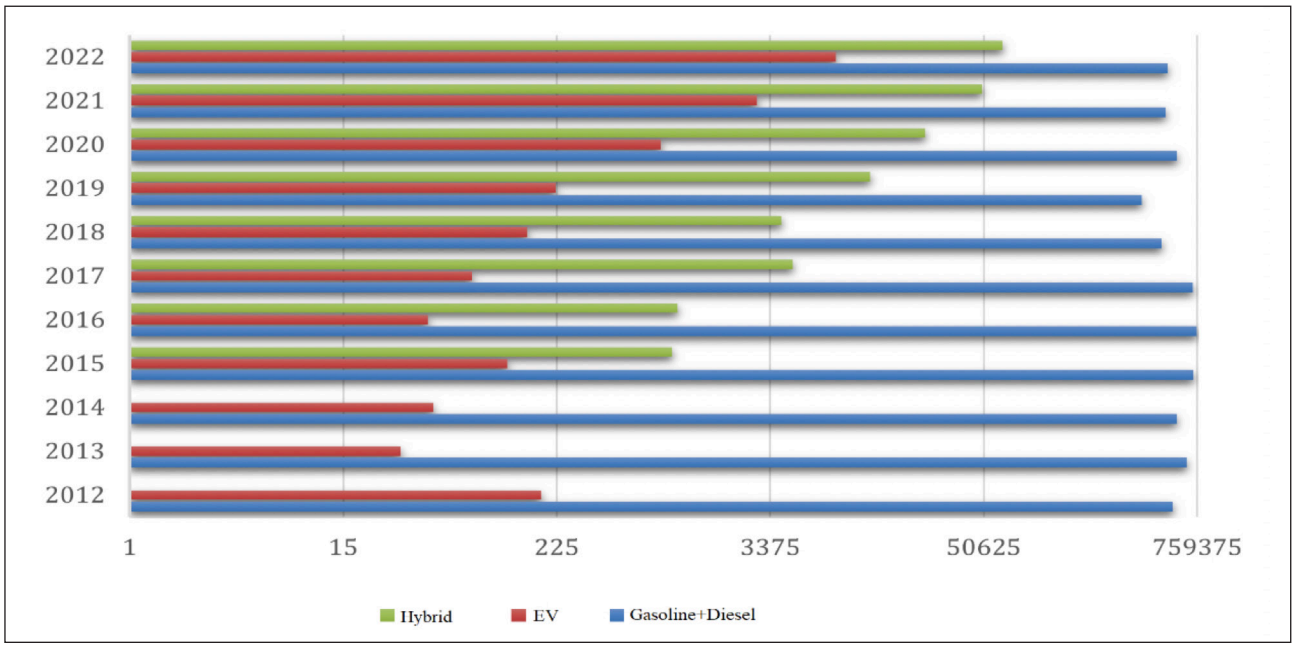

Figure 1: Sales of New Vehicles: Türkiye

Source: (ODMD, 2023)

public revenues, particularly within the current tax system. It compares the tax revenues generated by fossil-fuel vehicles (VAT, excise duties, road tax, etc.) with the tax revenues generated by EVs in categories such as registration, fuel, inspection, and maintenance. Thus, this study contributes to making the calculation fiscal losses/gains for both types of vehicles more transparent, particularly in the context of Turkey. Furthermore, while studies in the literature generally highlight tax differentials on fuel across countries, this study provides a more comprehensive examination from a public revenue perspective by considering multiple aspects such as vehicle registration, fuel consumption, and vehicle maintenance.

EVs* AND TÜRKİYE

In Türkiye, starting in 2016, the sales volume of ICEVs** such as gasoline and diesel has been declining, while the sales volume of hybrids and EVs has been on the rise. The increase in sales of hybrid vehicles is particularly noteworthy. In 2015, the sales of hybrid vehicles had not even reached 1,000 units, but by the year 2022, 64,387 units had been sold. The average increase in hybrid vehicle sales between 2015 and 2022 was approximately 110%. In contrast, during the same years, there has been a 1% decrease in sales of ICEVs. While there has been a general increase in EV sales in the reference years, the change in the last two years is of great significance. This change signals that in the coming years, EV sales will gradually increase.

In 2022, the total count of charging stations in Türkiye stood at 2,514, a substantial increase from the 1,357 recorded in 2020. Specifically, in 2020, there were 1,288 Alternating Current (AC) charging stations and 66 Direct Current (DC) charging stations. Fast forward to the first quarter of 2023, and we observed a remarkable 86% growth, bringing the AC charging stations to 2,402 and an astounding 715% surge in DC charging stations, totalling 538.

The vehicle sales figures show in Türkiye (ODMD, 2023) that there has been a decline in the market share of diesel-fueled vehicles, while electric and hybrid vehicles have been steadily gaining market share. In 2018, the market share of diesel vehicles sold in Türkiye was 58.09%, but by 2022, this figure had decreased to 17.43%. While the demand for diesel vehicles has been decreasing, there is a growing interest and demand for hybrid and electric vehicles. Hybrid vehicles, which had a market share of 0.80% in 2018, reached a share of 10.86% of total vehicle sales in 2022. A similar trend is observed in the demand for electric vehicles. In Türkiye, there were 155 electric vehicles sold in 2018, while in 2023 (January-August) 28,931 EVs were sold. In terms of market share, electric vehicles, which showed a significant increase from 0.03% to 4.8% (according to June 2023 data from(ODMD, 2023)), are likely to approach sales of ICEV in the coming years.

* EVs represents electrical passenger cars/vehicles (automobiles) and excludes the other vehicles such as buses, trucks.

** ICEVs represents internal combustion engine passenger cars/vehicles (automobiles) and excludes the other vehicles such as buses, trucks.

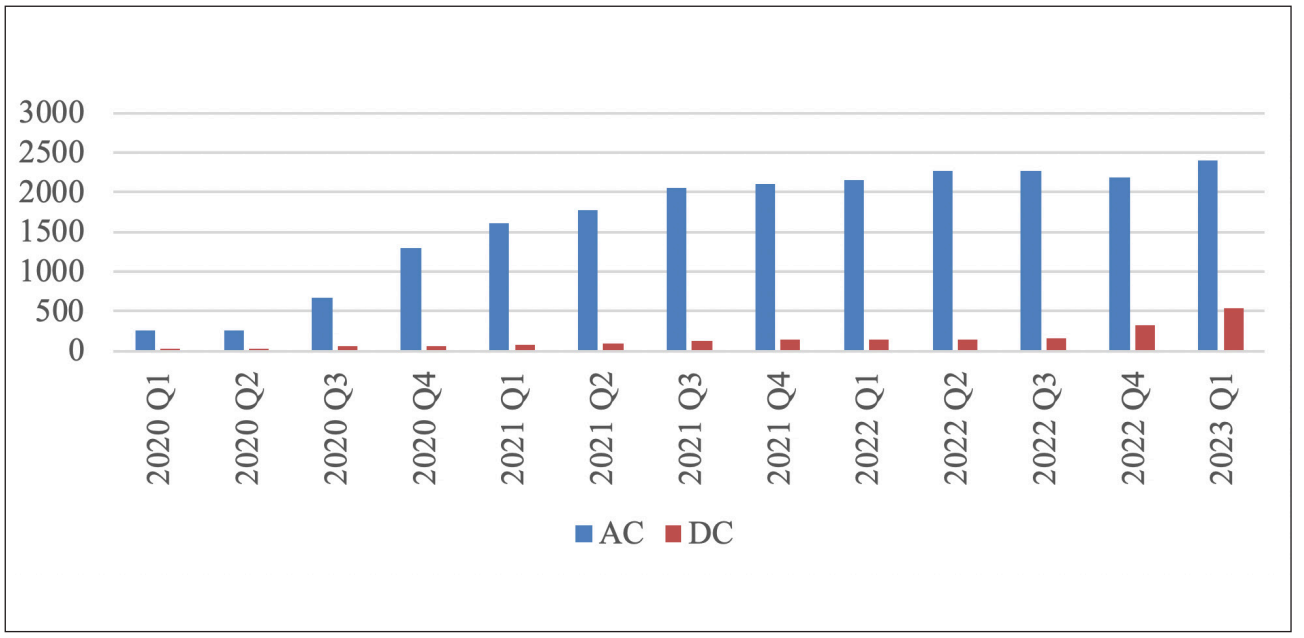

Figure 2: Charging Stations in Türkiye

Source: (EAFO, 2023)

This transformation is reflected in public revenues. Governments may come up against revenue losses, since consumer preferences shift from ICEVs to EVs for various reasons, such as environmental consciousness, fuel/charging costs, maintenance costs, technology, etc. (Bhat and Verma, 2023; Corradi et al., 2023; Rapson and Muehlegger, 2023; Rezvani et al., 2015; Singh et al., 2020).

In Türkiye, the best-selling EV in 2022 was the BMW IX *(luxury)* model with 1,502 units sold. The Renault Zoe *(economy)* model ranked second with sales of 1,155 units. In the third and fourth positions were the Skywell brand, with its ET5 and EV6 models, respectively (TEHAD, 2023).

The best-selling ICEVs in 2022 were Fiat Egea Sedan with 68,779 units, followed by the Renault Clio HB with 41,607, and the Toyota Corolla model with 30,948, respectively (ODMD, 2023). The study regards these sale rankings; however, it considers different fuel/engine types to examine the distinction between ICEVs and EVs. Accordingly, the research included top-tier models of the best-selling vehicles in Türkiye in 2022, top models are the 1.6 MultiJet diesel version of the Fiat Egea Sedan in the first place, the 1.0 TCe gasoline version of the Renault Clio HB in the second place, and the 1.8L hybrid gasoline version of the Toyota Corolla in the third place. Thus, it becomes possible to make an optimal assessment in terms of public tax revenues between EVs and ICEVs.

LITERATURE REVIEW

The increasing prevalence of EVs adoption on a global scale has become a significant driving force due to their low carbon emissions and environmental sustainability advantages. This transformation profoundly influences people's perceptions by emphasizing the fact that EVs represent a more environmentally friendly and economical alternative compared to conventional ICEVs. While the growing adoption of EVs makes significant contributions to environmental issues, due to the disparities in tax treatment between EVs and ICEVs, it impacts fiscal ways of current fuel taxes. Therefore, the issue of optimal taxation emerges as a problem that needs to be addressed. The EVs adoption's impacts on tax revenues bring about raise concerns in research in the countries.

This literature review focuses on aggregate predictions at an international/national/state scale by analyzing past data related to EV sales or vehicle registrations and on calculations revealing possible tax revenue losses. There are various studies in the literature that examine the impact of EVs usage on tax revenues both at the regional and national levels. Table 1 represents these studies.

Table 1: Summary of Literature Review

Author(s)	*Sample*	*Period*	*Tax Revenue Loss*
(IEA, 2023)	Global	2030	$60-70 billion
(Davis and Sallee, 2020)	The USA	2019	$250 million (annual)
(Davis and Sallee, 2020)	California	-	$90 million (annual)
(Jia et al., 2019)	Virginia	2019-2025	$200-900 million (annual)
(Van Dyke et al., 2022)	Kentucky	2016-2022	$1,3 million
(Ricciuti, 2020)	California	2020	$27,5 million
(Bonilla et al., 2022)	Mexico	2022-2050	$74,1 billion (cumulative)
(Soltani-Sobh et al., 2015)	Washington	2031	$106 million
(Hall, 2012)	The USA	2050	$74,1 billion (cumulative)
(Carlsson and Johansson-Stenman, 2003)	Sweden	2002-2010	$6,410 (per vehicle)
(Leurent and Windisch, 2015)	France	2015	$26,603 (per vehicle)
(Shafiei et al., 2018)	Iceland	2015-2050	%28-%35
(Hensher et al., 2021)	Sydney	2055	%66
(Rajagopal, 2023)	India	2021-2035	%85

While there is no specific study for Türkiye, there are numerous research efforts in other countries that discuss the anticipated impact of EVs on reducing tax revenues, employing various methods for estimation. The common thread among these studies is the likelihood of a decrease in tax revenues as EV sales increase.

METHODOLOGY

Total Cost of Ownership Model

Total Cost of Ownership Model (TCO) considers the costs incurred throughout the entire service life of a product. This process encompasses costs from the initial purchase transaction through the end of the ownership period. The main objective of TCO is to comprehensively assess all the expenses associated with owning and operating a particular product over its entire lifespan. This entails considering not only the upfront purchase cost but also ongoing expenditures, such as maintenance, fuel, insurance, taxes, and fees that accrue from the point of acquisition until the end of the ownership period. TCO primarily concentrates on individual or private costs, in contrast to social costs and benefits. These costs can be further segmented into various categories for a more detailed evaluation (Parker et al., 2021).

In this study, TCO has been employed as the foundation for comparing the ownership costs of EVs to those of traditional ICEVs. Then, the model calculates potential public revenue sources. The model includes tax revenues generated from fuel sales, the fiscal advantages associated with EVs, and the revenues generated through initial registration taxes and fees. The model is based on Parker et al. (2023). The original model covers a five-year period and is based on a 7% annual discount rate. The original model follows:

$$TCO = P + ST + TF - I + C + \left(\sum_{n=0.5}^{4.5} \frac{F+TX+IN+M}{(1+r)^n}\right) - \frac{R}{(1+r)^5} \qquad (1)$$

Where TCO is Total Cost of Ownership, *P* is the purchase price, *ST* is sales tax, *TF* is title fee, *I* is public subsidies, *C* is home charger *(wallbox)* costs, F is annual fuel costs, *TX* is annual taxes and fees, *IN* is annual insurance costs, *M* is annual maintenance and repair costs, *R* is resale value after five years, and *r* is the annual discount year.

The study aims to develop a user-centered perspective to calculate the total public revenues based on the taxes paid by users during the ownership *(purchase, usage, and maintenance)* of a vehicle. Consequently, the components contributing to the costs have been revised accordingly. The TCO is based on vehicle purchase price, fuel consumption, maintenance, and installation of home charger costs for home chargers. The model calculates the public revenues through these costs, and it is employed to calculate tax revenue loss:

Tax Revenue Loss= $[(TS_i) * (S_i + A_i + B_i)] - [(TS_e) * (S_e + A_e + W_e + B_e)]$ (2)

The model (2) is used for the calculation of tax revenue loss, and in the model, *TS* is total sales of vehicles, *S* is tax revenue from the purchase price, *A* is tax revenue from fuel costs, *B* is tax revenue from maintenance and repair costs, *W* is tax revenue from installation costs for a home charger. Finally, *i* and *e* represent ICEVs and EVs, respectively.

Utilizing this model, the total annual costs for users of ICEVs and EVs are calculated. Subsequently, tax amounts are determined based on these costs. These models cover a one-year period. Tax revenues are calculated by considering the amounts of excise duty[3], VAT (Value-added Tax), license plate costs, MVT (Motor Vehicles Tax) and Stamp Duty paid in the registration. Then, the total amount of tax revenue obtained by the government is calculated.

Vehicle-kilometer statistics in Türkiye according to vehicle types show that the annual average kilometers for all vehicle types were as follows: 14,236 km for the year 2019, 13,593 km for the year 2020, and 14,239 km for the year 2021.

Subsequently, the study assumes an annual vehicle kilometer traveled (VMT) of 15,000 kilometers. The rationale for this assumption is that after the initial registration stage *(purchased from dealers as "brand new")*, it is recommended by the vehicle dealer to have the first periodic maintenance of the respective vehicles performed at authorized service centers within the first 15,000 kilometers or 1 year.

Tax revenues generated from EVs and ICEVs were assessed under four main categories: initial registration, motor vehicle tax, fuel/charging cost, and maintenance. Accordingly, evaluating tax revenues generated over an average usage period of 15,000 kilometers or 1 year starting from the purchase of a brand-new vehicle, it can be easily stated that lower tax revenues are obtained from EVs compared to ICEVs. At the registration stage, the tax revenues obtained from EVs *(for economy vehicles)* are approximately two times lower than those of vehicles with gasoline and diesel engines. This difference increases to approximately three times when compared to a vehicle with hybrid/gasoline engine. The most notable point where EVs differentiate from other vehicle types is in the taxation based on fuel/charging. In this regard, the calculations of this study show

Table 2: Tax revenues per vehicle

	EVs *(Renault ZOE)*		**Gasoline** *(Renault Clio)*	**Diesel** *(Fiat Egea)*	**Hybrid-Gasoline** *(Toyota Corolla)*
Initial Registration *(SCT, VAT, MVT, Stamp Duty) (a)*	277,675.35 TL		541,719.86 TL	591,931.05 TL	817,599.20 TL
MVT *(Annual) (b)*	1,959.00 TL		2,545.00 TL	4,434.00 TL	7,834.00 TL
	Wallbox	*Charging Station*			
Fuel/Charging *(c)*	693.3 TL *(VAT+BTV)*	3,318.75 TL *(VAT)*	12,384.50 TL *(SCT+VAT)*	8,861.85 TL *(SCT+VAT)*	9,388.25 TL *(SCT+VAT)*
Maintenance *(d)*	258.83 TL *(VAT)*	258.83 TL *(VAT)*	948.17 TL *(VAT)*	1,037.42 TL *(VAT)*	969.43 TL *(VAT)*
Total Tax Revenues	280,586.48 TL *(a+b+c+d)*	283,211.93 TL *(a+b+c+d)*	557,597.53 TL *(a+b+c+d)*	606,264.32 TL *(a+b+c+d)*	835,790.88 TL *(a+b+c+d)*
Tax Revenues per km	₺18.70	₺18.88	₺37.17	₺40.42	₺55.72

Source: Author's own creation

[3] This represents the Special Consumption Tax (SCT). Special Consumption Tax rates for vehicles are determined according to the cylinder volume of the engine and the tax-free sales amount. While 45%, 50%, and 80% SCT is applied for vehicles up to 1600 cubic centimeters, 130% and 150% SCT are applied for vehicles with a cylinder volume between 1600 cubic centimeters and 2000 cubic centimeters. The tax rate is 10% for vehicles with an engine power of 160 kW (218 HP) and below and a tax base that is not exceeding 1.25 million TL; 40% for vehicles with an engine power of 160 kW (218 HP) below and a tax base that is exceeding 1.25 million TL; 50% for vehicles with an engine power over 160 kW (218 HP) and a tax base that is not exceeding 1.35 million TL; and 60% for vehicles with an engine power over 160 kW (218 HP) and tax base that is exceeding 1.35 million TL.

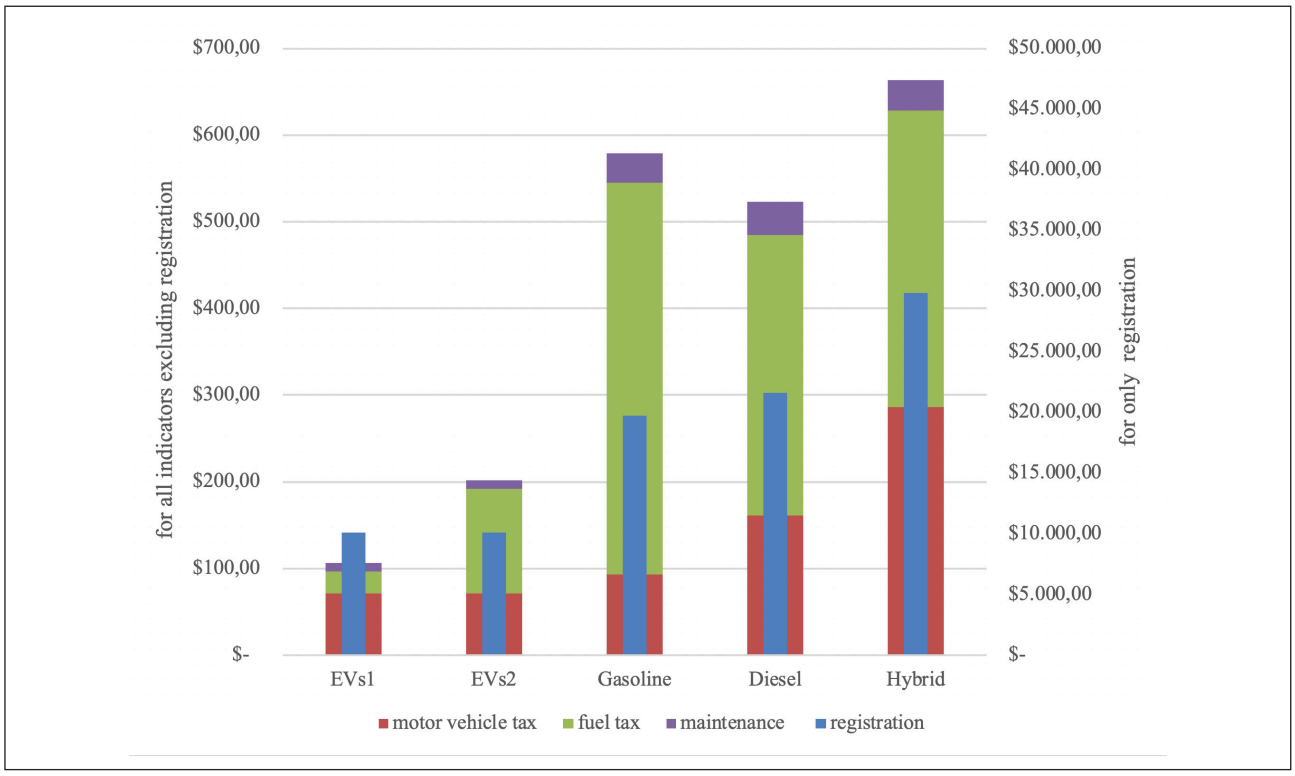

Figure 3: Tax Revenues Per Vehicle.

Source: Author's own creation

that the tax revenue obtained from a vehicle with gasoline engine after 15,000 km of usage is significantly higher, up to 18 times, than the total tax revenue obtained from an EVs *(wallbox/home charging)*. Due to the fact that EVs have relatively low maintenance costs, the tax revenues are also decreasing. When compared to the maintenance of a vehicle with diesel engine, the government collects four times lower tax revenues.

When considering various tax aspects *(initial registration, motor vehicle tax, fuel/charging, and maintenance),* tax revenues per kilometer levied after 15,000 kilometers of usage are calculated as follows: $0.68 for EVs1 *(for wallbox),* $0.69 for EVs2 *(for charging station),* $1.36 for vehicles with gasoline engine, $1.47 for vehicles with diesel engine, and $2.03 for the vehicles with hybrid-gasoline engine. The tax revenue per kilometer obtained from EVs is approximately 2 times lower than that of diesel and gasoline vehicles and about 3 times lower than hybrid gasoline vehicles. These results support the claim that increasing ownership of EVs could potentially lead to a reduction in tax revenues.

Forecasting and Scenarios

Vehicle sales trends in Türkiye (ODMD, 2023) show that there is not as sharp of a transition to EVs as European countries. The market share of vehicles with diesel engines has been decreasing while the market share of EVs and hybrid-gasoline vehicles has been steadily increasing. In 2018, the market share of diesel vehicles sold in Türkiye was 58.09%, but by 2022, this figure had declined significantly to 17.43%. While the demand for diesel vehicles has decreased, there has been a growing interest and demand for hybrid and EVs. Hybrid vehicles, which had a market share of only 0.80% in 2018, increased their share within total vehicle sales to 10.86% by 2022. This trend can be attributed to several factors, including advancements in technology, the expansion of electric vehicle model varieties, environmental awareness, and the significant rise in fossil fuel costs in recent times, all of which have revitalized the demand for EVs.

In Türkiye, the sales of EVs were only 155 units in 2018, but by 2022, the number had surged to 7,733 units. Looking at market share, EVs have made a significant leap from 0.03% to 4.8% (according to June 2023 data from (ODMD, 2023)). It appears likely that in the coming years, EVs may come closer to the sales figures of ICEVs. It would not be wrong to state that one reflection of this transformation will be on tax revenues. If consumer preferences continue to shift from ICEVs to EVs, it is likely that there will be a reduction in tax revenues. In order to examine this assertion, the study conducts estimations to determine the potential decrease in tax revenues in the event of such a transformation.

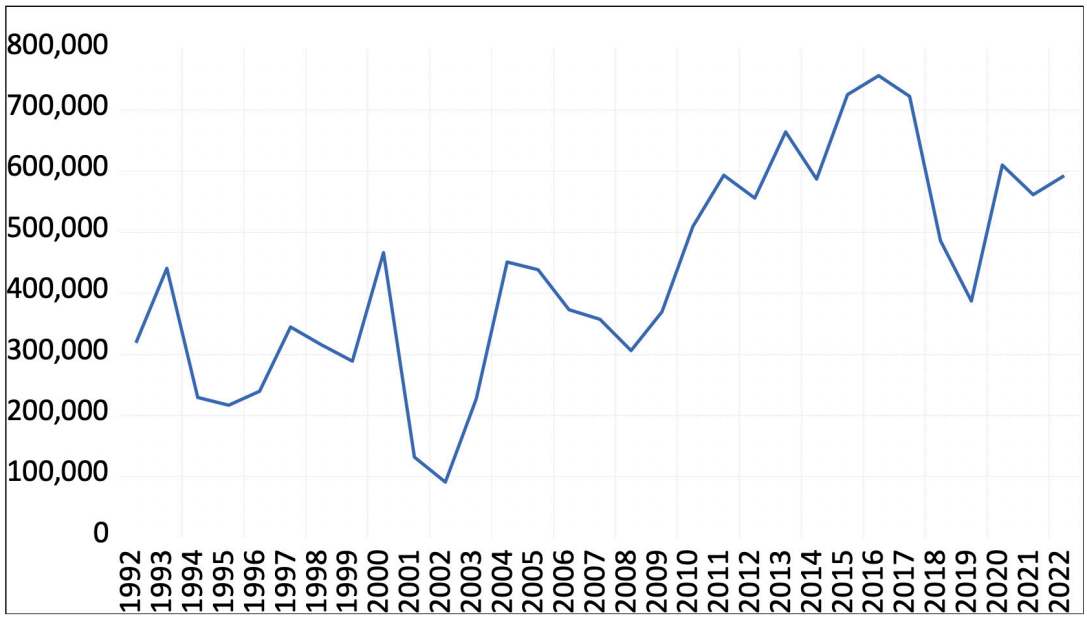

Figure 4: Vehicle Sales in Turkiye Between 1992-2022

Source: (ODMD, 2023; OSD, 2023)

Utilizing annual vehicle sales data for the period of 1992-2022 in Türkiye (ODMD, 2023; OSD, 2023), an estimation was conducted for the years 2025 and 2030 using the Exponential Smoothing method. The Exponential Smoothing method is a relatively simple but powerful approach for estimation. It can produce more successful results when compared to more complex estimation methods (Billah et al., 2006). This method, which was proposed in the late 1950s, is based on making estimations using a weighted average of the past values of the variable, where the weights decrease exponentially with the distance of the observations. In other words, more recent *(closer in time)* observations have a higher weight in the estimating process (Hyndman and Athanasopoulos, 2018).

There are various estimators used in the Exponential Smoothing method. Estimations have been leveraged by examining the graphical representation of vehicle sales data between the years 1992 and 2022 to make an inference about the selection of the most appropriate estimator.

Figure 4 shows that an increasing trend in vehicles sales is evident. Additionally, although there are periodic fluctuations in the data, it can be stated that there is no seasonal effect due to the data being annual. Based on the graphic, it is deemed appropriate to forecast using the Brown's Double Exponential Smoothing method, which captures the trend but does not include seasonality and the Holt's Exponential Smoothing method, which is devoid of seasonality.

In the recent years, a slowdown has been observed in the trend of EV sales data. Taking this slowdown into account, a forecast has been made utilizing the ETS Exponential Smoothing method. In this forecast, the Dampened Trend method has been utilized.

The model is developed by means of the first single exponential smoothing method. The model also considers the calculation of the second single exponential smoothing based on the first single exponential smoothing result. This approach is known as "double" exponential smoothing. The equations used for the Double Exponential Smoothing method for the time series 'y' are as follows (EUM, 2020).

$$S_t = \alpha y_t + (1-\alpha)S_{t-1}$$

$$D_t = \alpha S_t + (1-\alpha)D_{t-1}$$

In this context, St represents the single smoothed series, Dt stands for the double smoothed series, and α is the smoothing parameter ($0 < \alpha \leq 1$).

Prediction in this method is calculated through the following formula:

$$y_{T+k} = \left(2 + \frac{\alpha k}{1-\alpha}\right) S_T - \left(1 + \frac{\alpha k}{1-\alpha}\right) D_T = \left(2S_T - D_T + \frac{\alpha}{1-\alpha}(S_T - D_T)k\right)$$

In the Holt's Exponential Smoothing model, employed for a series exhibiting a linear trend and no seasonal pattern, two parameters are used for estimating. The

smoothed series, denoted by *y*, is derived via the subsequent equation [8].

$$y_{t+k} = \alpha + bk$$

In this equation, α and b denote the constant components signifying smoothing and trend, respectively.

$$\alpha(t) = \alpha y_t + (1-\alpha)(\alpha(t-1) + b(t-1))$$

$$b(t) = \beta\big(\alpha(t) - \alpha(t-1)\big) + (1-\beta)b(t-1)$$

The equation used for estimating is as follows:

$$y_{T+k} = \alpha(T) + b(T)k$$

α(T) represents the smoothing constant, and b(T) represents the slope parameter.

As part of the research, two different estimating methods were employed, and the results were compared. At this stage, the Holt's Exponential method was utilized for estimating in the years 2025 and 2030, as the results obtained through this method were deemed more meaningful.

RESULTS

To determine the loss in tax revenue resulting from the transition from ICEVs to EVs, it is first necessary to establish the total number of vehicles and their market share. Table 3 presents the vehicle sales and market shares in Türkiye for the year 2022.

In 2022, a total of 592,660 new vehicles were sold in Türkiye. The market share of the vehicles sold shows that gasoline engine vehicles are in the lead with 68.99%, followed by diesel and hybrid vehicles. EVs, on the other hand, obtained a market share of 1.3% with 7,733 units in the total vehicle market. Although this market share may seem low, it represents a significant increase when compared to the 0.51% EV market share in 2021. Furthermore, after expressing the 2022 vehicle sales figures and market shares, the market shares were recalculated by subtracting the 2022 EV sales from the

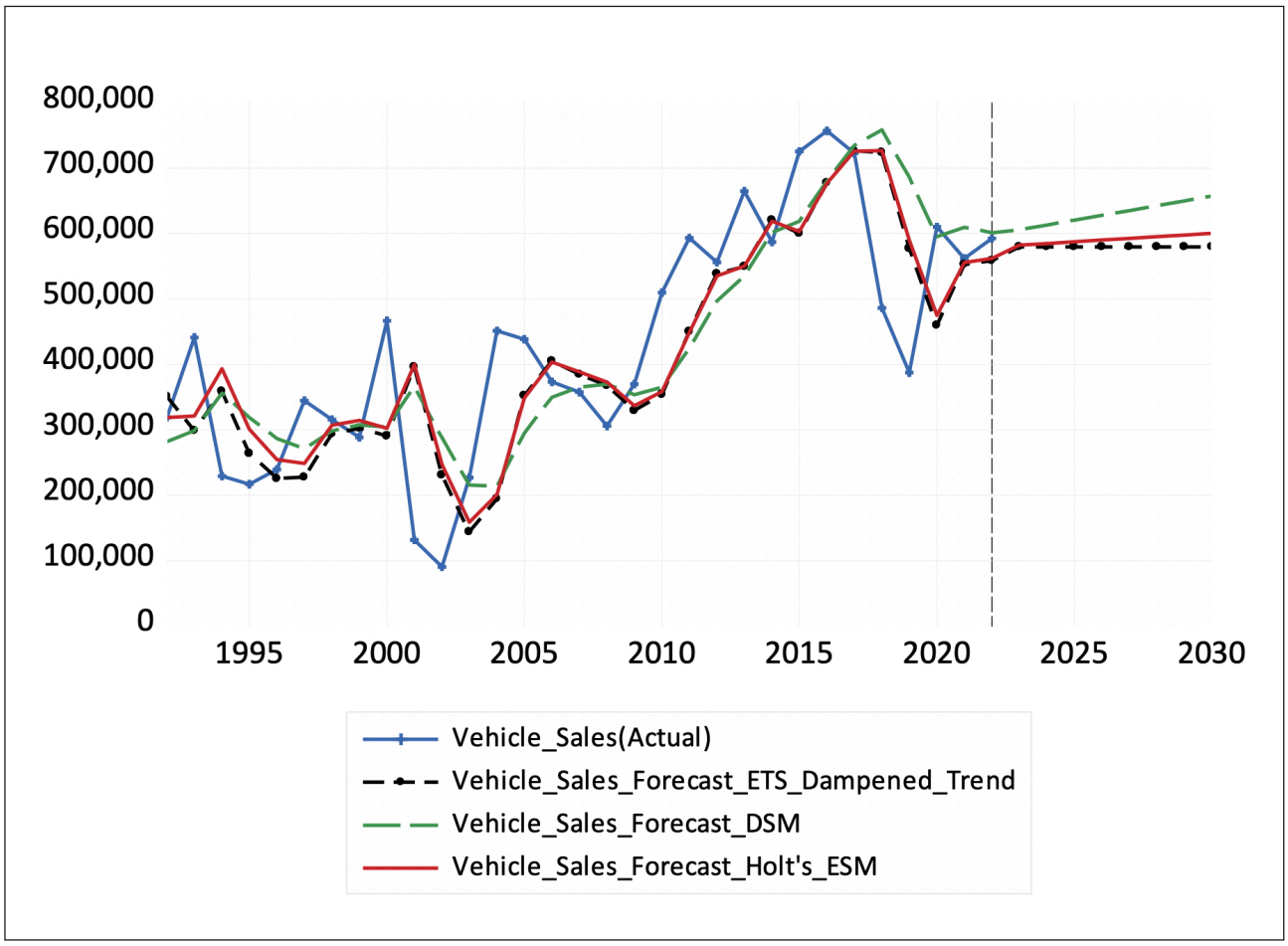

Figure 4: Forecasting Chart (2030)

Note: The figure displays a vertical line in the year 2022. The forecasting was performed utilizing the Eviews 12 software package.

Table 3. Number of vehicle sales and market share

	2022		2022 *(excluding EVs)*	
	Unit	Share	Unit	Share
Diesel	103,311	17.4317%	103,311	17.6622%
Gasoline	408,920	68.9974%	408,920	69.9096%
Electricity	7,733	1.3048%	-	-
Hybrid	64,387	10.8641%	64,387	11.0077%
Autogas	8,309	1.4020%	8,309	1.4205%
Total	592,660	100%	584,927	100%

Source: (ODMD, 2023; OSD, 2023)

total vehicle sales to determine the market shares for 2025 and 2030. This distribution was used within the scenarios created for the respective years.

The scenarios in the study were based on the "Mobility Vehicle and Technologies Roadmap" strategy document published by the Ministry of Industry and Technology of the Republic of Türkiye in 2022. These scenarios align with the Ministry's objective to raise the market share of EVs to 10% and 30% for 2025 and 2030, respectively.

In the forecasting made using the Holt's Exponential Smoothing method, the total number of vehicles sold for the year 2025 is 587,523, while for the year 2030, it is 600,457. Assuming that the market share distribution remains the same as in 2022 for the year 2025, the resulting tax revenue loss within the framework of the goal set by the Ministry of Industry and Technology of the Republic of Türkiye for 2025, which aims to achieve a 10% market share for EVs, is presented in Table 4.

The first scenario for evaluating the impact of EVs on tax revenues, with respect to ICEVs, assumes that the estimated total vehicle sales volume is 587,523, and the market share of EVs is 10%. In order to calculate the tax revenues generated under this circumstance, the market shares for the year 2022 were applied to the year 2025 (Scenario A).

In the second phase, the scenario where the market share of EVs is 10% was calculated based on the overall vehicle market shares in 2022, excluding EVs. According to this assumption, in 2025, assuming that the sales shares are based on the year 2022 and that the selected brands/models for the initial purchase and maintenance, as well as if the specified tax rates/costs in the study remain the same. The total tax revenue *(excluding Autogas)* will be approximately 343.6 billion TL (Scenario A). In addition, in 2025, when the market share of EVs is 10%, and the market share of other vehicle types is distributed according to this ratio, assuming all other conditions remain the same, the total tax revenue *(excluding Autogas)* will be approximately 327.8 billion TL (Scenario B).

In Scenario B, the total tax revenue derived from EVs amounts to approximately 16.4 billion TL, whereas in Scenario A, it is 2.1 billion TL. Despite the annual tax revenue from EVs being approximately 8 times higher in Scenario A, the total tax revenue remains at approximately 327.8 billion TL. Consequently, if the market share shifts in favor of EVs in this manner, there will be an estimated tax revenue loss of approximately 15.7 billion TL *($567.5 million)* for the year 2025.

The second scenario for evaluating the impact of EVs on tax revenues, with respect to ICEVs, assumes that the estimated total vehicle sales volume is 600,457 and the market share of EVs is 30%. In order to calculate the tax revenues generated under this circumstance, the market shares for the year 2022 were applied to the year 2030 (Scenario A). Accordingly, assuming that in 2030, the sales shares remain the same as in 2022, the total tax revenue *(excluding Autogas)* will be approximately 351.2 billion TL (Scenario A).

However, in addition, in 2025, when the market share of EVs is 30% and the market share of other vehicle types is distributed according to this ratio, assuming all other conditions remain the same, the total tax revenue *(excluding Autogas)* will be approximately 298.1 billion TL (Scenario B). In Scenario B, the total tax revenue derived from EVs amounts to approximately 50.5 billion TL, whereas in Scenario A, it is 2.2 billion TL. Despite the annual tax revenue from EVs being approximately 23 times higher in Scenario A, the total tax revenue remains at approximately 298.1 billion TL. Consequently, if the market share shifts in favor of EVs in this manner, there will be an estimated tax revenue loss of approximately 53.1 billion TL *($1.9 billion)* for the year 2030.

Table 4: Results for Scenarios *(10% market share for EVs)*

	2022 (excl. EVs)		**2025 (A)**				**2025 (B)**			
	Unit	**Share**	**Unit**	**Share** *(year of 2022)*	**Taxes per vehicle**	**Total Tax Revenue**	**Unit**	**Share**	**Taxes per vehicle**	**Total Tax Revenue**
Diesel	103,311	17.6622%	102,415	17.4317%	606,264.32 TL	62,090,560,332.80 TL	93,393	15.8960%	606,264.32 TL	56,620,843,637.76 TL
Gasoline	408,920	69.9096%	405,376	68.9974%	557,597.53 TL	226,036,656,321.28 TL	369,662	62.9187%	557,597.53 TL	206,122,618,134.86 TL
Electricity	-	-	7,666	1.3048%	280,586.48 TL	2,150,975,955.68 TL	58,752	10.0000%	280,586.48 TL	16,485,016,872.96 TL
Hybrid	64,387	11.0077%	63,829	10.8641%	835,790.88 TL	53,347,696,079.52 TL	58,205	9.9069%	835,790.88 TL	48,647,208,170.40 TL
Autogas	8,309	1.4205%	8,237	1.4020%	-	-	7,511	1.2784%	-	-
Total	**584,927**	**100%**	**587,523**	**100.00%**	**-**	**343,625,888,689.28 TL *($ 12.3 billion)***	**587,523**	**100%**	**-**	**327,875,686,815.98 TL *($ 11.8 billion)***
									*Estimated Tax Revenue Loss for 2025 (A)-(B)	**15,750,201,873.30 TL *($ 567.5 million)***

Source: Author's own creation

Table 5. Results for Scenarios *(30% market share for EVs)*

	2022 (Excl. EVs)		**2030 (A)**				**2030 (B)**			
	Unit	**Share**	**Unit**	**Share** *(year of 2022)*	**Taxes per vehicle**	**Total Tax Revenue**	**Unit**	**Share**	**Taxes per vehicle**	**Total Tax Revenue**
Diesel	103,311	17.6622%	104,670	17.4317%	606,264.32 TL	63,457,686,374.40 TL	74,238	12.3635%	606,264.32 TL	45,007,850,588.16 TL
Gasoline	408,920	69.9096%	414,300	68.9974%	557,597.53 TL	231,012,656,679.00 TL	293,844	48.9367%	557,597.53 TL	163,846,688,605.32 TL
Electric	-	-	7,835	1.3048%	280,586.48 TL	2,198,395,070.80 TL	180,137	30.0000%	280,586.48 TL	50,544,006,747.76 TL
Hybrid	64,387	11.0077%	65,234	10.8641%	835,790.88 TL	54,521,982,265.92 TL	46,268	7.7055%	835,790.88 TL	38,670,372,435.84 TL
Autogas	8,309	1.4205%	8418	1.4020%	-	-	5,970	0.9943%	-	-
Total	**584,927**	**100%**	**600,457**	**100.00%**	**-**	**351,190,720,390.12 TL *($ 12.6 billion)***	**600,457**	**100%**	**-**	**298,068,918,377.08 TL *($ 10.7 billion)***
									*Estimated Tax Revenue Loss for 2030 (A)-(B)	**53,121,802,013.04 TL *($ 1.9 billion)***

CONCLUSION AND POLICY IMPLICATIONS

The changing global trends and preferences in the automotive industry are progressively increasing the demand for electric vehicles. In response to this growing demand, vehicle manufacturers are shifting their production structures towards electric vehicles. A similar shift in demand can also be observed in Türkiye, with an increase in electric vehicle sales. While the transition to electric vehicles is accelerating for various reasons, such as environmental awareness, cost considerations, income levels, one of the consequences of this transformation is its impact on public revenues, particularly in terms of taxes.

Public revenues derived from EVs and ICEVs were comprehensively analyzed, encompassing aspects such as initial registration, motor vehicle tax, fuel/charging, and maintenance. Accordingly, tax revenues collected per kilometer during an average usage of 15,000 kilometers or 1 year, starting from the purchase of a new vehicle, were calculated collectively. In this study, public revenues collected from imported vehicles entering the domestic market (customs stage) have not been fully calculated due to limitations, mainly due to the reluctance of car companies to share more detailed financial information. In addition, the relatively new nature of electric vehicles and technologies leads to uncertainty in predicting how many electric vehicles will be sold in the future compared to fossil fuel vehicles. As time progresses on and clearer figures become available, the differences in public revenues between these vehicles will become much clearer.

Accordingly, tax revenues collected per kilometer during an average usage of 15,000 kilometers, considering different tax categories *(initial registration, motor vehicle tax, fuel/charging, and maintenance),* are calculated as follows: EVs *(economy vehicles)* amount to 18.70 TL *($0.67)* per kilometer, gasoline vehicles are at 37.17 TL *($1.34)*, diesel vehicles reach 40.42 TL *($1.46)*, and hybrid-gasoline vehicles stand at 55.72 TL *($2.01)* per kilometer.

The emergence of transportation alternatives stemming from the widespread adoption of electric vehicles necessitates a long-term perspective. Developments in battery technology, the advancement of charging infrastructure, and the resolution of the range issues through the emergence of new technologies contribute to accelerating the dissemination of electric vehicles. Therefore, policymakers should address these issues earnestly and formulate and implement long-term strategies to compensate for potential tax revenue losses. In this regard, it would be helpful in the policy-making process to consider several alternative policy suggestions.

Regulatory changes that encourage the installation of a minimum of three wallbox/home charging units in buildings with parking facilities can be implemented to offset the loss of the tax revenue in question. If such a regulatory amendment were to be enacted, with the installation of at least three charging units in one million buildings *(with parking facilities),* taking into account the tax revenue generated during the installation phase, it would be possible to compensate for the tax revenue loss arising from electric vehicles.

Türkiye is a country rich in alternative energy sources with high efficiency. Therefore, it is advisable to promote the use of solar panels to address various aspects: meeting the charging needs of electric vehicles, ensuring sustainability, minimizing negative environmental impacts, avoiding overloading the electrical grid for energy requirements, and mitigating potential public revenue losses resulting from the proliferation of electric vehicles.

With the increasing adoption of electric vehicles, the number of commercial charging stations is also on the rise. In this context, regulatory measures can be put in place by the Energy Market Regulatory Authority (EPDK) to mandate that a certain percentage of stations opened under the electric vehicle charging network operator license granted to companies (e.g., 40%) must generate energy from alternative sources *(such as wind energy, solar energy, etc.)*. This would not only promote sustainability but also potentially increase public revenues as a result of these additional investments.

In order to encourage and incentivize the usage of electric vehicles while also mitigating the potential loss of tax revenue resulting from this transition, it is deemed appropriate to impose an additional emissions tax per kilometer on internal combustion/fossil fuel-powered vehicle owners. Considering the existing vehicle stock in Türkiye, when calculated, the proposed emissions tax per kilometer can be as low as 0.05 TL.

In addition to the diminishing effect of the widespread adoption of electric vehicles on public revenues, there is also potential for a reduction in public expenditures in the context of mitigating negative externalities caused by environmental factors. Consequently, existing public expenditures aimed at preventing or mitigating negative

externalities may, in the future, equal or exceed the possible loss in public revenue that could arise with the proliferation of electric vehicles. In this context, it is recommended that future researchers in this field conduct an analysis of income *(potential revenue losses/ gains)* versus expenditure *(expenditures related to the mitigation of negative externalities)* using different data and methodologies to assess the results.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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ANALYSIS OF THE FINANCIAL PERFORMANCE OF AIRLINE COMPANIES IN STAR ALLIANCE USING LOPCOW-TOPSIS METHODS

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ABSTRACT

This study aims to comparatively evaluate the financial performance of the airlines included in Star Alliance for the period 2018-2022 (pre-COVID-19, COVID-19 and post-COVID-19 periods). For the performance evaluation, 5 criteria and a total of 9 financial performance ratios were used. The LOPCOW method was used to determine the criterion weights of the calculated financial performance ratios and the TOPSIS method was used to determine the performance rankings. According to the results of the LOPCOW analysis, the most important criterion was determined as net profit/total assets (PR3) for 2018, net profit/total equity (PR2) for 2019 and 2021, short-term debt/total assets (FSR3) for 2020 and net profit/net sales (PR1) for 2022. The criterion with the lowest importance weight was net balance sheet position/equity (CA) for 2018, 2019, and 2021, net sales/ current assets (AT) for 2020, and short-term debt/total assets (FSR3) for 2022. According to the TOPSIS performance evaluation results, the best-performing airline was Shenzhen Airlines in 2018, 2019 and 2020, Thai Airways International in 2021, and Aegean in 2022. The airlines that ranked last in the performance ranking were Croatia Airlines in 2018, Asian Airlines in 2019, Thai Airways International in 2020, Air Canada in 2021, and Air China in 2022.

Keywords: Star Alliance Airlines, Financial Performance, Multi-Criteria Decision Making Techniques, LOPCOW, TOPSIS.

JEL Classification Codes: Z3, Z31, M4, M41

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INTRODUCTION

Air transportation has an important place in the transportation sector as it is fast, reliable, safe, and economical (General Directorate of Civil Aviation, 2014). In recent years, there have been many developments that have increased the importance of airline companies in both transportation and global commercial activities. The trade liberalization between countries, business model renewal, starting open markets, and expansion of the air transport networks have made the sector more competitive (Bakır et al., 2020). The increasing demand for air transportation has also raised issues, such as how to provide the most appropriate service to customers, and the adequacy of the level of performance and competitiveness (Belton & Stewart, 2002).

One of the important developments affecting the aviation industry is COVID-19. After COVID-19, the aviation sector has gone through a recovery process. The number of passengers carried by air increased by approximately 47%, and Revenue Passenger Kilometres (RPK) by approximately 70% in 2022 compared to 2021 due to the rapid recovery of most international routes. Annual passenger revenues of airlines grew by 50% in 2022 compared to the previous year. With the strong recovery in airline passenger demand, passenger numbers in 2022 are estimated to have reached approximately 74% of the pre-pandemic number, and passenger revenues are estimated to have reached 68% of the revenue level in 2019 (Directorate General of Civil Aviation, 2022).

It has been stated that the total air traffic in 2022, based on paid passenger-km, increased by 64.4% compared to 2021, with the air traffic in 2022 at 68.5% of pre-pandemic (2019) levels. It was reported that in 2022, the international traffic increased by 152.7% compared to 2021 and reached 62.2% of pre-pandemic levels, while the domestic traffic increased by 10.9% compared to the previous year and reached 79.6% of the pre-pandemic levels. EUROCONTROL published a report containing the forecasts of the organizations regarding the elimination of the negative effects of COVID-19 on the aviation sector and the return to the pre-COVID-19 growth figures. According to the report, the European aviation sector was estimated to reach 92% of its 2019 level in 2023. These forecasts were based on the impact of the war in Ukraine, the pressure on energy prices, and the COVID-19 recovery.

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According to the optimistic expectation, the recovery of the aviation sector was expected to continue until 2023 according to the optimistic forecast, until 2025 according to the baseline forecast, and until 2028 according to the pessimistic forecast (Directorate General of Civil Aviation, 2022).

Turkiye has recovered faster than other countries as a result of the support provided to the sector and the right steps taken during the COVID-19 process. According to EUROCONTROL's analysis for 2022, Turkiye ranked 6th among the countries with the highest number of takeoffs/landings in Europe with 948 thousand flights. Turkish Airlines ranked 3rd among the airlines with the highest number of flights with an average of 1,245 daily flights. Istanbul Airport, the meeting point of the world, was the busiest airport in Europe with an average of 1,156 daily flights (General Directorate of Civil Aviation, 2022).

Considering the above-mentioned data on the sector, it is believed that the impact of the aviation sector on the growth of national economies will also be significant. Potential and existing investors, shareholders, and lenders, who are among a wide range of stakeholders, make various performance measurements to evaluate the performance of airline companies. When measuring financial performance, multi-criteria decision-making techniques are utilized in financial measurements with multiple criteria and alternatives.

The purpose of this study is to examine the financial performance of airline companies listed on https://www.staralliance.com/en/ in the pre-COVID-19, COVID-19 and post-COVID-19 periods. In the research, the years 2018 and 2019 were selected as the pre-COVID-19 period, 2020 as the COVID-19 period, and 2021 and 2022 as the post-COVID-19 period, considering that the impact of the pandemic would decrease on the financial performance of Star Alliance airline companies. In the study, firstly, the literature review is given, then the methodology, research universe, financial performance ratios to be used in the research, and the methods used in the research are mentioned. The LOgarithmic Percentage Change-driven Objective Weighting method (the LOPCOW method) was used to determine the criteria (importance) weights of the calculated financial performance ratios, and the Technique for Order Preferences by Similarity to an Ideal Solution (the TOPSIS method) was used to determine the performance rankings.

LITERATURE REVIEW

When the literature is examined, it is seen that many studies have been conducted on the performance evaluation of enterprises using multi-criteria decision-making techniques. Considering the purpose and scope of the study, the literature review section includes studies on the evaluation of the financial performance of airline companies using multi-criteria decision-making techniques. Some studies using the LOPCOW method, which is the criteria weighting method used in this research, are also included.

Chang and Yeh (2001) analyzed the performance of 5 domestic airlines in Taiwan with the main criteria of cost, efficiency, service quality, price, and 11 sub-criteria. The Simple Additive Weighting (SAW), Weighted Product (WP), and TOPSIS methods were used in the analysis and the best-performing airline was found to be Eastern Airlines.

Wanke, Barros, and Chen (2015) analyzed the financial performance of 35 airlines operating in Asia for the years 2006-2012 using the TOPSIS method. The criteria used in the study were operating cost, total assets, revenues, depreciation, salaries, fixed assets, and Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA). It was found that cost structure, ownership type, market position, and the distance program offered have significant impacts on the efficiency levels of airline operations.

Avcı and Çınaroğlu (2018), analyzed the financial performance of five airlines operating in Europe (Turkish Airlines, Lufthansa, EasyJet, Air France-KLM, and Rynair) using the Analytical Hierarchy Process (AHP) and TOPSIS methods. Current ratio, financial leverage ratio, asset turnover ratio, return on assets, equity multiplier, cash ratio, equity turnover ratio, and return on equity were used as criteria. It was determined that Ryanair had the best financial performance and Lufthansa had the worst financial performance.

Dağlı (2021) calculated the financial ratios using the financial data of the seven airline companies in the top ten in Europe for the second quarter of 2019, the fourth quarter of 2019 and the second quarter of 2020, and performed a financial performance analysis using the TOPSIS method. The performance ranking in the second quarter of 2019 was Pegasus Airlines, International Airlines Group, Aeroflot Airlines, Norwegian Airlines, Air France-KLM Group, Turkish Airlines and Lufthansa, respectively. The financial performance ranking in the fourth quarter

of 2019 was as follows: Air France-KLM Group, Lufthansa, Aeroflot Airlines, Turkish Airlines, International Airlines Group, Pegasus Airlines and Norwegian Airlines. The financial performance ranking in the second quarter of 2020 was determined as Norwegian Airlines, Pegasus Airlines, Turkish Airlines, Aeroflot Airlines, Air France-KLM Group, International Airlines Group and Lufthansa.

Teker, Teker and Polat (2022), analyzed the financial performance of the top 11 airlines in the world for the period 2019-2020-2021 (Covid period) using the TOPSIS method. In the study, airlines are grouped as US Airlines, European Airlines and Chinese Airlines. The result of the analysis shows that the COVID period significantly affects the profitability and operational efficiency of airline companies. As a result of the study, it was observed that China-based airlines managed the COVID period better than US and European airlines.

Bektaş (2022) analyzed the performance of the Turkish insurance sector for the period 2002-2021 using the Method based on the Removal Effects of Criteria (MEREC), LOPCOW, COCOSO, and Evaluation based on the Distance from Average Solution (EDAS) method. According to the results of the study, the most important criteria were found as total claims paid, total equity, and total assets, respectively. With COCOSO and EDAS methods, it was found that the best performance was in 2020.

Ecer and Pamucar (2022) analyzed the performance of nine banks operating in Turkey and published sustainability reports by using LOPCOW and DOmbi Bonferroni (DOBI) methods. In the study, banks were analyzed in terms of three main dimensions of sustainability and seventeen criteria created from these dimensions. It was determined that average return on equity, electricity consumption, number of branches and number of employees are the four most important criteria for sustainability and Garanti BBVA had the best sustainability performance.

Bektaş (2023) analyzed Akbank's sustainability performance for the period 2009-2021 with the LOPCOW and Combined Compromise Solution (COCOSO) methods. The most important criterion in the economic category was return on equity. The most important criterion in the social category was the total number of ATMs. The most important criterion in the environmental category was Scope 1 emissions. According to the COCOSO analysis, the best sustainability performance was achieved in 2018, 2017, and 2014, respectively.

Sürmeli Sarıgül, Ünlü, and Yaşar (2023) analyzed the financial performance of 6 airlines operating in Europe for the years 2019-2021 based on 8 financial criteria. The Criteria Importance Through Intercriteria Correlation (CRITIC) method was used to determine the weight levels of the criteria, and Multi-Attribute Utility Theory (MAUT) and Measurement of Alternatives and Ranking according to Compromise Solution (MARCOS) methods were used to obtain the financial performance ranking. The most important criterion is asset turnover ratio in 2019. The most important criterion is the financial leverage ratio in 2020 and 2021. It was determined that the airline with the best financial performance was Air France in 2019, 2020, and 2021 according to the MAUT method, but Pegasus Airlines in 2019, and EasyJet in 2020 and 2021 according to the MARCOS method.

Gülcemal and İzci (2024) conducted a financial performance analysis of the Turkish Participation Banking sector for the period January 2021-October 2022 using LOPCOW and Multi-Objective Optimization on the basis of Simple Ratio Analysis (MOOSRA) methods. In the study, the performance of participation banks was evaluated on 6 criteria using total sector data. These criteria are dividends received, loans, return on equity, return on assets, foreign resources/total equity, and operating expenses/average total assets. The most important criterion is the foreign resources/total equity criterion. The sector's best performance period was October 2022 and the worst performance period was January 2021.

Apart from the studies summarized above, there are other studies on analyzing the financial performance of airline companies using multi-criteria decision-making techniques: Kurt and Kablan (2022), Bae, Gupta and Mau (2021), Ellibeş and Candan (2021), Köse (2021), Perçin and Aldalou (2018), Pestana Barros and Wanke (2015), Ömürbek and Kınay (2012), Torlak, Sevkli, Sanal & Zaim (2011), Wang (2008), Feng and Wang (2000).

RESEARCH METHODOLOGY

The research is designed in three stages. In the first stage, the financial ratios given in Table 2 were calculated from the financial statements of the airline companies for the relevant years. In the 2nd stage, the criteria (importance) weights of the financial ratios obtained by the LOPCOW method, which is an objective criteria weighting method, were obtained. In the 3rd stage, in order to determine the performance rankings of airline companies, the criterion weights obtained by the LOPCOW method were used in the TOPSIS method, which is a performance ranking method.

RESEARCH POPULATION AND VARIABLES TO BE USED IN THE RESEARCH

In this study, 26 airline companies listed on https://www.staralliance.com/en/ were selected as the main population for the period 2018-2022. The following criteria were taken into consideration when determining the research population:

1. While calculating the financial performance ratios, the consolidated financial statements of the group, if any, including the airline companies were taken into consideration.

2. Airline companies that made financial reporting for the period January 1-December 31 were included in the research population. Accordingly, ANA, Air New Zealand, EGYPTAIR, Ethiopian Airlines, Scandinavian Airlines, Singapore Airlines, and South African Airways were excluded from the research population.

3. Air India and LOT Polish Airlines were not included in the research population since their annual financial reports were not available on the official website.

4. Avianca's annual financial reports for the years 2018-2022, which is the research period, were not included in the research population as they were not fully available on the official website of Avianca.

5. Since Austrian Airlines, Swiss International Airlines and Brussels Airlines are part of Lufthansa Group, the financial performance ratio was calculated by using the annual reports of Lufthansa Group.

According to the information given above, the research population is as shown in Table 1 below:

Table 1: Research Population

	Code	Airline Operation	Country of Operation
1	ACAN	Air Canada	Canada
2	ACHN	Air China	China
3	AEA	Aegean	Greece
4	ASAIR	Asiana Airlines	South Korea
5	COPAIR	Copa Airlines	Panama
6	CROAIR	Croatia Airlines	Croatia
7	EVA	EVA Air	Taiwan
8	LUF	Lufthansa	Germany
9	SHEAIR	Shenzhen Airlines	China
10	TAP	TAP Air Portugal	Portugal
11	THAIR	Thai Airways International	Thailand
12	TUAIR	Turkish Airlines	Turkiye
13	UNAIR	United Airlines	USA

The annual financial statement data for the years 2018 and 2022 were used in the study. The data were obtained from the official websites of the airline companies. Considering the research in the literature, the financial ratios that reflect the general performance results of airline companies were selected. Table 2 lists the financial ratios used in the study. If the annual activity report of the relevant airline is in a currency other than "euro", the financial statement data are converted into "euro/currency of the relevant country" at the end of the year and the financial ratios are calculated. The financial ratios/criteria to be used in the study, calculation method, target criteria, and symbol of the financial ratios/criteria are given in Table 2.

In column 3 of Table 2, the targets to be achieved in terms of the financial ratios are shown. Thus, the maximum asset turnover, profitability ratios, liquidity ratios, and capital adequacy ratios may positively affect both business performance and investor decisions in favor of the business. The minimization of short-term debt/total assets and total debt/total assets, which are among the financial structure ratios, can be welcomed positively. While creating ideal solutions in the application stage of the TOPSIS method to be used in this study, which aspect (benefit factor/cost factor) is important for decision-makers in terms of the contribution of the relevant ratios to performance was taken into account. In addition, in the application stage of the TOPSIS method, the importance weights for each criterion were calculated by using the LOPCOW method.

Table 2: Financial Ratios Used in the Study

Criteria	Calculation Format	Target	Symbol
Asset Turnover	Net sales/current assets	Maximum (benefit)	AT
Financial Structure Ratios	Current Assets/Total Assets	Maximum (benefit)	FSR1
	Total debt/total assets	Minimum (cost)	FSR2
	Short-term debt/total assets	Minimum (cost)	FSR3
Profitability ratios	Net profit/net sales	Maximum (benefit)	PR1
	Net profit/total equity	Maximum (benefit)	PR2
	Net profit/total assets	Maximum (benefit)	PR3
Liquidity ratio (Current Ratio)	Current assets/short-term debt	Maximum (benefit)	CR
Capital Adequacy	Net Balance Sheet Position/ equity	Maximum (benefit)	CA

METHODS USED IN THE RESEARCH

In this section of the study, two multi-criteria decision-making methods are described, namely the objective criteria weighting method, LOPCOW, and performance ranking method, TOPSIS.

The LOPCOW Method

The LOPCOW method is one of the multi-criteria decision-making techniques and was introduced to the literature by Ecer and Pamucar (2022). In this method, there is no limit to the number of criteria included in the decision matrix created in the first step. The LOPCOW method proposes a solution according to whether the criteria are benefit or cost-oriented. In case there is a dimension difference (data gap) in the data, the method eliminates this problem by taking the percentage of the standard deviation of the mean square values of the series. The LOPCOW method is not affected by negative values. The method consists of four steps (Ecer and Pamucar, 2022; Bektas, 2022).

Step 1: Creating the Decision Matrix

In the first step, the internal decision matrix (IDM) given in Equation (1) is constructed to identify and solve the decision problem. In Equation (1), m is the number of alternatives and n is the number of criteria. The decision matrix is created with the help of Equation (1).

$$IDM = \begin{bmatrix} x_{11} & \cdots & x_{1j} & \cdots & x_{1n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mj} & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

Step 2: Creating the Normalized Decision Matrix

Each criterion is subjected to the normalization process with the linear normalization technique (max-min), taking into account the cost and benefit characteristics of the internal decision matrix elements in the decision matrix. The normalization process is performed as in Equation (2) and Equation (3). If the criterion is cost-oriented (if it is desired to be minimum), it is calculated by Equation (2), and if the criterion is benefit-oriented (if it is desired to be maximum), it is calculated by Equation (3).

$$r_{ij} = \frac{x_{max} - x_{ij}}{x_{max} - x_{min}} \quad (2)$$

$$r_{ij} = \frac{x_{ij} - x_{min}}{x_{max} - x_{min}} \quad (3)$$

Step 3: Creating the PVij Matrix of Percentage Values for Each Criteria

The percentage value of each criterion is calculated as the mean square value as a percentage of the standard deviations of each criterion. Here, the difference (gap) due to the size of the data is eliminated. Percentile values are calculated as in equation (4):

$$PV_{ij} = \left| ln\left(\frac{\sqrt{\frac{\sum_{i=1}^{m} r_{ij}}{m}}}{\sigma} \right) * 100 \right| \quad (4)$$

Step 4: Calculation of Objective Weights (Wj)

The objective importance weight for each criterion is calculated by Equation (5).

$$w_j = \frac{PV_{ij}}{\sum_{i=1}^{n} PV_{ij}} \quad (5)$$

TOPSIS Method

The TOPSIS method was introduced to the literature by Hwang and Yoon (1981) and is one of the multi-criteria decision-making techniques that enables the selection of the alternative that is closest to the positive ideal solution (optimal solution, decision point) and the alternative that is farthest from the negative ideal solution. The positive ideal solution ensures that the benefit/maximum criteria are maximized and the cost/minimum criteria are minimized. The negative ideal solution minimizes the benefit/maximization criteria and maximizes the cost/minimization criteria. The TOPSIS method consists of six steps (Hwang and Yoon, 1981; Wang and Elhag, 2006; Tzeng and Huang, 2011; Behzadian et. al., 2012; Zhu et. al., 2012; Işık, 2019).

Step 1: In the decision matrix, the rows contain the decision points (decision units, decision alternatives) whose performance is to be compared up to "m1, m2, ..., mn" and the columns contain the decision criteria (evaluation factors) to be used in decision making. The size of the decision matrix (evaluation matrix) is $m*n$.

$$X\begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \quad (6)$$

Step 2: The decision matrix is normalized using equation (7) below:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, \; i = 1,2,3,\dots,m \text{, and } j = 1,2,3,\dots,n \quad (7)$$

Step 3: Normalized decision matrix: A weighted normalized decision matrix is obtained by multiplying the weight values of the decision units obtained by the LOPCOW method. Weighted normalized values ( ) are calculated with the help of equation (8):

$$v_{ij} = w_j * r_{ij}, \; i = 1,2,3,\dots,m \text{ and } j = 1,2,3,\dots,n \quad (8)$$

In the above equation, $w_j \sum_{i=1}^{n} w_j = 1$ denotes the weight of criterion *i*.

Step 4: Positive ideal solutions and negative ideal solutions are calculated with the help of equation (9) and equation (10) below:

$$A^+ = \left\{v_1^+, v_2^+, \dots, v_j^+, \dots, v_n^+\right\} = \left\{\left(\max_i v_{ij} \,\middle|\, j \in J_1\right), \left(\min_i v_{ij} \,\middle|\, j \in J_2,\ i = 1,2,\dots,m\right)\right\} \quad (9)$$

$$A^+ = \left\{v_1^+, v_2^+, \dots, v_j^+, \dots, v_n^+\right\} = \left\{\left(\max_i v_{ij} \,\middle|\, j \in J_1\right), \left(\min_i v_{ij} \,\middle|\, j \in J_2,\ i = 1,2,\dots,m\right)\right\} \quad (10)$$

Here, J_1 is the benefit criterion set, while J_2 is the cost criterion set.

Step 5: Based on the Euclidean distance approach, the distances of each alternative to the positive ideal (D_i^+) and negative ideal (D_i^-) solution points are calculated with the help of equation (11) and equation (12) below:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2}, \; i = 1,2,3,\dots,m \quad (11)$$

$$D_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}, \; i = 1,2,3,\dots,m \quad (12)$$

Step 6: The relative closeness coefficient of each alternative to the ideal solution, C_i is calculated by the equation below:

$$D_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}, \; i = 1,2,3,\dots,m \quad (13)$$

$0 < C_i \leq 1$ being in Equation (13), C_i the coefficient taking the value of 1 shows that the relevant alternative is at the positive ideal solution point, and taking the value of 0 shows that the relevant alternative is at the negative ideal solution point. At this stage, the C_i values are compared with each other, and the alternatives are ranked in descending order. The alternative with the highest C_i value is evaluated as the highest-performing alternative compared to the other alternatives.

FINDINGS

LOPCOW and TOPSIS methods were applied respectively for the relevant years and the results obtained are shown below in summary tables. More detailed analysis results are given in the Appendix.

LOPCOW Analysis Results

The LOPCOW criteria (importance) weights of the criteria for each year were calculated by applying the stages of the LOPCOW weighting method respectively, and the results are summarized in Table 3.

The most important criteria are net profit/total assets (PR3) for 2018, net profit/total equity (PR2) for 2019 and 2021, short-term debt/total assets (FSR3) for 2020 and net profit/net sales (PR1) for 2022. The criteria with the lowest importance weight are net balance sheet position/equity for 2018, 2019, and 2021 (CA), net sales/current assets for 2020 (AT), and short-term debt/total assets for 2022 (FSR3).

Table 3: LOPCOW Criteria (Importance) Weights (Wj)) Calculated for Criteria by Year

	2018	2018	2019	2019	2020	2020	2021	2021	2022	2022
Criteria	Wj	Rank	Wj	Rank	Wj	Rank	Wj	Rank	Wj	Rank
CR	0,0651	7	0,0857	8	0,0919	6	0,1110	5	0,0928	8
PR1	0,0457	8	0,1036	7	0,1543	2	0,0909	7	0,1399	1
PR2	0,1744	2	0,1692	1	0,1253	5	0,2089	1	0,1144	4
PR3	0,1926	1	0,1395	2	0,1349	4	0,1335	3	0,1101	6
AT	0,0888	6	0,1201	4	0,0372	9	0,0764	8	0,1216	2
CA	0,0376	9	0,0333	9	0,0709	8	0,0012	9	0,1151	3
FSR1	0,0942	5	0,1086	6	0,0852	7	0,1075	6	0,1005	7
FSR2	0,1430	4	0,1160	5	0,1379	3	0,1557	2	0,1130	5
FSR3	0,1585	3	0,1239	3	0,1624	1	0,1149	4	0,0926	9

Table 4: Relative Proximity Coefficients to the Ideal Solution and Performance Rankings-TOPSIS Analysis Results

Business Code	2018 ROCS	2018 Rank	2019 ROCS	2019 Rank	2020 ROCS	2020 Rank	2021 ROCS	2021 ROCS	2022 ROCS	2022 Rank
ACAN	0,5646	9	0,6288	2	0,6388	8	0,2268	13	0,5704	11
ACHN	0,6585	5	0,5455	8	0,7326	5	0,6126	10	0,2964	13
AEA	0,7414	2	0,6276	3	0,6355	9	0,6597	6	**0,7918**	**1**
ASAIR	0,2502	12	0,1489	13	0,7513	4	0,6221	9	0,7299	8
COPAIR	0,6062	8	0,6169	5	0,7060	7	0,6681	4	0,7821	3
CROAIR	0,2479	13	0,3478	10	0,6053	10	0,5700	11	0,5551	12
EVA	0,6423	7	0,5155	9	0,7927	2	0,6733	3	0,7317	6
LUF	0,6825	4	0,5510	7	0,5759	12	0,6283	8	0,7314	7
SHEAIR	**0,7632**	**1**	**0,7394**	**1**	**0,8039**	**1**	0,6890	2	0,7004	9
TAP	0,3077	10	0,2775	11	0,5938	11	0,5036	12	0,7600	4
THAIR	0,2561	11	0,1513	12	0,3270	13	**0,8075**	**1**	0,6507	10
TUAIR	0,6436	6	0,5585	6	0,7622	3	0,6655	5	0,7831	2
UNAIR	0,7014	3	0,6244	4	0,7212	6	0,6427	7	0,7478	5

TOPSIS Performance Ranking Results

The stages of the TOPSIS method were applied in order and the relative closeness coefficients to the ideal solution (ROCS) were calculated for each alternative and the performance rankings of the alternatives in line with these calculations are summarized in Table 4.

According to the data in Table 4, in the period covering the years 2018-2022, the position of the airline companies in the performance ranking varies over the years. The evaluations regarding the performance of airlines for the pre-COVID-19, COVID-19, and post-COVID-19 periods are summarized below:

1. The best-performing airline was Shenzhen Airlines in 2018, 2019, and 2020, Thai Airways International in 2021, and Aegean in 2022.
2. The last airline in the performance ranking was Croatia Airlines in 2018, Asiana Airlines in 2019, Thai Airways International in 2020, Air Canada in 2021, and Air China in 2022.
3. The airline companies whose performance ranking increased in 2020, which was selected as the COVID-19 period, compared to 2019, which was selected as the pre-COVID-19 period are Air China, Asiana Airlines, TAP Airlines, and Turkish Airlines.
4. The airlines whose performance ranking decreased in 2020, the COVID-19 period, compared to 2019, the pre-COVID-19 period, were Air Canada, Aegean, Copa Airlines, Croatia Airlines, Lufthansa and United Airlines.

5. In 2021 and 2022, the post-COVID-19 period, Aegean, Copa Airlines, and Lufthansa were the airlines whose performance ranking increased in both years compared to 2020, while Air China, Croatia Airlines, EVA, and Shenzhen Airlines were the airlines whose performance ranking decreased in both years.

6. Turkish Airlines ranked 6th in 2018 and 2019, 3rd in 2020, 5th in 2021 and 2nd in 2022 in the performance ranking.

CONCLUSION

The airline sector, which is one of the components of the transportation sector that brings together many different sectors of the national and international economy, is of great importance for the development of commercial and tourism activities, ensuring economic growth and sustainability. In fact, the volume of transactions related to both passenger transportation and the transportation of commercial goods and services from one place to another by air is increasing day by day. This situation has also created a great competitive environment for domestic and international transportation. As a result of competition, information users, such as customers, current and potential investors, and shareholders, conduct performance measurements to evaluate the performance of airline companies for use in future decisions. One of the social phenomena that made information users important for performance measurement was COVID-19. Closures around the world due to the pandemic negatively affected the airline industry. Based on this, it was thought that it would be important to measure the financial performance of airline companies before, during, and after COVID-19, and the study was designed accordingly.

The aim of the study is to measure the financial performance of 13 out of 26 airlines (Lufthansa Group includes Austrian Airlines, Swiss International Airlines, and Brussels Airlines) in the Star Alliance, which includes the best airlines, and smaller and regional member airlines operating worldwide, for the years 2018-2022. In the calculation of financial performance, 9 criteria were selected: Net sales/ current assets, current assets/total assets, net profit/net sales, net profit/total equity, net profit/total assets, current assets/short-term debt, net balance sheet position/equity, total debt/total assets, and short-term debt/total assets. While the first 7 of these criteria are benefit (maximum) oriented, the last 2 are cost (minimum) oriented.

After calculating the financial ratios of the airline companies for the period January 1- December 31, 2018-2022, the analysis process started. The LOPCOW method was used to determine the importance weights of the criteria and the TOPSIS method was used to determine the performance ranking.

The results of the LOPCOW method analysis determined net profit/total assets (PR3) for 2018, net profit/total equity (PR2) for 2019 and 2021, short-term debt/total assets (FSR3) for 2020, and net profit/net sales (PR1) for 2022. The criterion with the lowest importance weight was net balance sheet position/equity (CA) for 2018, 2019, and 2021, net sales/ current assets (AT) for 2020, and short-term debt/total assets (FSR3) for 2022. These results show that while profitability ratios were the criteria with the highest criterion weight in 2018 and 2019, short-term debt/total assets (PR3), which is one of the financial structure ratios, was the most important criterion in the COVID-19 period, and profitability ratios were again the most important criteria in the following years.

According to the TOPSIS method analysis results, the top-performing airlines were Shenzhen Airlines in 2018, 2019, and 2020, Thai Airways International in 2021, and Aegean in 2022. The worst-performing airlines were Croatia Airlines in 2018, Asian Airlines in 2019, Thai Airways International in 2020, Air Canada in 2021, and Air China in 2022. In 2020, the COVID-19 period, the performance ranking of some airlines increased and some decreased compared to 2019. Air China, Asiana Airlines, TAP Airlines, and Turkish Airlines improved their performance ranking, while Air Canada, Aegean, Copa Airlines, Croatia Airlines, Lufthansa, and United Airlines decreased their performance ranking. In 2021 and 2022, Aegean, Copa Airlines, and Lufthansa were the airlines whose performance ranking increased in both years compared to 2020, while Air China, Croatia Airlines, EVA and Shenzhen Airlines were the airlines whose performance ranking decreased in both years. The performance ranking of Turkish Airlines operating in Turkey was 6 in 2018 and 2019, 3 in 2020, 5 in 2021, and 2 in 2022.

The results obtained in the research show that the financial performance of Star Alliance airline companies was generally negatively affected during the COVID-19 period, but the COVID-19 effect gradually decreased in 2021 and 2022. In Dağlı's (2021) study, it was determined that the performances of 7 airline companies in Europe before and during COVID-19 differed. In addition, this study also provides evidence for the results of Kurt and

Kablan's (2022) study, which is also mentioned in the literature review. Similarly, Teker, Teker, and Polat's (2022) study shows that the COVID period significantly affects the profitability and operational efficiency of airlines.

This study, which analyzes the financial performance of airline companies operating worldwide and participating in the Star Alliance, is thought to make important contributions to the airline industry in terms of the results obtained. When the literature is examined, although there are many financial performance analysis studies on airline companies, this study is unique because it analyzes the financial performance of airline companies in Star Alliance and it is thought to contribute to the literature.

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APPENDIX 1: 2018 LOPCOW Analysis Results

Decision Matrix									
Target Criteria	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Min**	**Min**
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	1,23573	0,00924	0,04141	0,00870	0,94103	4,75998	0,32823	0,78992	0,26561
ACHN	0,48605	0,05831	0,08174	0,03371	5,93789	2,42450	0,09737	0,58754	0,09737
AEA	1,28046	0,05720	0,24441	0,09356	1,63580	2,61232	0,64859	0,61720	0,50653
ASAIR	0,44925	-0,02727	-0,17916	-0,02391	4,74574	7,49285	0,18479	0,86654	0,41133
COPAIR	1,01616	0,03290	0,04786	0,02155	2,51640	2,22051	0,26034	0,54965	0,25620
CROAIR	0,44584	-0,05058	-0,26527	-0,09401	7,68986	2,82211	0,24170	0,64559	0,54213
EVA	1,24742	0,04010	0,10289	0,02991	2,36731	3,43974	0,31508	0,70928	0,25259
LUF	0,65705	0,06034	0,22595	0,05660	0,93801	3,99175	0,27881	0,74948	0,42433
SHEAIR	2,39793	0,56357	0,14713	0,07736	0,38876	1,90182	0,35311	0,47419	0,14726
TAP	1,13472	-0,01846	-0,55407	-0,02636	2,07482	21,02108	0,68813	0,95243	0,60643
THAIR	0,55729	-0,05904	-0,56555	-0,04305	3,95506	13,13633	0,18438	0,92388	0,33086
TUAIR	0,86921	0,06436	0,12930	0,03708	0,57623	3,48664	0,21733	0,71319	0,25004
UNAIR	0,54385	0,05159	0,21402	0,04758	5,74610	4,49794	0,16050	0,77768	0,29511
Max	2,39793	0,56357	0,24441	0,09356	7,68986	21,02108	0,68813	0,95243	0,60643
Min	0,44584	-0,05904	-0,56555	-0,09401	0,38876	1,90182	0,09737	0,47419	0,09737
Normalization of Criteria									
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	0,40464	0,10967	0,74936	0,54758	0,07564	0,14949	0,39078	0,33982	0,66951
ACHN	0,02060	0,18848	0,79916	0,68094	0,76004	0,02734	0,00000	0,76298	1,00000
AEA	0,42756	0,18669	1,00000	1,00000	0,17080	0,03716	0,93307	0,70097	0,19625
ASAIR	0,00175	0,05103	0,47704	0,37372	0,59676	0,29243	0,14797	0,17959	0,38326
COPAIR	0,29216	0,14767	0,75733	0,61611	0,29141	0,01667	0,27586	0,84220	0,68800
CROAIR	0,00000	0,01358	0,37074	0,00000	1,00000	0,04813	0,24431	0,64159	0,12632
EVA	0,41063	0,15923	0,82527	0,66066	0,27099	0,08044	0,36853	0,50842	0,69510
LUF	0,10820	0,19175	0,97720	0,80297	0,07523	0,10931	0,30712	0,42436	0,35772
SHEAIR	1,00000	1,00000	0,87989	0,91364	0,00000	0,00000	0,43290	1,00000	0,90201
TAP	0,35290	0,06517	0,01418	0,36068	0,23093	1,00000	1,00000	0,00000	0,00000
THAIR	0,05710	0,00000	0,00000	0,27168	0,48846	0,58760	0,14728	0,05971	0,54134
TUAIR	0,21688	0,19819	0,85788	0,69890	0,02568	0,08289	0,20306	0,50025	0,70011
UNAIR	0,05021	0,17769	0,96247	0,75487	0,73377	0,13579	0,10685	0,36541	0,61156

Square Matrix										
Criteria / Alternative	CR	PR1	PR2	PR3	AT	CA	FSR1	FSR2	FSR3	
ACAN	0,16373	0,01203	0,56155	0,29984	0,00572	0,02235	0,15271	0,11547	0,44824	
ACHN	0,00042	0,03552	0,63866	0,46368	0,57766	0,00075	0,00000	0,58213	1,00000	
AEA	0,18280	0,03485	1,00000	1,00000	0,02917	0,00138	0,87061	0,49135	0,03852	
ASAIR	0,00000	0,00260	0,22757	0,13967	0,35612	0,08551	0,02190	0,03225	0,14689	
COPAIR	0,08536	0,02181	0,57355	0,37959	0,08492	0,00028	0,07610	0,70931	0,47335	
CROAIR	0,00000	0,00018	0,13745	0,00000	1,00000	0,00232	0,05969	0,41164	0,01596	
EVA	0,16862	0,02535	0,68107	0,43648	0,07344	0,00647	0,13581	0,25849	0,48316	
LUF	0,01171	0,03677	0,95492	0,64475	0,00566	0,01195	0,09432	0,18008	0,12796	
SHEAIR	1,00000	1,00000	0,77421	0,83473	0,00000	0,00000	0,18740	1,00000	0,81363	
TAP	0,12454	0,00425	0,00020	0,13009	0,05333	1,00000	1,00000	0,00000	0,00000	
THAIR	0,00326	0,00000	0,00000	0,07381	0,23859	0,34528	0,02169	0,00356	0,29305	
TUAIR	0,04704	0,03928	0,73595	0,48847	0,00066	0,00687	0,04123	0,25025	0,49015	
UNAIR	0,00252	0,03157	0,92636	0,56983	0,53842	0,01844	0,01142	0,13352	0,37400	
Total	1,79000	1,24422	7,21148	5,46093	2,96370	1,50159	2,67287	4,16807	4,70490	
m	13	13	13	13	13	13	13	13	13	
total/m	0,13769	0,09571	0,55473	0,42007	0,22798	0,11551	0,20561	0,32062	0,36192	
Square Root(total/m)	0,37107	0,30937	0,74480	0,64813	0,47747	0,33986	0,45344	0,56623	0,60159	
Standard Deviation (Standardization of Criteria)	0,27847	0,25292	0,34503	0,27715	0,32277	0,28790	0,29930	0,30145	0,29904	
Square Root(total/m)/Standard Deviation (Standardization of Criteria)	1,33254	1,22319	2,15865	2,33853	1,47928	1,18051	1,51499	1,87840	2,01172	
pwij	28,70855	20,14642	76,94844	84,95207	39,15549	16,59443	41,54096	63,04179	69,89925	440,98741
wj	0,06510	0,04568	0,17449	0,19264	0,08879	0,03763	0,09420	0,14296	0,15851	1
Rank	7	8	2	1	6	9	5	4	3	

APPENDIX 2: 2018 TOPSIS Analysis Results

Target Criteria	Max	Max	Max	Max	Max	Max	Max	Min	Min
Weight Values	0,06510	0,04568	0,17449	0,19264	0,08879	0,03763	0,09420	0,14296	0,15851
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	1,23573	0,00924	0,04141	0,00870	0,94103	4,75998	0,32823	0,78992	0,26561
ACHN	0,48605	0,05831	0,08174	0,03371	5,93789	2,42450	0,09737	0,58754	0,09737
AEA	1,28046	0,05720	0,24441	0,09356	1,63580	2,61232	0,64859	0,61720	0,50653
ASAIR	0,44925	-0,02727	-0,17916	-0,02391	4,74574	7,49285	0,18479	0,86654	0,41133
COPAIR	1,01616	0,03290	0,04786	0,02155	2,51640	2,22051	0,26034	0,54965	0,25620
CROAIR	0,44584	-0,05058	-0,26527	-0,09401	7,68986	2,82211	0,24170	0,64559	0,54213
EVA	1,24742	0,04010	0,10289	0,02991	2,36731	3,43974	0,31508	0,70928	0,25259
LUF	0,65705	0,06034	0,22595	0,05660	0,93801	3,99175	0,27881	0,74948	0,42433
SHEAIR	2,39793	0,56357	0,14713	0,07736	0,38876	1,90182	0,35311	0,47419	0,14726
TAP	1,13472	-0,01846	-0,55407	-0,02636	2,07482	21,02108	0,68813	0,95243	0,60643
THAIR	0,55729	-0,05904	-0,56555	-0,04305	3,95506	13,13633	0,18438	0,92388	0,33086
TUAIR	0,86921	0,06436	0,12930	0,03708	0,57623	3,48664	0,21733	0,71319	0,25004
UNAIR	0,54385	0,05159	0,21402	0,04758	5,74610	4,49794	0,16050	0,77768	0,29511
Normalization of Criteria									
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	0,31672	0,01575	0,04258	0,04578	0,06886	0,17015	0,26109	0,29891	0,20034
ACHN	0,12457	0,09933	0,08406	0,17742	0,43452	0,08667	0,07746	0,22233	0,07345
AEA	0,32818	0,09743	0,25135	0,49235	0,11970	0,09338	0,51592	0,23355	0,38206
ASAIR	0,11514	-0,08747	-0,28977	-0,53794	0,70513	0,10844	0,21148	0,31082	0,47376
COPAIR	0,26044	0,05604	0,04922	0,11342	0,18415	0,07937	0,20709	0,20799	0,19324
CROAIR	0,11427	-0,08616	-0,27280	-0,49472	0,56273	0,10088	0,19226	0,24430	0,40891
EVA	0,31971	0,06831	0,10581	0,15740	0,17324	0,12296	0,25063	0,26840	0,19052
LUF	0,16840	0,10279	0,23236	0,29786	0,06864	0,14269	0,22177	0,28361	0,32006
SHEAIR	0,61458	0,96000	0,15131	0,40711	0,02845	0,06798	0,28088	0,17944	0,11107
TAP	0,29083	-0,03145	-0,56980	-0,13870	0,15183	0,75142	0,54737	0,36041	0,45741
THAIR	0,14283	-0,10056	-0,58161	-0,22655	0,28942	0,46957	0,14667	0,34960	0,24955
TUAIR	0,22278	0,10963	0,13297	0,19515	0,04217	0,12463	0,17288	0,26988	0,18859
UNAIR	0,13939	0,08789	0,22010	0,25039	0,42049	0,16078	0,12767	0,29428	0,22260
Multiplication of Normalized Matrices by Weight Values									

Criteria / Alternative	CR	PR1	PR2	PR3	AT	CA	FSR1	FSR2	FSR3
ACAN	0,02062	0,00072	0,00743	0,00882	0,00611	0,00640	0,02459	0,04273	0,03176
ACHN	0,00811	0,00454	0,01467	0,03418	0,03858	0,00326	0,00730	0,03178	0,01164
AEA	0,02136	0,00445	0,04386	0,09485	0,01063	0,00351	0,04860	0,03339	0,06056
ASAIR	0,00750	-0,00400	-0,05056	-0,10363	0,06261	0,00408	0,01992	0,04443	0,07509
COPAIR	0,01695	0,00256	0,00859	0,02185	0,01635	0,00299	0,01951	0,02973	0,03063
CROAIR	0,00744	-0,00394	-0,04760	-0,09530	0,04996	0,00380	0,01811	0,03492	0,06481
EVA	0,02081	0,00312	0,01846	0,03032	0,01538	0,00463	0,02361	0,03837	0,03020
LUF	0,01096	0,00470	0,04055	0,05738	0,00609	0,00537	0,02089	0,04054	0,05073
SHEAIR	0,04001	0,04386	0,02640	0,07843	0,00253	0,00256	0,02646	0,02565	0,01761
TAP	0,01893	-0,00144	-0,09943	-0,02672	0,01348	0,02828	0,05156	0,05152	0,07250
THAIR	0,00930	-0,00459	-0,10149	-0,04364	0,02570	0,01767	0,01382	0,04998	0,03956
TUAIR	0,01450	0,00501	0,02320	0,03759	0,00374	0,00469	0,01629	0,03858	0,02989
UNAIR	0,00907	0,00402	0,03841	0,04824	0,03734	0,00605	0,01203	0,04207	0,03528
Positive ideal solutions and negative ideal solutions									
A+	0,04001	0,04386	0,04386	0,09485	0,06261	0,02828	0,05156	0,02565	0,01164
A-	0,00744	-0,00459	-0,10149	-0,10363	0,00253	0,00256	0,00730	0,05152	0,07509

Distance of each alternative to the positive ideal and negative ideal solution points and performance ranking

Alternative	Di+	Di-	Ci	Rank
ACAN	0,12672	0,16429	0,56455	9
ACHN	0,10147	0,19566	0,65849	5
AEA	**0,08762**	**0,25121**	**0,74141**	**2**
ASAIR	0,24004	0,08010	0,25019	12
COPAIR	0,11399	0,17549	0,60622	8
CROAIR	0,22947	0,07565	0,24794	13
EVA	0,10447	0,18760	0,64232	7
LUF	0,10100	0,21706	0,68245	4
SHEAIR	**0,07424**	**0,23927**	**0,76320**	**1**
TAP	0,21117	0,09386	0,30770	10
THAIR	0,21878	0,07533	0,25613	11
TUAIR	0,10785	0,19476	0,64361	6
UNAIR	**0,09095**	**0,21361**	**0,70138**	**3**

APPENDIX 3: 2019 LOPCOW Analysis Results

Decision Matrix									
Target Criteria	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Min**	**Min**
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	0,96669	0,07715	0,33545	0,05317	2,54537	6,30886	0,27076	0,84149	0,28009
ACHN	0,31828	0,05180	0,07168	0,02469	5,65099	2,90346	0,08435	0,65558	0,26503
AEA	1,41084	0,06001	0,23913	0,05890	1,82939	4,06025	0,53652	0,75370	0,38028
ASAIR	0,34239	-0,11741	-0,90047	-0,06057	4,46308	14,86689	0,11558	0,93274	0,33757
COPAIR	1,23737	0,09123	0,12766	0,05669	2,19322	2,25198	0,28330	0,55595	0,22895
CROAIR	0,40924	-0,04824	-0,34275	-0,06217	7,88247	5,51313	0,16349	0,81861	0,39950
EVA	0,93642	0,02677	0,06209	0,01362	2,34813	4,55903	0,21670	0,78066	0,23141
LUF	0,70593	0,03418	0,12139	0,02918	3,22765	4,15942	0,26454	0,75958	0,37474
SHEAIR	2,09171	0,42268	0,15018	0,07778	0,53185	1,93085	0,34598	0,48209	0,16541
TAP	1,06892	-0,02931	-0,71086	-0,01856	1,75901	38,30027	0,35997	0,97389	0,33678
THAIR	0,58713	-0,06665	-1,02131	-0,04682	3,63950	21,81468	0,19299	0,95416	0,32870
TUAIR	0,80015	0,06038	0,11094	0,03088	2,65069	3,60022	0,19295	0,72224	0,24114
UNAIR	0,54795	0,06960	0,26201	0,05724	5,28322	4,57753	0,15565	0,78154	0,28406
Max	2,09171	0,42268	0,33545	0,07778	7,88247	38,30027	0,53652	0,97389	0,39950
Min	0,31828	-0,11741	-1,02131	-0,06217	0,53185	1,93085	0,08435	0,48209	0,16541
Normalization of Criteria									
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	0,36563	0,36025	1,00000	0,82418	0,27392	0,12038	0,41225	0,26921	0,51011
ACHN	0,00000	0,31330	0,80559	0,62065	0,69642	0,02674	0,00000	0,64723	0,57445
AEA	0,61607	0,32851	0,92901	0,86510	0,17652	0,05855	1,00000	0,44772	0,08210
ASAIR	0,01360	0,00000	0,08907	0,01144	0,53482	0,35568	0,06907	0,08368	0,26454
COPAIR	0,51826	0,38632	0,84684	0,84929	0,22602	0,00883	0,43999	0,84983	0,72855
CROAIR	0,05129	0,12808	0,50013	0,00000	1,00000	0,09850	0,17502	0,31573	0,00000
EVA	0,34856	0,26696	0,79852	0,54155	0,24709	0,07226	0,29270	0,39292	0,71803
LUF	0,21859	0,28069	0,84223	0,65278	0,36674	0,06128	0,39850	0,43577	0,10578
SHEAIR	1,00000	1,00000	0,86344	1,00000	0,00000	0,00000	0,57862	1,00000	1,00000
TAP	0,42327	0,16313	0,22882	0,31161	0,16695	1,00000	0,60954	0,00000	0,26796
THAIR	0,15160	0,09398	0,00000	0,10970	0,42277	0,54672	0,24026	0,04012	0,30243

TUAIR	0,27172	0,32920	0,83453	0,66492	0,28825	0,04590	0,24018	0,51170	0,67647	
UNAIR	0,12951	0,34627	0,94587	0,85323	0,64639	0,07277	0,15768	0,39111	0,49314	
Square Matrix										
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**	
ACAN	0,13368	0,12978	1,00000	0,67927	0,07503	0,01449	0,16995	0,07247	0,26021	
ACHN	0,00000	0,09816	0,64897	0,38521	0,48501	0,00072	0,00000	0,41891	0,32999	
AEA	0,37954	0,10792	0,86305	0,74839	0,03116	0,00343	1,00000	0,20045	0,00674	
ASAIR	0,00018	0,00000	0,00793	0,00013	0,28603	0,12651	0,00477	0,00700	0,06998	
COPAIR	0,26859	0,14924	0,71714	0,72129	0,05108	0,00008	0,19359	0,72221	0,53078	
CROAIR	0,00263	0,01640	0,25013	0,00000	1,00000	0,00970	0,03063	0,09969	0,00000	
EVA	0,12149	0,07127	0,63763	0,29328	0,06105	0,00522	0,08567	0,15438	0,51557	
LUF	0,04778	0,07878	0,70935	0,42612	0,13450	0,00375	0,15880	0,18989	0,01119	
SHEAIR	1,00000	1,00000	0,74553	1,00000	0,00000	0,00000	0,33480	1,00000	1,00000	
TAP	0,17916	0,02661	0,05236	0,09710	0,02787	1,00000	0,37154	0,00000	0,07180	
THAIR	0,02298	0,00883	0,00000	0,01203	0,17874	0,29890	0,05773	0,00161	0,09147	
TUAIR	0,07383	0,10838	0,69643	0,44212	0,08309	0,00211	0,05768	0,26183	0,45761	
UNAIR	0,01677	0,11991	0,89466	0,72801	0,41782	0,00530	0,02486	0,15297	0,24319	
Total	2,24665	1,91527	7,22320	5,53295	2,83139	1,47021	2,49003	3,28142	3,58853	
m	13	13	13	13	13	13	13	13	13	
total/m	0,17282	0,14733	0,55563	0,42561	0,21780	0,11309	0,19154	0,25242	0,27604	
Square Root(total/m)	0,41572	0,38383	0,74541	0,65239	0,46669	0,33629	0,43765	0,50241	0,52540	
Standard Deviation (Standardization of Criteria)	0,28114	0,23919	0,34427	0,34505	0,26970	0,28894	0,26654	0,29591	0,29841	
Square Root(total/m)/Standard Deviation (Standardization of Criteria)	1,47868	1,60472	2,16520	1,89070	1,73042	1,16390	1,64195	1,69783	1,76064	
pwij	39,11530	47,29499	77,25107	63,69463	54,83645	15,17741	49,58867	52,93529	56,56764	456,46144
wj	0,08569	0,10361	0,16924	0,13954	0,12013	0,03325	0,10864	0,11597	0,12393	1,00000
Rank	8	7	1	2	4	9	6	5	3	

APPENDIX 4: 2019 TOPSIS Analysis Results

Target Criteria	Max	Max	Max	Max	Max	Max	Max	Min	Min
Weight Values	0,08569	0,10361	0,16924	0,13954	0,12013	0,03325	0,10864	0,11597	0,12393
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	0,96669	0,07715	0,33545	0,05317	2,54537	6,30886	0,27076	0,84149	0,28009
ACHN	0,31828	0,05180	0,07168	0,02469	5,65099	2,90346	0,08435	0,65558	0,26503
AEA	1,41084	0,06001	0,23913	0,05890	1,82939	4,06025	0,53652	0,75370	0,38028
ASAIR	0,34239	-0,11741	-0,90047	-0,06057	4,46308	14,86689	0,11558	0,93274	0,33757
COPAIR	1,23737	0,09123	0,12766	0,05669	2,19322	2,25198	0,28330	0,55595	0,22895
CROAIR	0,40924	-0,04824	-0,34275	-0,06217	7,88247	5,51313	0,16349	0,81861	0,39950
EVA	0,93642	0,02677	0,06209	0,01362	2,34813	4,55903	0,21670	0,78066	0,23141
LUF	0,70593	0,03418	0,12139	0,02918	3,22765	4,15942	0,26454	0,75958	0,37474
SHEAIR	2,09171	0,42268	0,15018	0,07778	0,53185	1,93085	0,34598	0,48209	0,16541
TAP	1,06892	-0,02931	-0,71086	-0,01856	1,75901	38,30027	0,35997	0,97389	0,33678
THAIR	0,58713	-0,06665	-1,02131	-0,04682	3,63950	21,81468	0,19299	0,95416	0,32870
TUAIR	0,80015	0,06038	0,11094	0,03088	2,65069	3,60022	0,19295	0,72224	0,24114
UNAIR	0,54795	0,06960	0,26201	0,05724	5,28322	4,57753	0,15565	0,78154	0,28406
Normalization of Criteria									
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	0,26790	0,16052	0,20083	0,29956	0,18176	0,13043	0,27728	0,29816	0,25559
ACHN	0,08820	0,10777	0,04292	0,13910	0,40352	0,06003	0,08638	0,23229	0,24184
AEA	0,39099	0,12485	0,14317	0,33182	0,13063	0,08394	0,54943	0,26705	0,34702
ASAIR	0,09489	-0,24429	-0,53910	-0,34124	0,31870	0,30735	0,11836	0,33049	0,30804
COPAIR	0,34292	0,18982	0,07643	0,31936	0,15661	0,04656	0,29012	0,19698	0,20892
CROAIR	0,11341	-0,10037	-0,20520	-0,35025	0,56287	0,11398	0,16743	0,29005	0,36455
EVA	0,25951	0,05569	0,03717	0,07673	0,16767	0,09425	0,22192	0,27660	0,21117
LUF	0,19564	0,07112	0,07268	0,16442	0,23048	0,08599	0,27091	0,26914	0,34196
SHEAIR	0,57968	0,87942	0,08991	0,43819	0,03798	0,03992	0,35431	0,17082	0,15094
TAP	0,29623	-0,06099	-0,42558	-0,10457	0,12561	0,79181	0,36863	0,34507	0,30731
THAIR	0,16271	-0,13868	-0,61145	-0,26376	0,25989	0,45099	0,19764	0,33808	0,29995
TUAIR	0,22175	0,12564	0,06642	0,17400	0,18928	0,07443	0,19760	0,25591	0,22005
UNAIR	0,15186	0,14482	0,15686	0,32247	0,37726	0,09463	0,15940	0,27692	0,25921

Multiplication of Normalized Matrices by Weight Values									
Criteria / Alternative	CR	PR1	PR2	PR3	AT	CA	FSR1	FSR2	FSR3
ACAN	0,02296	0,01663	0,03399	0,04180	0,02184	0,00434	0,03012	0,03458	0,03167
ACHN	0,00756	0,01117	0,00726	0,01941	0,04848	0,00200	0,00938	0,02694	0,02997
AEA	0,03350	0,01294	0,02423	0,04630	0,01569	0,00279	0,05969	0,03097	0,04300
ASAIR	0,00813	-0,02531	-0,09124	-0,04762	0,03829	0,01022	0,01286	0,03833	0,03817
COPAIR	0,02939	0,01967	0,01293	0,04456	0,01881	0,00155	0,03152	0,02284	0,02589
CROAIR	0,00972	-0,01040	-0,03473	-0,04887	0,06762	0,00379	0,01819	0,03364	0,04518
EVA	0,02224	0,00577	0,00629	0,01071	0,02014	0,00313	0,02411	0,03208	0,02617
LUF	0,01676	0,00737	0,01230	0,02294	0,02769	0,00286	0,02943	0,03121	0,04238
SHEAIR	0,04967	0,09112	0,01522	0,06114	0,00456	0,00133	0,03849	0,01981	0,01871
TAP	0,02539	-0,00632	-0,07203	-0,01459	0,01509	0,02633	0,04005	0,04002	0,03808
THAIR	0,01394	-0,01437	-0,10348	-0,03681	0,03122	0,01500	0,02147	0,03921	0,03717
TUAIR	0,01900	0,01302	0,01124	0,02428	0,02274	0,00247	0,02147	0,02968	0,02727
UNAIR	0,01301	0,01500	0,02655	0,04500	0,04532	0,00315	0,01732	0,03211	0,03212
Positive ideal solutions and negative ideal solutions									
A+	0,04967	0,09112	0,03399	0,06114	0,06762	0,02633	0,05969	0,01981	0,01871
A-	0,00756	-0,02531	-0,10348	-0,04887	0,00456	0,00133	0,00938	0,04002	0,04518

The distance of each alternative to the positive ideal and negative ideal solution points and its performance ranking				
Alternative	Di+	Di-	Ci	Rank
ACAN	**0,10235**	**0,17339**	**0,62881**	**2**
ACHN	0,11954	0,14349	0,54553	8
AEA	**0,10322**	**0,17392**	**0,62755**	**3**
ASAIR	0,21640	0,03784	0,14885	13
COPAIR	0,10043	0,16169	0,61686	5
CROAIR	0,17847	0,09516	0,34776	10
EVA	0,12495	0,13292	0,51546	9
LUF	0,11738	0,14401	0,55095	7
SHEAIR	**0,07350**	**0,20852**	**0,73936**	**1**
TAP	0,17603	0,06760	0,27746	11
THAIR	0,21102	0,03761	0,15127	12
TUAIR	0,11459	0,14498	0,55852	6
UNAIR	0,10303	0,17127	0,62440	4

APPENDIX 5: 2020 LOPCOW Analysis Results

Decision Matrix									
Target Criteria	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Min**	**Min**
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	1,21460	-0,79667	-2,70962	-0,16072	0,67270	16,85889	0,29990	0,94068	0,24691
ACHN	0,24487	-0,21413	-0,18880	-0,05568	3,74245	3,39047	0,06949	0,70506	0,28377
AEA	1,01032	-0,54904	-2,93767	-0,15816	0,68928	18,57412	0,41792	0,94616	0,41365
ASAIR	0,45476	-0,12912	-0,46172	-0,03631	1,63241	12,71550	0,17227	0,92136	0,37882
COPAIR	1,49913	-0,75788	-0,47295	-0,15754	0,65690	3,00211	0,31644	0,66690	0,21108
CROAIR	1,67119	-0,65844	-1,65333	-0,48640	0,73871	7,66023	0,44374	0,86946	0,26552
EVA	1,23109	-0,03680	-0,04274	-0,00994	1,59208	4,29910	0,16972	0,76739	0,13786
LUF	0,68490	-0,49489	-4,84859	-0,17032	1,35349	28,46720	0,25428	0,96487	0,37126
SHEAIR	1,14728	0,31043	0,10326	0,05335	0,49904	1,93552	0,34438	0,48333	0,30017
TAP	0,56390	-1,18073	1,06585	-0,24818	0,59856	-4,29464	0,35116	1,23285	0,62273
THAIR	0,06547	-2,95873	1,09727	-0,67618	2,41662	-1,62275	0,09457	1,61624	1,44446
TUAIR	0,64710	-0,12677	-0,14902	-0,03142	1,51499	4,74303	0,16360	0,78916	0,25282
UNAIR	1,16270	-0,46024	-1,19214	-0,11873	1,03750	10,04049	0,24866	0,90040	0,21386
Max	1,67119	0,31043	1,09727	0,05335	3,74245	28,46720	0,44374	1,61624	1,44446
Min	0,06547	-2,95873	-4,84859	-0,67618	0,49904	-4,29464	0,06949	0,48333	0,13786
Normalization of Criteria									
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	0,71565	0,66135	0,35974	0,70656	0,05354	0,64568	0,61566	0,59630	0,91653
ACHN	0,11172	0,83954	0,78370	0,85054	1,00000	0,23458	0,00000	0,80429	0,88833
AEA	0,58843	0,73710	0,32139	0,71007	0,05865	0,69803	0,93102	0,59147	0,78892
ASAIR	0,24244	0,86555	0,73780	0,87710	0,34944	0,51921	0,27465	0,61336	0,81558
COPAIR	0,89284	0,67322	0,73591	0,71092	0,04867	0,22272	0,65986	0,83797	0,94396
CROAIR	1,00000	0,70363	0,53739	0,26014	0,07390	0,36490	1,00000	0,65918	0,90229
EVA	0,72592	0,89379	0,80827	0,91324	0,33700	0,26231	0,26781	0,74926	1,00000
LUF	0,38577	0,75366	0,00000	0,69340	0,26344	1,00000	0,49377	0,57495	0,82136
SHEAIR	0,67372	1,00000	0,83282	1,00000	0,00000	0,19017	0,73452	1,00000	0,87577
TAP	0,31041	0,54387	0,99472	0,58668	0,03068	0,00000	0,75263	0,33841	0,62890
THAIR	0,00000	0,00000	1,00000	0,00000	0,59122	0,08156	0,06702	0,00000	0,00000
TUAIR	0,36223	0,86627	0,79039	0,88380	0,31323	0,27586	0,25147	0,73005	0,91201

UNAIR	0,68333	0,76426	0,61496	0,76412	0,16602	0,43756	0,47874	0,63186	0,94183	
Square Matrix										
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**	
ACAN	0,51215	0,43738	0,12941	0,49922	0,00287	0,41690	0,37904	0,35558	0,84004	
ACHN	0,01248	0,70483	0,61419	0,72342	1,00000	0,05503	0,00000	0,64688	0,78913	
AEA	0,34625	0,54331	0,10329	0,50420	0,00344	0,48725	0,86680	0,34983	0,62239	
ASAIR	0,05878	0,74917	0,54435	0,76930	0,12211	0,26957	0,07543	0,37621	0,66517	
COPAIR	0,79717	0,45322	0,54157	0,50541	0,00237	0,04960	0,43542	0,70219	0,89105	
CROAIR	1,00000	0,49510	0,28879	0,06767	0,00546	0,13315	1,00000	0,43451	0,81413	
EVA	0,52696	0,79885	0,65330	0,83401	0,11357	0,06881	0,07172	0,56140	1,00000	
LUF	0,14882	0,56801	0,00000	0,48080	0,06940	1,00000	0,24381	0,33057	0,67464	
SHEAIR	0,45390	1,00000	0,69360	1,00000	0,00000	0,03616	0,53952	1,00000	0,76698	
TAP	0,09635	0,29579	0,98946	0,34419	0,00094	0,00000	0,56645	0,11452	0,39552	
THAIR	0,00000	0,00000	1,00000	0,00000	0,34955	0,00665	0,00449	0,00000	0,00000	
TUAIR	0,13121	0,75042	0,62472	0,78111	0,09812	0,07610	0,06324	0,53297	0,83177	
UNAIR	0,46694	0,58409	0,37817	0,58387	0,02756	0,19145	0,22919	0,39924	0,88705	
Total	4,55101	7,38018	6,56085	7,09321	1,79538	2,79068	4,47512	5,80391	9,17786	
m	13	13	13	13	13	13	13	13	13	
total/m	0,35008	0,56771	0,50468	0,54563	0,13811	0,21467	0,34424	0,44645	0,70599	
Square Root(total/m)	0,59167	0,75346	0,71041	0,73867	0,37163	0,46332	0,58672	0,66817	0,84023	
Standard Deviation (Standardization of Criteria)	0,30355	0,24561	0,28589	0,27725	0,28356	0,27676	0,31595	0,24549	0,25836	
Square Root(total/m)/Standard Deviation (Standardization of Criteria)	1,94919	3,06767	2,48493	2,66424	1,31057	1,67412	1,85700	2,72184	3,25223	
pwij	66,74143	112,09178	91,02439	97,99189	27,04630	51,52848	61,89604	100,13065	117,93398	726,38493
wj	0,09188	0,15431	0,12531	0,13490	0,03723	0,07094	0,08521	0,13785	0,16236	1
Rank	6	2	5	4	9	8	7	3	1	

APPENDIX 6: 2020 TOPSIS Analysis Results

Target Criteria	Max	Max	Max	Max	Max	Max	Max	Min	Min
Weight Values	0,09188	0,15431	0,12531	0,13490	0,03723	0,07094	0,08521	0,13785	0,16236
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	1,21460	-0,79667	-2,70962	-0,16072	0,67270	16,85889	0,29990	0,94068	0,24691
ACHN	0,24487	-0,21413	-0,18880	-0,05568	3,74245	3,39047	0,06949	0,70506	0,28377
AEA	1,01032	-0,54904	-2,93767	-0,15816	0,68928	18,57412	0,41792	0,94616	0,41365
ASAIR	0,45476	-0,12912	-0,46172	-0,03631	1,63241	12,71550	0,17227	0,92136	0,37882
COPAIR	1,49913	-0,75788	-0,47295	-0,15754	0,65690	3,00211	0,31644	0,66690	0,21108
CROAIR	1,67119	-0,65844	-1,65333	-0,48640	0,73871	7,66023	0,44374	0,86946	0,26552
EVA	1,23109	-0,03680	-0,04274	-0,00994	1,59208	4,29910	0,16972	0,76739	0,13786
LUF	0,68490	-0,49489	-4,84859	-0,17032	1,35349	28,46720	0,25428	0,96487	0,37126
SHEAIR	1,14728	0,31043	0,10326	0,05335	0,49904	1,93552	0,34438	0,48333	0,30017
TAP	0,56390	-1,18073	1,06585	-0,24818	0,59856	-4,29464	0,35116	1,23285	0,62273
THAIR	0,06547	-2,95873	1,09727	-0,67618	2,41662	-1,62275	0,09457	1,61624	1,44446
TUAIR	0,64710	-0,12677	-0,14902	-0,03142	1,51499	4,74303	0,16360	0,78916	0,25282
UNAIR	1,16270	-0,46024	-1,19214	-0,11873	1,03750	10,04049	0,24866	0,90040	0,21386
Normalization of Criteria									
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	0,33435	-0,22333	-0,39743	-0,17109	0,11753	0,39227	0,29564	0,27565	0,13387
ACHN	0,06741	-0,06003	-0,02769	-0,05928	0,65385	0,07889	0,06850	0,20660	0,15385
AEA	0,27811	-0,15391	-0,43088	-0,16836	0,12043	0,43218	0,41198	0,27725	0,22427
ASAIR	0,12518	-0,03620	-0,06772	-0,03865	0,28520	0,29586	0,16982	0,26999	0,20538
COPAIR	0,41267	-0,21245	-0,06937	-0,16770	0,11477	0,06985	0,31194	0,19542	0,11444
CROAIR	0,46003	-0,18458	-0,24250	-0,51776	0,12906	0,17824	0,43743	0,25478	0,14396
EVA	0,33889	-0,01032	-0,00627	-0,01058	0,27815	0,10003	0,16730	0,22487	0,07474
LUF	0,18854	-0,13873	-0,71116	-0,18131	0,23647	0,66237	0,25066	0,28274	0,20129
SHEAIR	0,31582	0,08702	0,01515	0,05679	0,08719	0,04504	0,33949	0,14163	0,16274
TAP	0,15523	-0,33099	0,15633	-0,26418	0,10458	-0,09993	0,34617	0,36126	0,33762
THAIR	0,01802	-0,82941	0,16094	-0,71978	0,42221	-0,03776	0,09322	0,47361	0,78314
TUAIR	0,17813	-0,03554	-0,02186	-0,03345	0,26468	0,11036	0,16127	0,23125	0,13707
UNAIR	0,32006	-0,12902	-0,17486	-0,12639	0,18126	0,23362	0,24512	0,26385	0,11595

Multiplication of Normalized Matrices by Weight Values									
Criteria / Alternative	CR	PR1	PR2	PR3	AT	CA	FSR1	FSR2	FSR3
ACAN	0,03072	-0,03446	-0,04980	-0,02308	0,00438	0,02783	0,02519	0,03800	0,02173
ACHN	0,00619	-0,00926	-0,00347	-0,00800	0,02435	0,00560	0,00584	0,02848	0,02498
AEA	0,02555	-0,02375	-0,05399	-0,02271	0,00448	0,03066	0,03511	0,03822	0,03641
ASAIR	0,01150	-0,00559	-0,00849	-0,00521	0,01062	0,02099	0,01447	0,03722	0,03335
COPAIR	0,03792	-0,03278	-0,00869	-0,02262	0,00427	0,00496	0,02658	0,02694	0,01858
CROAIR	0,04227	-0,02848	-0,03039	-0,06985	0,00481	0,01264	0,03727	0,03512	0,02337
EVA	0,03114	-0,00159	-0,00079	-0,00143	0,01036	0,00710	0,01426	0,03100	0,01213
LUF	0,01732	-0,02141	-0,08912	-0,02446	0,00880	0,04699	0,02136	0,03897	0,03268
SHEAIR	0,02902	0,01343	0,00190	0,00766	0,00325	0,00319	0,02893	0,01952	0,02642
TAP	0,01426	-0,05108	0,01959	-0,03564	0,00389	-0,00709	0,02950	0,04980	0,05482
THAIR	0,00166	-0,12799	0,02017	-0,09710	0,01572	-0,00268	0,00794	0,06529	0,12715
TUAIR	0,01637	-0,00548	-0,00274	-0,00451	0,00986	0,00783	0,01374	0,03188	0,02225
UNAIR	0,02941	-0,01991	-0,02191	-0,01705	0,00675	0,01657	0,02089	0,03637	0,01882
Positive ideal solutions and negative ideal solutions									
A+	0,04227	0,01343	0,02017	0,00766	0,02435	0,04699	0,03727	0,01952	0,01213
A-	0,00166	-0,12799	-0,08912	-0,09710	0,00325	-0,00709	0,00584	0,06529	0,12715

The distance of each alternative to the positive ideal and negative ideal solution points and its success ranking				
Alternative	Di+	Di-	Ci	Rank
ACAN	0,09805	0,17340	0,63880	8
ACHN	0,07461	0,20443	0,73261	5
AEA	0,09843	0,17162	0,63550	9
ASAIR	0,06665	0,20132	0,75127	4
COPAIR	0,07928	0,19034	0,70595	7
CROAIR	0,11068	0,16971	0,60526	10
EVA	**0,05762**	**0,22029**	**0,79268**	**2**
LUF	0,12691	0,17232	0,57588	12
SHEAIR	**0,05609**	**0,22997**	**0,80392**	**1**
TAP	0,11385	0,16644	0,59381	11
THAIR	0,22660	0,11010	0,32700	13
TUAIR	**0,06522**	**0,20906**	**0,76221**	**3**
UNAIR	0,07409	0,19169	0,72122	6

APPENDIX 7: 2021 LOPCOW Analysis Results

Decision Matrix									
Target Criteria	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Min**	**Min**
Criteria / **Alternative**	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	1,45191	-0,56281	-400,22222	-0,11766	0,63663	3401,55556	0,32838	0,99971	0,22617
ACHN	0,33177	-0,23946	-0,28592	-0,06308	2,58588	4,53253	0,10187	0,77937	0,30706
AEA	1,24380	0,00751	0,02373	0,00329	0,95504	7,21041	0,45871	0,86131	0,36880
ASAIR	0,48963	-0,11909	-0,99177	-0,03950	1,69170	25,10603	0,19608	0,96017	0,41709
COPAIR	1,17632	0,02904	0,03374	0,01032	1,21888	3,26941	0,29160	0,69413	0,24789
CROAIR	1,24940	-0,40397	4,16266	-0,20347	1,36031	-20,45855	0,37026	1,04888	0,29635
EVA	1,39764	0,06431	0,07206	0,02053	1,59356	3,50904	0,20037	0,71502	0,14336
LUF	0,91779	-0,13033	-0,48797	-0,05151	1,24757	9,47394	0,31678	0,89445	0,34515
SHEAIR	0,93254	0,32845	0,09659	0,04923	0,68632	1,96198	0,21841	0,49031	0,23419
TAP	0,70976	-1,17789	3,41636	-0,33893	1,09596	-10,07974	0,26255	1,09921	0,37013
THAIR	0,52368	2,55483	-0,77351	0,34185	0,87000	-2,26271	0,15380	1,44195	0,29369
TUAIR	0,72750	0,08435	0,09280	0,02322	1,47998	3,90191	0,18602	0,74372	0,25570
UNAIR	1,19266	-0,07965	-0,39256	-0,02879	1,12824	13,63485	0,32040	0,92666	0,26864
Mak	1,45191	2,55483	4,16266	0,34185	2,58588	3401,55556	0,45871	1,44195	0,41709
Min	0,33177	-1,17789	-400,22222	-0,33893	0,63663	-20,45855	0,10187	0,49031	0,14336
Normalization of Criteria									
Criteria / **Alternative**	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	1,00000	0,16478	0,00000	0,32503	0,00000	1,00000	0,63477	0,46472	0,69747
ACHN	0,00000	0,25141	0,98900	0,40520	1,00000	0,00730	0,00000	0,69625	0,40197
AEA	0,81421	0,31757	0,98976	0,50269	0,16335	0,00809	1,00000	0,61015	0,17642
ASAIR	0,14093	0,28365	0,98725	0,43983	0,54127	0,01332	0,26402	0,50626	0,00000
COPAIR	0,75397	0,32334	0,98979	0,51302	0,29870	0,00693	0,53169	0,78582	0,61813
CROAIR	0,81922	0,20733	1,00000	0,19898	0,37126	0,00000	0,75214	0,41305	0,44108
EVA	0,95155	0,33279	0,98988	0,52802	0,49092	0,00700	0,27603	0,76387	1,00000
LUF	0,52317	0,28064	0,98850	0,42220	0,31342	0,00875	0,60225	0,57533	0,26280
SHEAIR	0,53633	0,40355	0,98995	0,57017	0,02550	0,00655	0,32659	1,00000	0,66818
TAP	0,33745	0,00000	0,99815	0,00000	0,23565	0,00303	0,45029	0,36016	0,17156
THAIR	0,17133	1,00000	0,98779	1,00000	0,11973	0,00532	0,14552	0,00000	0,45081
TUAIR	0,35328	0,33816	0,98994	0,53197	0,43265	0,00712	0,23582	0,73372	0,58959

UNAIR	0,76856	0,29422	0,98874	0,45557	0,25221	0,00996	0,61239	0,54148	0,54232	
Square Matrix										
Kriter / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**	
ACAN	1,00000	0,02715	0,00000	0,10564	0,00000	1,00000	0,40293	0,21596	0,48647	
ACHN	0,00000	0,06320	0,97812	0,16418	1,00000	0,00005	0,00000	0,48476	0,16158	
AEA	0,66294	0,10085	0,97963	0,25270	0,02668	0,00007	1,00000	0,37228	0,03112	
ASAIR	0,01986	0,08046	0,97467	0,19345	0,29297	0,00018	0,06971	0,25630	0,00000	
COPAIR	0,56848	0,10455	0,97968	0,26318	0,08922	0,00005	0,28270	0,61751	0,38208	
CROAIR	0,67112	0,04299	1,00000	0,03959	0,13783	0,00000	0,56571	0,17061	0,19455	
EVA	0,90545	0,11075	0,97987	0,27880	0,24101	0,00005	0,07619	0,58350	1,00000	
LUF	0,27371	0,07876	0,97713	0,17825	0,09823	0,00008	0,36270	0,33100	0,06907	
SHEAIR	0,28765	0,16285	0,97999	0,32509	0,00065	0,00004	0,10666	1,00000	0,44647	
TAP	0,11387	0,00000	0,99631	0,00000	0,05553	0,00001	0,20276	0,12971	0,02943	
THAIR	0,02935	1,00000	0,97574	1,00000	0,01433	0,00003	0,02118	0,00000	0,20323	
TUAIR	0,12481	0,11435	0,97997	0,28299	0,18719	0,00005	0,05561	0,53834	0,34762	
UNAIR	0,59068	0,08657	0,97760	0,20754	0,06361	0,00010	0,37503	0,29320	0,29411	
Total	5,24791	1,97248	11,77872	3,29143	2,20726	1,00070	3,52118	4,99317	3,64573	
m	13	13	13	13	13	13	13	13	13	
total/m	0,40369	0,15173	0,90606	0,25319	0,16979	0,07698	0,27086	0,38409	0,28044	
Square Root(total/m)	0,63536	0,38952	0,95187	0,50318	0,41205	0,27745	0,52044	0,61975	0,52957	
Standard Deviation (Standardization of Criteria)	0,32830	0,22679	0,27481	0,22738	0,26162	0,27544	0,27466	0,24543	0,26735	
Square Root(total/m)/Standard Deviation (Standardization of Criteria)	1,93531	1,71755	3,46379	2,21298	1,57502	1,00728	1,89483	2,52513	1,98081	
pwij	66,02652	54,08967	124,23629	79,43395	45,42691	0,72555	63,91265	92,62935	68,35079	594,83167
wj	0,11100	0,09093	0,20886	0,13354	0,07637	0,00122	0,10745	0,15572	0,11491	1
Rank	5	7	1	3	8	9	6	2	4	

APPENDIX 8: 2021 TOPSIS Analysis Results

Decision Matrix									
Target Criteria	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Min**	**Min**
Weight Value	0,11100	0,09093	0,20886	0,13354	0,07637	0,00122	0,10745	0,15572	0,11491
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	1,45191	-0,56281	-400,22222	-0,11766	0,63663	3401,55556	0,32838	0,99971	0,22617
ACHN	0,33177	-0,23946	-0,28592	-0,06308	2,58588	4,53253	0,10187	0,77937	0,30706
AEA	1,24380	0,00751	0,02373	0,00329	0,95504	7,21041	0,45871	0,86131	0,36880
ASAIR	0,48963	-0,11909	-0,99177	-0,03950	1,69170	25,10603	0,19608	0,96017	0,41709
COPAIR	1,17632	0,02904	0,03374	0,01032	1,21888	3,26941	0,29160	0,69413	0,24789
CROAIR	1,24940	-0,40397	4,16266	-0,20347	1,36031	-20,45855	0,37026	1,04888	0,29635
EVA	1,39764	0,06431	0,07206	0,02053	1,59356	3,50904	0,20037	0,71502	0,14336
LUF	0,91779	-0,13033	-0,48797	-0,05151	1,24757	9,47394	0,31678	0,89445	0,34515
SHEAIR	0,93254	0,32845	0,09659	0,04923	0,68632	1,96198	0,21841	0,49031	0,23419
TAP	0,70976	-1,17789	3,41636	-0,33893	1,09596	-10,07974	0,26255	1,09921	0,37013
THAIR	0,52368	2,55483	-0,77351	0,34185	0,87000	-2,26271	0,15380	1,44195	0,29369
TUAIR	0,72750	0,08435	0,09280	0,02322	1,47998	3,90191	0,18602	0,74372	0,25570
UNAIR	1,19266	-0,07965	-0,39256	-0,02879	1,12824	13,63485	0,32040	0,92666	0,26864
Normalization of Criteria									
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	0,39745	-0,19181	-0,99990	-0,21499	0,12944	0,99993	0,32720	0,30001	0,20999
ACHN	0,09082	-0,08161	-0,00071	-0,11526	0,52576	0,00133	0,10151	0,23389	0,28509
AEA	0,34048	0,00256	0,00006	0,00601	0,19418	0,00212	0,45706	0,25848	0,34242
ASAIR	0,13403	-0,04059	-0,00248	-0,07218	0,34395	0,00738	0,19538	0,28815	0,38725
COPAIR	0,32201	0,01008	0,00605	0,01931	0,24992	0,08315	0,30747	0,21837	0,23541
CROAIR	0,34202	-0,13768	0,01040	-0,37179	0,27658	-0,00601	0,36893	0,31477	0,27515
EVA	0,38260	0,02192	0,00018	0,03752	0,32400	0,00103	0,19965	0,21458	0,13311
LUF	0,25124	-0,04442	-0,00122	-0,09412	0,25366	0,00278	0,31564	0,26843	0,32046
SHEAIR	0,25528	0,11194	0,00024	0,08995	0,13954	0,00058	0,21763	0,14714	0,21744
TAP	0,19429	-0,40144	0,00854	-0,61932	0,22283	-0,00296	0,26161	0,32987	0,34365
THAIR	0,14336	0,87071	-0,00193	0,62465	0,17689	-0,00067	0,15325	0,43273	0,27268
TUAIR	0,19915	0,02875	0,00023	0,04243	0,30091	0,00115	0,18535	0,22319	0,23741
UNAIR	0,32648	-0,02714	-0,00098	-0,05261	0,22939	0,00401	0,31924	0,27809	0,24943

Multiplication of Normalized Matrices by Weight Values									
Criteria / Alternative	CR	PR1	PR2	PR3	AT	CA	FSR1	FSR2	FSR3
ACAN	0,04412	-0,01744	-0,20884	-0,02871	0,00989	0,00122	0,03516	0,04672	0,02413
ACHN	0,01008	-0,00742	-0,00015	-0,01539	0,04015	0,00000	0,01091	0,03642	0,03276
AEA	0,03779	0,00023	0,00001	0,00080	0,01483	0,00000	0,04911	0,04025	0,03935
ASAIR	0,01488	-0,00369	-0,00052	-0,00964	0,02627	0,00001	0,02099	0,04487	0,04450
COPAIR	0,03574	0,00092	0,00126	0,00258	0,01909	0,00010	0,03304	0,03401	0,02705
CROAIR	0,03796	-0,01252	0,00217	-0,04965	0,02112	-0,00001	0,03964	0,04902	0,03162
EVA	0,04247	0,00199	0,00004	0,00501	0,02474	0,00000	0,02145	0,03342	0,01530
LUF	0,02789	-0,00404	-0,00025	-0,01257	0,01937	0,00000	0,03391	0,04180	0,03682
SHEAIR	0,02834	0,01018	0,00005	0,01201	0,01066	0,00000	0,02338	0,02291	0,02499
TAP	0,02157	-0,03650	0,00178	-0,08270	0,01702	0,00000	0,02811	0,05137	0,03949
THAIR	0,01591	0,07918	-0,00040	0,08342	0,01351	0,00000	0,01647	0,06739	0,03133
TUAIR	0,02211	0,00261	0,00005	0,00567	0,02298	0,00000	0,01992	0,03476	0,02728
UNAIR	0,03624	-0,00247	-0,00020	-0,00703	0,01752	0,00000	0,03430	0,04331	0,02866
Positive ideal solutions and negative ideal solutions									
A+	0,04412	0,07918	0,00217	0,08342	0,04015	0,00122	0,04911	0,02291	0,01530
A-	0,01008	-0,03650	-0,20884	-0,08270	0,00989	-0,00001	0,01091	0,06739	0,04450

the distance of each alternative from the positive ideal and negative ideal solution points and its performance ranking				
Alternative	Di+	Di-	Ci	Rank
ACAN	0,26113	0,07661	0,22683	13
ACHN	0,14274	0,22570	0,61258	10
AEA	0,12093	0,23443	0,65970	6
ASAIR	0,13678	0,22520	0,62213	9
COPAIR	0,11702	0,23552	0,66806	4
CROAIR	0,16599	0,22006	0,57003	11
EVA	**0,11500**	**0,23705**	**0,67333**	**3**
LUF	0,13376	0,22612	0,62832	8
SHEAIR	**0,10835**	**0,24007**	**0,68902**	**2**
TAP	0,20943	0,21242	0,50355	12
THAIR	**0,06938**	**0,29099**	**0,80747**	**1**
TUAIR	0,11759	0,23395	0,66549	5
UNAIR	0,12744	0,22920	0,64267	7

APPENDIX 9: 2022 LOPCOW Analysis Results

Decision Matrix									
Target Criteria	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Min**	**Min**
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	1,03336	-0,10268	1,09325	-0,05761	1,71298	-18,97556	0,32755	1,05270	0,31698
ACHN	0,24053	-0,80277	-2,09836	-0,15314	2,52965	13,70198	0,07541	0,92702	0,31352
AEA	1,15495	0,07987	0,30675	0,05285	1,65812	5,80397	0,39905	0,82770	0,34551
ASAIR	0,47592	0,00427	0,03707	0,00197	2,18213	18,80168	0,21139	0,94681	0,44417
COPAIR	1,03540	0,11739	0,23326	0,07421	2,39923	3,14344	0,26348	0,68188	0,25447
CROAIR	1,61850	-0,09799	-1,46159	-0,08128	1,69333	17,98265	0,48986	0,94194	0,30022
EVA	1,09151	0,05666	0,08129	0,02448	1,62957	3,32015	0,26516	0,69881	0,24293
LUF	0,86148	0,02414	0,09334	0,01825	2,14815	5,11388	0,35202	0,80445	0,40863
SHEAIR	0,62730	0,12468	0,03508	0,01450	0,50954	2,41842	0,22830	0,58651	0,36394
TAP	0,86557	0,01894	0,15707	0,01109	1,81939	14,16070	0,32183	0,92938	0,37181
THAIR	0,93947	-0,00242	0,00354	-0,00127	1,73680	-2,79027	0,30177	1,35839	0,32121
TUAIR	0,87701	0,15243	0,26144	0,08198	2,30333	3,18900	0,23350	0,68642	0,26624
UNAIR	1,00320	0,01644	0,10765	0,01098	2,24125	9,80757	0,29791	0,89804	0,29696
Mak	1,61850	0,15243	1,09325	0,08198	2,52965	18,80168	0,48986	1,35839	0,44417
Min	0,24053	-0,80277	-2,09836	-0,15314	0,50954	-18,97556	0,07541	0,58651	0,24293
Normalization of Criteria									
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	0,57536	0,73292	1,00000	0,40629	0,59573	0,00000	0,60837	0,39603	0,63204
ACHN	0,00000	0,00000	0,00000	0,00000	1,00000	0,86501	0,00000	0,55886	0,64920
AEA	0,66360	0,92404	0,75357	0,87611	0,56857	0,65594	0,78089	0,68752	0,49024
ASAIR	0,17082	0,84489	0,66907	0,65971	0,82797	1,00000	0,32809	0,53321	0,00000
COPAIR	0,57684	0,96331	0,73055	0,96693	0,93544	0,58551	0,45378	0,87644	0,94263
CROAIR	1,00000	0,73784	0,19951	0,30565	0,58600	0,97832	1,00000	0,53952	0,71532
EVA	0,61756	0,89974	0,68293	0,75546	0,55444	0,59019	0,45783	0,85451	1,00000
LUF	0,45062	0,86569	0,68671	0,72896	0,81115	0,63767	0,66742	0,71764	0,17659
SHEAIR	0,28068	0,97094	0,66845	0,71301	0,00000	0,56632	0,36890	1,00000	0,39866
TAP	0,45359	0,86025	0,70668	0,69850	0,64841	0,87715	0,59457	0,55579	0,35954
THAIR	0,50723	0,83788	0,65857	0,64593	0,60752	0,42844	0,54616	0,00000	0,61100
TUAIR	0,46190	1,00000	0,73938	1,00000	0,88797	0,58672	0,38144	0,87056	0,88415

UNAIR	0,55347	0,85763	0,69119	0,69801	0,85724	0,76192	0,53685	0,59640	0,73151	
Square Matrix										
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**	
ACAN	0,33104	0,53718	1,00000	0,16507	0,35490	0,00000	0,37011	0,15684	0,39948	
ACHN	0,00000	0,00000	0,00000	0,00000	1,00000	0,74824	0,00000	0,31232	0,42147	
AEA	0,44037	0,85385	0,56787	0,76756	0,32328	0,43025	0,60979	0,47269	0,24033	
ASAIR	0,02918	0,71385	0,44766	0,43522	0,68553	1,00000	0,10764	0,28431	0,00000	
COPAIR	0,33275	0,92797	0,53370	0,93496	0,87505	0,34282	0,20592	0,76816	0,88855	
CROAIR	1,00000	0,54441	0,03980	0,09342	0,34340	0,95711	1,00000	0,29108	0,51168	
EVA	0,38139	0,80954	0,46640	0,57072	0,30741	0,34832	0,20961	0,73019	1,00000	
LUF	0,20306	0,74942	0,47157	0,53138	0,65796	0,40662	0,44545	0,51501	0,03119	
SHEAIR	0,07878	0,94273	0,44683	0,50839	0,00000	0,32072	0,13608	1,00000	0,15893	
TAP	0,20575	0,74003	0,49939	0,48791	0,42043	0,76939	0,35351	0,30891	0,12927	
THAIR	0,25728	0,70205	0,43372	0,41722	0,36908	0,18356	0,29829	0,00000	0,37333	
TUAIR	0,21335	1,00000	0,54668	1,00000	0,78849	0,34424	0,14549	0,75787	0,78172	
UNAIR	0,30633	0,73553	0,47774	0,48722	0,73485	0,58052	0,28821	0,35569	0,53510	
Total	3,77927	9,25655	5,93136	6,39907	6,86038	6,43179	4,17012	5,95306	5,47104	
m	13	13	13	13	13	13	13	13	13	
total/m	0,29071	0,71204	0,45626	0,49224	0,52772	0,49475	0,32078	0,45793	0,42085	
Square Root(total/m)	0,53918	0,84383	0,67547	0,70160	0,72644	0,70339	0,56637	0,67670	0,64873	
Standard Deviation (Standardization of Criteria)	0,24407	0,25554	0,25428	0,27396	0,25724	0,26310	0,24013	0,25784	0,29420	
Square Root(total/m)/Standard Deviation (Standardization of Criteria)	2,20909	3,30212	2,65635	2,56096	2,82402	2,67351	2,35861	2,62449	2,20510	
pwij	79,25811	119,45654	97,69548	94,03812	103,81631	98,33905	85,80732	96,48869	79,07711	853,97673
wj	0,09281	0,13988	0,11440	0,11012	0,12157	0,11515	0,10048	0,11299	0,09260	1
Rank	8	1	4	6	2	3	7	5	9	

APPENDIX 10: 2022 TOPSIS Performance Results

Decision Matrix									
Target Criteria	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Max**	**Min**	**Min**
Weight Values	0,09281	0,13988	0,11440	0,11012	0,12157	0,11515	0,10048	0,11299	0,09260
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	1,03336	-0,10268	1,09325	-0,05761	1,71298	-18,97556	0,32755	1,05270	0,31698
ACHN	0,24053	-0,80277	-2,09836	-0,15314	2,52965	13,70198	0,07541	0,92702	0,31352
AEA	1,15495	0,07987	0,30675	0,05285	1,65812	5,80397	0,39905	0,82770	0,34551
ASAIR	0,47592	0,00427	0,03707	0,00197	2,18213	18,80168	0,21139	0,94681	0,44417
COPAIR	1,03540	0,11739	0,23326	0,07421	2,39923	3,14344	0,26348	0,68188	0,25447
CROAIR	1,61850	-0,09799	-1,46159	-0,08128	1,69333	17,98265	0,48986	0,94194	0,30022
EVA	1,09151	0,05666	0,08129	0,02448	1,62957	3,32015	0,26516	0,69881	0,24293
LUF	0,86148	0,02414	0,09334	0,01825	2,14815	5,11388	0,35202	0,80445	0,40863
SHEAIR	0,62730	0,12468	0,03508	0,01450	0,50954	2,41842	0,22830	0,58651	0,36394
TAP	0,86557	0,01894	0,15707	0,01109	1,81939	14,16070	0,32183	0,92938	0,37181
THAIR	0,93947	-0,00242	0,00354	-0,00127	1,73680	-2,79027	0,30177	1,35839	0,32121
TUAIR	0,87701	0,15243	0,26144	0,08198	2,30333	3,18900	0,23350	0,68642	0,26624
UNAIR	1,00320	0,01644	0,10765	0,01098	2,24125	9,80757	0,29791	0,89804	0,29696
Normalization of Criteria									
Criteria / Alternative	**CR**	**PR1**	**PR2**	**PR3**	**AT**	**CA**	**FSR1**	**FSR2**	**FSR3**
ACAN	0,29692	-0,12035	0,38639	-0,25820	0,24310	-0,47059	0,29770	0,32694	0,26514
ACHN	0,06911	-0,94088	-0,74162	-0,68631	0,35899	0,33980	0,06854	0,28791	0,26225
AEA	0,33186	0,09362	0,10841	0,23685	0,23531	0,14394	0,36269	0,25706	0,28901
ASAIR	0,13675	0,00501	0,01310	0,00883	0,30968	0,46628	0,19213	0,29406	0,37153
COPAIR	0,29751	0,13758	0,08244	0,33256	0,34049	0,07796	0,23947	0,21177	0,21286
CROAIR	0,46505	-0,11484	-0,51657	-0,36425	0,24031	0,44596	0,44523	0,29254	0,25112
EVA	0,31363	0,06641	0,02873	0,10973	0,23126	0,08234	0,24100	0,21703	0,20320
LUF	0,24753	0,02829	0,03299	0,08180	0,30485	0,12682	0,31995	0,24984	0,34180
SHEAIR	0,18025	0,14613	0,01240	0,06500	0,07231	0,05998	0,20750	0,18215	0,30442
TAP	0,24871	0,02220	0,05551	0,04971	0,25820	0,35118	0,29251	0,28864	0,31101
THAIR	0,26994	-0,00284	0,00125	-0,00569	0,24648	-0,06920	0,27427	0,42188	0,26868
TUAIR	0,25200	0,17866	0,09240	0,36740	0,32688	0,07909	0,21222	0,21318	0,22270
UNAIR	0,28826	0,01927	0,03805	0,04919	0,31807	0,24322	0,27077	0,27891	0,24839

Multiplication of Normalized Matrices by Weight Values									
Criteria / Alternative	CR	PR1	PR2	PR3	AT	CA	FSR1	FSR2	FSR3
ACAN	0,02756	-0,01683	0,04420	-0,02843	0,02955	-0,05419	0,02991	0,03694	0,02455
ACHN	0,00641	-0,13161	-0,08484	-0,07558	0,04364	0,03913	0,00689	0,03253	0,02428
AEA	0,03080	0,01310	0,01240	0,02608	0,02861	0,01657	0,03644	0,02904	0,02676
ASAIR	0,01269	0,00070	0,00150	0,00097	0,03765	0,05369	0,01931	0,03322	0,03440
COPAIR	0,02761	0,01925	0,00943	0,03662	0,04139	0,00898	0,02406	0,02393	0,01971
CROAIR	0,04316	-0,01606	-0,05910	-0,04011	0,02921	0,05135	0,04474	0,03305	0,02325
EVA	0,02911	0,00929	0,00329	0,01208	0,02811	0,00948	0,02422	0,02452	0,01882
LUF	0,02297	0,00396	0,00377	0,00901	0,03706	0,01460	0,03215	0,02823	0,03165
SHEAIR	0,01673	0,02044	0,00142	0,00716	0,00879	0,00691	0,02085	0,02058	0,02819
TAP	0,02308	0,00311	0,00635	0,00547	0,03139	0,04044	0,02939	0,03261	0,02880
THAIR	0,02505	-0,00040	0,00014	-0,00063	0,02996	-0,00797	0,02756	0,04767	0,02488
TUAIR	0,02339	0,02499	0,01057	0,04046	0,03974	0,00911	0,02132	0,02409	0,02062
UNAIR	0,02675	0,00270	0,00435	0,00542	0,03867	0,02801	0,02721	0,03151	0,02300
Positive ideal solutions and negative ideal solutions									
A+	0,04316	0,02499	0,04420	0,04046	0,04364	0,05369	0,04474	0,02058	0,01882
A-	0,00641	-0,13161	-0,08484	-0,07558	0,00879	-0,05419	0,00689	0,04767	0,03440

the distance of each alternative from the positive ideal and negative ideal solution points and its performance ranking				
Alternative	Di+	Di-	Ci	Rank
ACAN	0,13819	0,18349	0,57042	11
ACHN	0,24043	0,10127	0,29636	13
AEA	**0,05762**	**0,21910**	**0,79179**	**1**
ASAIR	0,07737	0,20903	0,72985	8
COPAIR	**0,06279**	**0,22541**	**0,78213**	**3**
CROAIR	0,13869	0,17306	0,55512	12
EVA	0,07454	0,20329	0,73171	6
LUF	0,07366	0,20054	0,73135	7
SHEAIR	0,08787	0,20546	0,70044	9
TAP	0,06591	0,20867	0,75995	4
THAIR	0,09827	0,18305	0,65069	10
TUAIR	**0,06395**	**0,23086**	**0,78310**	**2**
UNAIR	0,06864	0,20352	0,74780	5

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Workplace Conflict Effect on Innovative Behavior: The Roles of Engagement and Proactive Personality

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ABSTRACT

Conflict is as natural a phenomenon as harmony in social relations. In all industries, especially those prioritizing collaborative teamwork, it is clear that effective conflict management is critical to sustaining positive employee relationships. With this study, we set out to investigate the impact of workplace conflicts on employee innovation. For this purpose, data were collected from employees through a survey conducted in the aviation industry in Turkey, and 393 responses were received. Structural Equation Modeling was used for hypothesis testing. The study revealed that conflict with colleagues has a detrimental impact on both innovative behaviors and work engagement. Work engagement was identified as a complete mediator in the relationship between conflict and innovative behaviors. Furthermore, a proactive personality was found to moderate the influence of conflict on innovative behaviors, also playing a significant role in the indirect relationship among these variables. The research concludes with practical recommendations for managers and suggestions to researchers for future studies.

Keywords: Conflict with Colleagues, Innovative Behaviors, Work Engagement, Proactive Personality.

JEL Classification Codes: MM12, O15, J24

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INTRODUCTION

Humans have the inherent ability to exercise agency and cultivate equilibrium within their environment, thus ensuring the continuity of their existence. Nonetheless, when disparities in needs and aspirations arise among individuals, the process of adaptation inevitably encounters obstacles, giving rise to tensions and conflicts. Conflict could be defined as a process that begins with the perception that something that one of the parties values is about to negatively affect or negatively affects the other party (Robbins & Judge, 2015), as a state of interaction that occurs in the form of incompatibility or disagreement between individuals and groups (Rahim, 1985). According to Thomas (1992), conflict can be characterized as the unfolding of events initiated when one party observes that another has obstructed or is about to obstruct a matter of concern to them.

In exploring theories that elucidate conflict, it is essential to consider two prominent perspectives. The social exchange theory offers valuable insights by suggesting that individuals aim to maximize rewards while minimizing costs, thus favoring situations where rewards surpass costs. This theory delves into behavioral outcomes within diverse social contexts, encompassing factors such as age, race, gender, and class, spanning domains like marriage, sexuality, and employment (Blumer, 1975; Mead, 1934; Thibaut & Kelley, 1959; Emerson, 1962). It presents a comprehensive framework incorporating concepts such as exchange, reciprocity, agreement, behavioral sources, cost-benefit analysis, distributive justice, honest exchange, and power dynamics. Complementing this perspective, Lewin's field theory offers further insights into the interplay between individuals and their organizational environment, influencing behaviors. For instance, employees often exhibit positive outcomes when they operate within a conducive and meaningful work environment. When employees' roles and organizational objectives are well-aligned, it fosters motivation and dedication to their work and the organization (Burnes & Cooke, 2013).

Coping with conflicts and managing them is an element that will increase organisations' productivity and success (Thomas, 1992). Companies should cease regarding conflict as inherently negative and detrimental. Instead, they should actively strive to resolve conflicts efficiently and proactively. It's essential to acknowledge that promoting engagement and fostering innovative behavior greatly relies on employees' awareness of the conflict management climate (Jung & Yoon, 2018). It is important to have optimal conflict management to maintain good interpersonal relationships, especially among employees in sectors teamwork is important (Lee & Hyun, 2016). With the culture fostering collaborative

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conflict management has a positive impact on both job satisfaction and perceived work productivity (Choi & Ha, 2018). Due to a weak link in the chain, work harmony can deteriorate quickly. After all such performance failure in the team and the avoidance approaches that will be shown toward conflicts may have a negative impact on the achievement of the company's goals and may hinder harmony and innovative behavior in the workplace (Seedhouse, 2020).

This research examines the impact of interpersonal conflict on innovative behavior in organizations, with a focus on the air transportation sector. Additionally, the study evaluates the moderating and mediating effects of two other variables: work engagement and proactive personality. Understanding the effects of conflict on innovative behavior, which is critical to the development of air transportation, is essential for organizations. To the best of the authors' knowledge, this is one of the first few studies to examine the mechanism through which interpersonal conflict impacts innovative behavior and this is the first study in the context of the Turkish aviation sector. The findings are anticipated to provide insights for managerial practices in the workplace and to contribute to the existing literature on related topics.

Theoretical Framework and Hypotheses

The Effect of Conflict with Colleagues on Innovative Behaviors

Innovation is fostered within an integrative organizational structure and culture that places emphasis on and supports diversity, belief in the abilities of employees, cooperation, and teamwork (Kanter, 1988). The introduction of a new idea or the acceptance, realization, and implementation of an idea put forward by others is defined as innovative behavior (West & Farr, 1989; Yuan & Woodman, 2010). The discovery or acceptance of innovative ideas could be an individual activity; however, the innovation must be implemented and accepted collectively by the organization, and management processes must be carried out correctly so that such an activity could be considered an innovation (Van De Ven, 1986).

The climate in the work environment has a significant impact on the employee performance in workplaces. Interpersonal conflict is the most common stress factor at work, and occupational factors such as monotonous work at a busy pace and status are closely related to interpersonal conflicts at work (Appelberg et al., 1991). In these processes, employees often experience conflicts related to their jobs while interacting with colleagues or delivering service to customers (Lee & Hyun 2016). Only enterprises with a resource-rich working environment can ensure that job demands can be met, especially when there are high job demands, and thus they can encourage employee engagement in their work (Bakker et al., 2011).

Jung & Yoon (2018) highlight the importance for organizations to foster a positive approach toward conflict, encouraging the development of innovative behaviors. They suggest that viewing conflicts as opportunities and actively resolving them can enhance innovative contributions. Conversely, avoiding conflicts is linked to reduced innovative behaviors. Therefore, organizations should prioritize implementing effective conflict management strategies to cultivate a culture that promotes employees' innovative potential. According to Chen et al. (2012), integrative conflict management is positively related to job satisfaction and innovative behaviors. Accordingly, when the conciliatory approach increases, job satisfaction and innovative behaviors increase as they are positively affected. Innovative behaviors are considered to contribute significantly to increased organizational success by enhancing organizational performance and providing a competitive advantage (Bakker & Schaufeli, 2008; Lee & Hyun, 2016).

Based on the studies stated above and the relevant literature, it can be concluded that conflicts among employees have effects on their innovative behavior, as expressed in the following hypothesis:

H1. Conflict with colleagues significantly affects the innovative behavior of employees.

The mediating Role of Work Engagement

The concept of engagement was first introduced by Kahn (1990). According to Kahn, engagement refers to the ability of organizational members to physically, cognitively and emotionally involve themselves in their work roles (Kahn, 1990). Schaufeli et al. (2002) define work engagement as a positive mood associated with job involvement, dedication and vigor. Engaged employees demonstrate enthusiasm in their tasks, feel a sense of significance in their roles, and possess the capability to effectively manage work demands. Consequently, burnout and work engagement are distinct concepts that warrant separate measurement tools. On the other hand, Maslach & Leiter (2016) define work engagement from a different perspective, considering it the antithesis of burnout. They define burnout as a psychological syndrome that arises as a long-term reaction to enduring interpersonal stressors in the workplace.

Engaged employees tend to experience positive emotions more frequently, such as happiness, joy, and enthusiasm. Consequently, they cultivate their own resources and transmit the positive aspects of their engagement to their peers (Bakker & Demerouti, 2008; Schaufeli & Salanova, 2007). These employees often demonstrate behaviors such as belief in the organization, a drive for continuous improvement, a deep understanding of business demands and the broader context, as well as showing respect and support towards colleagues. They also exhibit a proactive approach to advancement and maintain up-to-date

knowledge about developments in their field (Robinson et al., 2004). According to Schaufeli and Salanova (2007: 167), work engagement correlates with positive organizational outcomes on both attitudinal and behavioral levels, including increased job satisfaction, organizational commitment, engagement in extra-role activities, and enhanced performance. Moreover, work engagement is closely linked to mental well-being.

There are many studies examining the relationship between work engagement, conflict, and innovative behavior. Agarwal et al. (2011) state that the quality of direct interactions between employees and their supervisors affects the level of employee engagement. According to this, work engagement is positively related to innovative work behavior and negatively related to the intention to quit work. While work engagement mediates the relationship between work engagement, leader-member interaction, and innovative business behavior, it also partially mediates the intention to quit the job. Chen & Huang (2016) argue that employee engagement could increase innovative behavior, and engagement can reduce task conflict, suggesting that managers should invest in increasing employee engagement instead of using available resources for other applications. According to Jung & Yoon (2018), if businesses stop considering conflict as negative and harmful and make more efforts to solve conflict efficiently and actively, and when employees are positively affected by this new conflict management climate, their level of engagement in work increases, which leads to increased innovative behavior. Work engagement has a full mediating effect between conflict management and innovative behaviors.

Based on the current empirical results and previous studies, the following hypotheses were developed regarding the relationship between work engagement, conflict with colleagues, and innovative behaviors:

H2. Conflict with colleagues significantly affects employees' work engagement.

H3. Work engagement significantly affects employees' innovative behavior.

H4. Work engagement has a mediating effect between conflict with colleagues and innovative behaviors.

The Moderating Role of Proactive Personality

Proactivity is strongly linked to job performance, encompassing key behaviors essential for achieving work-related objectives (Crant, 1995). Frese & Fay (2001) define proactivity as the ability to anticipate opportunities and threats before they arise and to take proactive action. It can be argued that individuals with higher levels of proactivity exhibit a greater willingness to enhance their work performance, such as through improved communication with superiors or colleagues and providing constructive feedback. Proactive individuals are more inclined towards career development, psychological empowerment, and self-improvement, demonstrating conscientious task execution and efficient energy utilization in pursuit of their goals. Moreover, they excel in establishing effective communication networks (Fuller & Marler 2009).

Numerous studies highlight the positive impact of proactive employees in the workplace. Spizmuller et al. (2015, 35) assert that proactive personality correlates positively with both job performance and organizational citizenship behavior. Proactive individuals demonstrate an aptitude for recognizing and seizing opportunities, taking initiative to effect meaningful change. Bakker et al. (2012) underscore that employees capable of proactively adapting their work environment exhibit stronger organizational commitment and enhanced performance, with proactive tendencies correlating with higher levels of organizational citizenship. Dikkers et al. (2010) posit that proactive personalities represent a valuable personal resource that positively influences employees' engagement with their work. With support from colleagues and managers, proactive individuals can cultivate increasingly high levels of work engagement over time.

Studies examining the effect of proactive personality on individuals'creativity and innovative behaviors have found that proactive personality positively affects employees' creativity and that managerial support enhances this relationship (Kim et al., 2009). Additionally, proactive individuals are less affected by interpersonal conflicts due to their higher work engagement compared to others, resulting in minimal changes in their performance (Li et al., 2014). In the aviation sector, where even minor mistakes can have severe consequences, employees' individual characteristics and abilities are critically important. Air transportation employees work in shift systems in extremely stressful environments under time pressure, often dealing with passengers who do not adhere to established rules. Ultimately, conflicts become inevitable in this working environment. In the aviation sector, service quality is closely linked to employee-customer interactions (Yelgin & Ergün, 2022). Ji et al., (2019) investigated the effect of proactive personality on the safe behavior of airline cabin crew and concluded that proactive personality has a positive, albeit indirect, effect on the safe behavior attitudes of cabin crew.

Considering the importance of exploring the relationship between proactive personality as a predictor of proactive behaviors, and variables such as conflicts with colleagues, work engagement, and innovative behavior, the following hypotheses were formulated:

H5. Proactive personality has a moderating effect on the relationship between conflict with colleagues and innovative behavior.

H6. Proactive personality has a moderating effect on the indirect effect of conflict with colleagues on innovative behaviors through work engagement.

In this study, the following situational mediation model, in line with the empirical research in the literature, was created (See Figure 1).

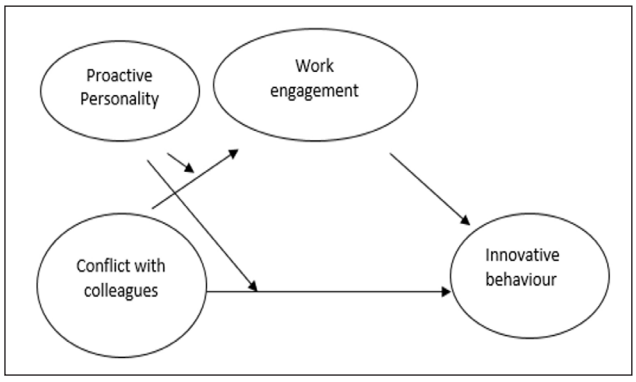

Figure 1: Research Model

RESEARCH METHODOLOGY

Participants

Due to the challenges associated with accessing the entire population, researchers often focus on a research universe perceived as a representative subset. For this study, the selection of the research universe was guided by a focus on a field emphasizing teamwork, intense communication and interaction, and where personnel performance significantly influences organizational outputs. Hence, the aviation sector was deemed suitable for this purpose. The research sample consists of employees who voluntarily participated in the study at the offices of aviation organisations carrying out ground services in different provinces of Turkey.

Before administering the survey, a pilot study was conducted on 30 employees to determine how the survey statements would be perceived by the aviation employees who would fill it out. Through face-to-face interviews during this pilot study, it was understood that there were no statements that would be misunderstood by the employees. Subsequently, the researcher delivered a total of 420 surveys to the offices of the aviation organization. During the survey administration stage, employees were briefed about the research, and the content and scope of the surveys were explained to the participants. The researcher clarified any statements that participants had misunderstood while filling out the questionnaires, ensuring accurate completion. Ultimately, the study obtained 393 valid questionnaires constituting the sample. According to Kline (2005), a sample size of 384 is considered sufficient to make generalizations about the research population.

Scales

The study employed a survey technique, a widely used quantitative research method, for data collection. The survey comprised two sections: the first aimed to gather participants' demographic information (age, gender, marital status, education level, tenure at the institution, city of work, and position within the organization), while the second included questions from four different scales pertaining to the research variables.

The scale of conflict with colleagues: The levels of conflict that participants experienced with their colleagues were measured with a scale consisting of four statements adapted into Turkish from Janssen (2003) (Topçu et. al., 2018). The Cronbach Alpha coefficient of the scale was calculated as 0.86. The scale includes the following questions: "Do you and your colleagues have conflicts about work-related issues?", "Do you and your colleagues have different opinions on some workplace issues?", "Do you experience conflicts in personal relationships between you and your coworkers?" and "Do you and your colleagues have different perspectives on work-related issues?".

The scale of innovative behavior: The innovative behavior scale used in this study is a one-dimensional scale consisting of six items used and validated by Scott & Bruce (1994), and is quite commonly used in Turkey. The reliability of the scale in the original language was 0.89. The scale was adapted into Turkish by Çalışkan, Akkoç &Turunç (2019). The scale was found to have a single-factor structure in Turkish as in its original form.

The scale of work engagement: To find out the level of employees' work engagement, the 17-expression *Utrecht Work Engagement Scale (UWES)* developed by Schaufeli et al. (2002) was shortened to nine items by Schaufeli et al. (2006), and then used in this study. The validity and reliability of the scale were tested and adapted to Turkish by Özkalp & Meydan (2015). The nine-item version of the scale consists of three dimensions: vigour, engagement and concentration. Each of these dimensions is measured with three items. The Cronbach Alpha value was found to be 0.94 for the one-dimensional version of the scale with nine items.

The scale of proactive personality: The shortened *Proactive Personality Scale* developed by Bateman and Crant (1993) and later revised by Claes, Beheydt and Lemmens (2005) was used to measure the proactive personality characteristics of employees in the study. The shortened proactive personality scale consists of 10 items. The internal consistency and reliability coefficients of the shortened form of the scale were found to be 0.76 and 0.86. The scale was adapted into Turkish by Akın et al. (2011).

Table 1: *Correlations, Validity, Reliabilty and Means among Variables*

	1	2	3	4	α	KMO	Mean
1 Proactive personality	1				0.850	0.872	4.22
2 Conflict with colleagues	.06	1			0.749	0.716	3.21
3 Work engagement	.48**	-.181**	1		0.881	0.831	4.15
4 Innovative behavior	.48**	-.15**	.54**	1	0.847	0.834	4.00

Notes: n = 393. *p < .05. **p < .01.

Data Analysis

After collecting the data, the subsequent stage involved data analysis. During this stage, it is crucial to select analysis methods that align with the research, the structure of the scales, and the variables under investigation. The collected data were analyzed using the SPSS and Amos programs. Descriptive analyses, factor analyses, and structural equation modeling were employed for this purpose.

Exploratory and confirmatory factor analyses were performed to measure the validity of the scales used in the research. The survey items were extensively reviewed in light of the relevant literature to ensure content validity, and the suitability of the scales was confirmed by interviewing field experts and managers. The scales used in this study are the scales previously used in some academic studies, and so the validity and reliability of them had been tested and confirmed. Cronbach α values of the scales used in the study were found to be between 0.749 and 0.881, and α is considered to have an acceptable reliability when above 0.70 (Nunnally, 1978). Kaiser-Meyer Olkin (KMO) and Bartlett tests were performed to determine the suitability of the data collected through the scales for factor analysis. Although all KMO values were found to be above 0.70, Bartlett values of the variables were found to be significant (p<0.000). These results reveal that the scales used in the study to measure the validity are suitable for factor analysis. When examining the correlation values, significant relationships between variables were identified. The "conflict with colleagues" variable was negatively correlated with both innovative behaviors and work engagement. Positive and significant relationships were observed for the other variables (see Table 1).

Following the validity and reliability analyses, the data analysis stage was started, and the relationships between variables were tested through the Structural Equation Model. In order to determine the validity of the scales used in the research, the varimax rotational Confirmatory Factor Analysis (CFA) was applied to the items that were previously determined to be suitable for factor analysis by the principle components analysis method. With CFA, when eigenvalues are greater than 1, a factor is established. Accordingly, based on the factor analysis applied to the Work Engagement Scale consisting of three dimensions and nine items, the third item was removed from the scale as it was found to have loaded another dimension and the 7th item was removed from the scale as its loading value was below 0.400. The remaining seven items in the structure were found to explain 58.65% of the structure under one dimension. The other three scales retained their single-factor structures. The factor load values of the expressions included in all scales were found to be above 0.400.

In addition, the scales were examined with DFA to determine the compatibility of the factor structure obtained with the exploratory factor analysis. Based on the DFA analysis, relevant modifications were made by combining the items that had a high relationship on the scales whose relationship could easily be defined. Following the modifications, the fit values were found to have increased and single-factor models had acceptable compliance values (See Table 2).

Table 2: *The values of single-factor DFA models*

Index	Conflict with Colleagues	Innovative Behavior	Work Engagement	Proactive Personality	Acceptable Compliance
χ^2	2,654	15,756	54,468	84,055	-
Df	1	6	12	33	-
P	0,103	0,015	0,000	0,000	-
χ^2/df	2,654	2,626	4,789	2,547	<5
TLI	0,974	0,989	0,906	0,943	>,90
CFI	0,996	0,973	0,946	0,958	>,90
RMSEA	0,065	0,064	0,078	0,063	<,08
SRMR	0,013	0,020	0,081	0,040	<,10

RESULTS

Participants

Several key findings emerged from the survey results based on the demographic characteristics of participants. The results show that the group under the age of 30 (*n*= 134; 34.1%) constituted the largest segment. When the gender distribution of employees was considered, the number of males (*n*= 264; 67.2%) was found to be more than twice the number of females (*n*= 129; 32.8%). Regarding marital status, the number of married individuals (*n*=189, 48.1%) was nearly equivalent to the number of single individuals (*n*=197; 50.1%), indicating that nearly half of the employees were married. Upon examining the educational status of the employees, those holding undergraduate degrees (*n*= 166; 42.2%) constituted the majority, followed by those with high school degrees (*n*= 140; 35.6%). Regarding employee titles, those occupying office positions were the most represented (*n*= 180; 45.8%), indicating that approximately half of all participants held office roles.

Analysis of the Indirect Effect

An indirect effect is an effect that occurs when a third variable or variables mediate the effect between two variables. The simple relationship that exists between two variables is not sufficient to explain the relationship between variables in depth. In order to fully understand the causal relationship between these two variables, determining how this relationship occurs through a connection (mediation) or under what circumstances it can change (moderating) is very important for understanding social reality (Memon at., 2019).

Three different methods are usually used in indirect effect analysis: regression analysis, structural equation modelling and process macro analysis. The method used in this study is *Structural Equation Modeling (SEM)*. In SEM, causal relationships that are theoretically thought to exist between variables are tested through structural models and current relationships are determined by this analysis. Although path analysis with observed variables is similar to traditional regression analyses, what makes it superior to these analyses is that it allows multiple relationships to be tested at the same time. For this reason, SEM models are preferred more in cases where it is desired to test the moderating effects between variables and to test complex variables (Byrne, 2016).

The Mediating Effect of Work Engagement

Among the approaches employed in testing mediation models, the Baron and Kenny method, also referred to as the classical approach, stands out as the most widely employed causal step approach. According to this approach, four criteria must be met for the mediation test to be performed, which are listed below (Baron & Kenny, 1986).

1. The relationship between the independent and dependent variables should be statistically significant,
2. The relationship between the independent and mediating variables should be statistically significant,
3. When used together with the independent variable, the relationship between the mediating variable and dependent variable should be statistically significant,
4. If the relationship between the dependent variable and independent variable becomes statistically non-significant when the independent and the mediating variable are handled together in the analysis, then the full mediation effect occurs, if the relationship decreases, the partial mediation effect occurs.

According to Baron and Kenny, if a variable that is claimed to be a mediating variable meets four criteria, it is called the mediating variable. Baron & Kenny's approach was adopted in this study, and the mediation effect was analyzed following the stages stated above.

Stage 1: The independent variable (Conflict with colleagues) has a significant impact on the dependent variable (Innovative behavior of employees)

According to the results obtained with the path analysis conducted with the observed variables, it was found that the effect of employees' conflict levels with colleagues on innovative behaviors was statistically significant and negative at the 99% confidence level (r=-0.156; p=0.000). Thus, a 1-unit increase in the level of conflict with colleagues reduces innovative behavior by 0.156 units. Therefore, conflict has a reducing effect on innovative behaviors. Based on these results, the H1 hypothesis "Conflict with colleagues significantly affects the innovative behavior of employees" was accepted.

Stage 2: The independent variable (Conflict with colleagues) significantly affects the mediating variable (work engagement).

According to the results of the path analysis conducted with the observed variables, it was found that the effect of conflict with colleagues on work engagement was statistically significant and negative at the 99% confidence level (r=-0.181; p=0.000). According to these results, a 1-unit increase in the level of conflict with colleagues reduces the level of work engagement by 0.181 units. Based on this analysis, the H2 hypothesis "Conflict with colleagues significantly affects employees' work engagement" was accepted.

Stage 3: The mediating variable (work engagement) significantly affects the dependent variable (innovative behaviors).

According to the results of the path analysis with the observed variables, there is a statistically significant and positive effect of the direct effect of work engagement on innovative behaviors in the 99% confidence level (r= -0.542; p=0.000) (See Figure 2). Accordingly, a 1-unit change in employee engagement leads to a 0.542-unit change in innovative behavior, which indicates that the increase or decrease in the level of engagement of employees changes proportionally in innovative behaviors. Therefore, the H3 hypothesis "Work engagement significantly affects the innovative behavior of employees" was accepted.

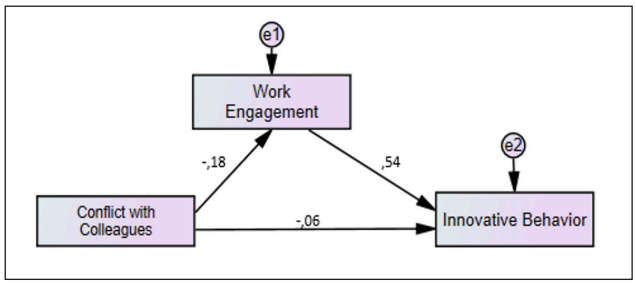

Figure 2: Mediating Effect of Work Engagement

Stage 4: Regarding the achievement status of the fourth stage, which serves as the final criterion for determining the presence of a mediation effect (See Figure 4.1), when examining the model, the effect of the independent variable (Conflict with colleagues) on the dependent variable (Innovative behaviors) (path coefficient) is observed to be -0.06 if a mediating variable is present. This shows that the relationship which was found to be significant before has become statistically insignificant (r= -0.058; p=0.178), as presented below (Table 3**)**. This result also shows that work engagement has a full mediating effect on the relationship between conflict with colleagues and innovative behaviors. Based on these results, the H4 hypothesis "work engagement has a mediating effect between conflict with colleagues and innovative behaviors" was accepted.

The Moderating Effect of Proactive Personality

A mediation impact path analysis was conducted with the IBM Amos program to test the moderating role of proactive personality in the effect of conflict with colleagues on innovative behaviors. The estimated and moderating variable values were standardized before the moderating impact analysis was performed. If the values are analyzed without standardization, the effect of the interactive term on the result variable will cause multiple connection problems, and this may prevent accurate determination. The path analysis regarding the effect of proactive personality and obtained findings are presented in Table 4.

Examining the results regarding the moderating impact analysis, it was found that conflict with colleagues had negative effects on innovative behaviors (Beta=-0.151; p=0.000), and proactive personality had positive and significant effects on innovative behaviors (Beta=0.477; p=0.000). It was also found that the interactional effect (moderating effect) of the variables of conflict with colleagues and proactive personality was significant (Beta=-0.137; p<0.01). Therefore, if the proactive personality is high, the effect of conflict with colleagues on innovative behaviors decreases, which means that the relationship between conflict with colleagues and innovative behaviors is moderated by proactive personality. Based on this, the H5 hypothesis "Proactive personality has a moderating effect on the relationship between conflict and innovative behavior with colleagues" was accepted.

Structural Model Analysis

What is meant by creating a model in structural equation modeling is the creation of a structure in which the causal relationships of variables with each other are revealed. In SEM, when the model is prepared based on theoretical foundations, drawing and defining this model can be done later. For the current study, the parameters in the model are defined and the variables

Table 3: Analysis results regarding the mediating effect of work engagement

Independent Variable	Direction of Relationship	Dependent Variable	Standardised Beta Coefficient	p
Conflict with colleagues	→	Work engagement	-0,181	**0,000****
Conflict with colleagues	→	Innovative behavior	-0,058	0,178
Work engagement	→	Innovative behavior	0,542	**0,000****

Table 4: Analysis Results Regarding the Moderating Effect of Proactive Personality

Independent Variable	Relationship direction	Dependent Variable	Standardised Beta Coefficient	p
Conflict with colleagues	→	Innovative behavior	-0,151	**0,000****
Proactive personality	→	Innovative behavior	0,477	**0,000****
Interactive variable	→	Innovative behavior	-0,137	**0,002****

and relationships to be presented in the model are determined as below (See Figure 3). The values of the predictive and moderating variables were standardized before the analysis. The path analysis performed and the results obtained with this analysis are presented in Figure 3 and Table 5.

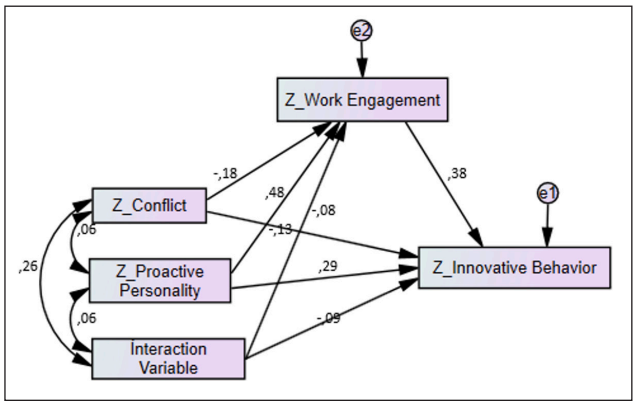

Figure 3: Structural Model Analysis with Standardised Factors Loads

After structural model analysis (See figure 3 and table 5), the following results were obtained:

- There is a statistically significant and positive effect of proactive personality on work engagement (r= 0.481; p=0.000). Based on this, proactive personality significantly affects employees' level of dedication to work.
- Moreover, a proactive personality has a statistically significant and positive effect on innovative behaviors (r= 0.295; p=0.000). Employees with a proactive personality exhibit more innovative behaviors. Based on this, the H5 hypothesis "Proactive personality significantly affects the innovative behavior of employees" was accepted.
- The results of the analysis revealed some negative effects of conflict with colleagues on work engagement (Beta=-0.179; p<0.000), and proactive personality had positive and significant effects on work engagement (Beta=0.481; p=0.000). The interactional effect (moderating effect) of conflict with colleagues and proactive personality variables on work engagement was significant (Beta=-0.127; p<0.01). Based on this, the hypothesis "proactive personality has a moderating effect on the relationship between conflict with colleagues and work engagement" was supported. Therefore, if the proactive personality is high, the effect of conflict with colleagues on work engagement decreases, which means that the relationship between conflict with colleagues and work engagement is moderated by proactive personality.
- The situational mediation effect of proactive personality was concluded to be statistically significant in the indirect relationship of conflict with colleagues mediated by work engagement on innovative behaviors. Accordingly, when the indirect relationship between conflict with colleagues and work engagement and innovative behaviors was added to the model as a moderating variable in the direct relationship between conflict and innovative behaviors with colleagues, the relationship between conflict with colleagues and innovative behavior became statistically significant in the full mediation of work engagement (Beta=-0.083; p<0.05). The relationship between conflict with colleagues and innovative behavior became statistically significant**.** In this case, the mediating effect of work engagement, which has a full mediating effect, turned into partial mediation with the moderating effect of a proactive personality. In addition, the significant effect of work engagement on innovative behaviors was found to have decreased from (Beta= 0.542) to (Beta= 0.380). As such, proactive personality as a moderating variable reduces the impact of conflict on work engagement, as well as reducing the impact of conflict on innovative behavior and the impact of work engagement on innovative behavior. The full mediating effect of work engagement transforms into partial mediation. Therefore, the H6 hypothesis "Proactive personality has a moderating effect on the indirect effect of conflict with colleagues on innovative behaviors through work engagement" was accepted.

In conclusion, the comprehensive analysis of the research results unequivocally validates all six hypotheses.

Table 5: Results Regarding the Structural Model Analysis

Independent Variable	Relationship direction	Dependent Variable	Standardised Beta Coefficient	p
Conflict with colleagues	→	Work engagement	-0,179	**0,000****
Conflict with colleagues	→	Innovative behavior	-0,083	**0,048***
Proactive Personality	→	Work engagement	0,481	**0,000****
Proactive Personality	→	Innovative behavior	0,295	**0,000****
Interaction Variable	→	Work engagement	-0,127	**0,004****
Interaction Variable	→	Innovative behavior	-0,088	**0,034***

DISCUSSION AND IMPLICATIONS

Recognition of conflict within organizations has remained consistently significant over time. Managers are observed to dedicate a substantial portion of their managerial efforts to resolving conflicts (Appelbaum et al., 1999). Examining the historical development of approaches to organizational conflict, it is observed that there is a process that evolves from viewing conflict as a preventable situation, then perceiving it as an inevitable reality for the organization, and finally recognizing it as a situation that can create positive outcomes for the organization (Tosi et al., 2000).

Integration of participatory conflict management methods increases the innovative behavior of employees, while avoiding conflict management methods reduces the innovative behavior of employees (Jung & Yoon, 2018). According to Lewin's field theory, when employees are in good alignment with their jobs and organizations, it motivates them to be dedicated to their work and organizations (Burnes & Cooke, 2013). In sectors where stress levels are high due to the fast pace, time pressure, and communication problems, positive performances of employees may decrease. As outlined in social exchange theory, employees seek to receive certain reciprocations in their relationships. When expectations are not met, individuals are adversely affected (Blumer, 1975; Mead, 1934; Thibaut & Kelley, 1959; Emerson, 1962).

In fields such as air transportation where people from different cultures work together, employees frequently experience conflicts regarding their work while interacting with colleagues or serving customers (Lee & Hyun, 2016). They have to work in a shift system in an extremely stressful work environment and under time pressure, where they deal with passengers who do not follow the set rules. As a result of the tensions experienced in this working environment, conflicts become inevitable. Therefore, the quality of services is closely related to the behavior of employees interacting with the customer (Yelgin & Ergün, 2022). When a positive interaction is achieved with the customer, customer satisfaction can be gained and positive perceptions regarding the organisation and the delivered services can be created. In the delivery of a service, presenting the service by employees in a way that satisfies the customer makes the biggest difference. It is possible to claim that the quality of cabin service is one of the priority criteria for passengers to prefer an airline over another (Park et al., 2014).

The findings obtained in this study make a significant contribution to both scholarly literature and practical applications for five reasons:

Firstly, our study highlights that conflicts with colleagues have a significantly negative impact on employees' innovative behaviors. Accordingly, the increase in conflict in an organization decreases the innovative behaviors of employees. The conflicts that are destructive and negatively affect group performance are considered unfunctional conflicts. If conflicts cannot be managed properly, the innovation and development climate are negatively affected in the organisation. It should be remembered that teamwork can easily be harmed due to elements negatively affecting good teamwork (Seedhouse, 2020). Therefore, positive and reconciliatory approaches to conflict management increase employees' innovative behaviors, while avoiding conflict management reduces the innovative behaviors of employees (Jung & Yoon, 2018; Chen et al., 2012).

Secondly, conflicts with colleagues have a significant and negative impact on employees' work engagement. In organizations where there is minimal conflict among colleagues, employee work engagement is expected to increase. Conversely, frequent conflicts are likely to decrease the overall engagement level within the organization. Research in the literature consistently demonstrates that engaged employees tend to outperform their less engaged counterparts. Engaged individuals experience positive emotions, such as happiness, joy, and enthusiasm, which they often share with their colleagues (Bakker & Demerouti, 2008). Agarwal et al. (2011) also highlight the importance of the quality of direct interactions between employees and their supervisors in influencing employee engagement. Furthermore, according to Chen & Huang (2016), increased employee engagement correlates with higher levels of innovative behavior, ultimately reducing task-related conflicts.

Thirdly, work engagement has a positive effect on employees' innovative behaviors. The related research literature similarly shows that employees who are engaged in work exhibit extra behaviors outside of their work roles (Robinson et al., 2004; Agarwall et al., 2012). Engaged employees with high energy and strong job identification tend to perform better, fostering innovation. This underscores the positive impact of work engagement on innovative behavior. They create their business resources, perform better, have a higher level of psychological capital, are happy with their jobs and find it fun to work in the organisation (Bakker et al., 2011). Another finding on work engagement revealed by this study is, work engagement serves as a full mediator in the relationship between conflict with colleagues and innovative behaviors. This means that when work engagement level increases, the impact of conflict with colleagues on innovative behaviors becomes insignificant. Some studies support this conclusion. For example, Jung & Yoon (2018) demonstrate that work engagement has a full mediating effect on the relationship between conflict management climate and innovative behaviors. Some other studies associate work engagement with positive organizational outcomes, such as job satisfaction, organizational commitment, extra-role behavior, and high performance (Schaufeli & Salanova, 2007; Leiter & Bakker, 2010).

Fourthly, our results indicate that proactive personality reduces the negative impact of conflict on work engagement in the model. This means that decreases in the level of conflict allow employees to focus more on their work. Similarly, proactive employees are less affected by conflicts, and they also tend to exhibit a higher level of innovative behavior. Moreover, proactive personality is a personal resource that positively affects the level of engagement level of employees. Proactive personality has a positive moderating effect on the relationship between conflict with colleagues and innovative behaviors (Li & Kong, 2018; Dikkers et al., 2010). Fuller & Marler (2009) assert that proactive individuals are closer to career development, psychological empowerment, and personal development issues. Therefore, an increase in the level of proactive personality significantly increases the level of work engagement, as well as leading to an increase in innovative behavior.

Finally, proactive personality indirectly has a moderating effect on the relationship mediated by work engagement in the effect of conflict with colleagues on innovative behaviors. According to Frese & Fay (2001), those who have a proactive personality trait enable people to cope more actively with job difficulties, such as stressors, unemployment, or career changes. These findings reveal that emphasizing the importance of a proactive personality can increase employees' level of work engagement and innovative behaviors. In this indirect relationship, proactive personality weakens the effect explained in the full mediation of work engagement, and the mediating effect of work engagement turns into partial mediation. Therefore, proactive personality has a moderating role in the relationship by reducing the impact of conflict with colleagues on work engagement and innovative behaviors. Higher level of proactive personality diminishes the impact of conflicts on employees, fostering increased engagement and a propensity for more innovative behaviors. Some studies also collectively emphasize the importance of proactive personality traits, employee engagement, and managerial support in fostering positive outcomes such as coping with stress, innovation, and reduced conflict in the workplace (Bateman & Crant, 1993; Chen & Huang, 2016; Kim et al., 2010).

In light of the findings obtained from the study, the suggestions can be listed under the following headings: recruitment and teamwork, human resources policies, innovative organizational culture, employee development and training, person-job alignment and performance, conflict management organizational structure and innovation, employee engagement and conflict resolution, and priority on proactive personalities. Therefore, the following recommendations can be made to managers:

- In sectors like aviation where teamwork is intense, ensure appropriate selection of team members. Since individuals who are good at teamwork will be able to work more harmoniously with their team, they may experience less conflict in the business environment, leading to potential increases in their task performance.
- Foster an environment that supports innovative behaviors and encourages employee satisfaction, positive emotions, and problem-solving abilities. Modern aviation safety theory today is mainly focusing on understanding how people react to operational situations, and how the human factor interacts with new technologies and developments in aviation safety systems. The correct understanding of the human-caused factors in airplane crashes and the adoption of the correct applications for this purpose can be considered effective initiatives to reduce aviation crash rates (Sant & Hilal, 2021).
- Provide training opportunities tailored to employees' needs and preferences to enhance their competencies and confidence in innovation.
- Align job characteristics with employee competencies to improve performance and engagement in innovative behaviors. The ability of employees to perform well can only be realized with the compatibility of the job characteristics with the level of competencies of employees (Sadullah, 2018).
- Manage conflicts effectively rather than aiming for complete elimination, especially in safety-critical sectors like aviation.
- Adopt organizational structures that are open to innovation to remove barriers and resistance within the organization. In today's dynamic business environment, organizations recognize the important strategic role of employees' innovative behavior for the long-term growth and organizations performance.
- Invest in employee engagement to promote positive outcomes in conflict management and innovative behaviors.
- Prioritize the employment of proactive individuals who exhibit behaviors conducive to innovation and are less affected by conflicts.

In future studies, researchers should consider exploring the effects of additional variables on the relationships examined in the study. This could involve investigating factors such as organizational culture, leadership styles, or technological advancements, which may influence the dynamics of organizational conflict, innovative behaviors, and employee engagement. Furthermore, conducting further research with larger samples or in different sectors for comparative analysis can provide valuable insights into the generalizability and applicability of findings across diverse organizational contexts.

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The Classification of Success Performance of Entrepreneurial and Innovative Universities with Artificial Intelligence Methods

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ABSTRACT

With the increasing competition in higher education in the world and our country, universities are becoming entrepreneurial structures that attach importance to collaborations with industry, Intellectual and Property Rights, techno-parks, incubation centers, and international mobility of students and academics in addition to their traditional education and research functions. In this study, the Entrepreneurial and Innovative University Index (EIUI) score is used to categorize universities. In addition, it also investigates the distribution of the EIU index according to the status of universities (Foundation - State) and the relationship between URAP ranking scores. This study classifies universities using artificial intelligence methods that have been widely used in recent years. This positioning study, while clustering EIU universities in our country, aims to provide guidance for other universities to analyze their current situation and to determine future strategies in line with their competencies and goals.

Keywords: Entrepreneurial and Innovative University Index, Artificial Intelligence, Random Forest, Classification, University Performances, URAP, Research University.

JEL Classification Codes: Yazar tarafından gönderilmeli

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INTRODUCTION

Universities are among the most important institutions that contribute to society, economic stability, social welfare, the ability of nations to engage in international cooperation and internationalization, and the quality of life in a wide range of economic, social, and cultural terms.

At present, it is known that with the development of distance education opportunities and the increase in the applications of technology developments associated with education, the content and volume of education have increased significantly. These paradigm shifts require the redesign of all educational processes, from preschool education to higher education. The speed of circulation of educational outputs in terms of both graduates and knowledge has accelerated at an accelerated pace. As a result, industry, production, and financial structures attach more importance to collaborations with universities to access and benefit from the knowledge produced at universities faster and earlier. As a necessity of these conditions, universities have gone beyond being just areas where knowledge is produced, and have become institutions that work in cooperation with industry, transform knowledge into marketable products, create incentives for graduates and researchers to establish companies, and provide various benefits as a component of social projects. Although the variety of activities of universities has increased, their most important mission is education and scientific research. Additionally, scientific research is crucial for universities to gain a reputation and status abroad (Altbach, 2008).

Universities are adapting to promote regional, social, and economic welfare through contact with industry while maintaining their traditional roles of education and research (Odabaşı, 2006). It is observed that universities go beyond providing graduates who meet the human capital demand of this change and that the organizational structures of universities include new units such as career development centers, technology transfer offices, start-up incubation centers, and similar entities to adapt to this process.

The growing demand for higher education in our nation and around the world, in addition to the shift to mass education in the 1990s and the lack of adequate public resources, have forced institutions to look for

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new funding sources. Higher education institutions have turned to initiatives that provide universities with external resources, partnerships with universities in various regions, the use of intellectual property rights, techno-parks, incubation centers, international mobility of students and academics, and institution procedures where students are viewed as "customers" in this competitive environment. Due to the implementation of neo-liberal policies by some country governments, such as the USA, it has also been stated that colleges should be "entrepreneurial" to develop resources (Küçükcan&Gür, 2009).

The most important step in the economic, social, societal, and technological changes and developments of this paradigm is the spread of entrepreneurship culture. The cornerstone of the entrepreneurship ecosystem is entrepreneurial individuals and entrepreneurial organizational structures. The roles, areas of accountability, structures, and procedures of universities, as well as their capacity to raise money and perceive their surroundings, have all undergone significant changes as a result of this circumstance. Universities have now a new mission to pursue as a result of this transformation. The goal of this mission has been to increase university knowledge of entrepreneurship and to institutionalize the entrepreneurial ecosystem within the university. (Geçgil et al., 2018). An entrepreneurial university is, essentially, one that encourages research, entrepreneurship, education, and training. (Etzkowitz et al., 2000).

As a reflection of this change, the entrepreneurial university vision has started to become one of the positioning options of universities in our country. As a result of these processes, nowadays universities have become financially self-sufficient institutions, develop business ideas, contribute to employment, and adopt entrepreneurial activities along with education and research (Uysal&Çatı, 2016).

At the same time, some studies argue that the entrepreneurial university approach will lead to close cooperation with industry and that being involved in the free market economy has a negative impact on academic and educational achievement (Kirby, 2006). Three main types of potential threats were highlighted by Anderson (1990). The first is that colleges expose themselves to commercial risks. For instance, businesses occasionally risk losing money. The second category of risks is the management risks. Since outputs can be measured in terms of money in commercial companies, evaluation and control are conceptually simple. In universities, however, the objectives are many and difficult since they call for value judgments. There is the possibility of misuse and waste of institutional culture and goal-oriented support. Becoming an entrepreneurial university requires a fundamental, long-term, culture change in the entire organization. Thus, the created entrepreneurial culture may conflict with the academic culture over time (Çetin 2007).

On the other hand, it can also be stated that universities with entrepreneurial university visions exhibit significant developments in terms of academic autonomy and academic productivity. These universities develop high-value-added products with the knowledge they produce, create a strong financial structure, actively cooperate with their internal and external constituents, expand their research facilities and physical capacities, and thus attract qualified academics and successful students.

The evaluation of whether universities are entrepreneurial, innovative, student-oriented, research-oriented, or not has been tried to be measured and ranked with many scales developed in recent years. In order to meet this need, various institutions and organizations have developed indices and scores based on different parameters. The Times Higher Education - QS World University Rankings, Newsweek Magazine's Top 100 Global Universities, Shanghai Jiaotong University Academic Ranking of World Universities, Cybermetric Labs Webometrics, and others are the most well-known of these (Saka &Yaman, 2011). While examining the common criteria used in these scales, criteria such as the number of articles in different journal platforms, projects, patents, number of awards, number of academicians, university infrastructure and social facilities, campus facilities, technological infrastructure, etc. come forward. It can be said that these rankings are developed within the framework of different scales such as universal, regional, field/sector-based, and national levels.

University rankings based on different systems are not objective and there is no complete compatibility between the rankings. These differences in rankings indicate that there are significant contradictions between the ranking criteria. Therefore, when evaluating the rankings of different systems, the ranking criteria on which they are based should be taken into consideration. However, despite the criticisms of these ranking systems, most of the top universities find these rankings significant and are interested in taking the necessary actions to find a place for themselves in the top rankings (Saka &Yaman, 2011).

THEORETICAL FRAMEWORK

There are many studies on the definition, elements, structure, and culture of the entrepreneurial university in the literature. The large number of shareholders and characteristics around the entrepreneurial university concept have led to the production of different diagrams in the theoretical literature. The most popular of these is the Helix structure. Leydesdorff and Etzkowitz first examined the relationship between the government, the university, and the business sector with the Triple Helix model.

In the first stage of this model, it is seen that the government assumes an inclusive, guiding, and developing role for the university and the business sector, while in the second stage, it is stated that the structures have independent institutional characteristics but are related to each other. In the third stage, the relationship between the state, university, and the sector is seen to be in the form of structures that are institutional partners and intersectional clusters (Lefebvre, Pallez, &Fixari, 2009).

Carayannis and Campbell added the media to this diagram in 2009, and in 2010 they took into account the impact of the environmental factor and transformed the model into a Quintuple Helix model. The Helix diagram is also important in terms of showing the key actors of the entrepreneurial university ecosystem and its development over time (Barth, 2013).

Rankings that evaluate universities in terms of entrepreneurship and innovation activities have a relatively short background compared to general university rankings. The most comprehensive ranking on this subject is "The World's Most Innovative Universities" ranking by Thomson Reuters (Uslu et al. 2020). The literature on this subject focuses more on qualitative characteristics and the determination of variables.

The most basic components of the entrepreneurial university concept are social sensitivity, entrepreneurial institutional identity, and innovation-oriented characteristics (Yıldız, 2019). While examining the sub-dimensions of the TUBİTAK entrepreneurial and innovative university index, we can state that it considers many indicators within the theoretical framework covering these basic components.

In general, the index ranks the top 50 universities in Turkey in terms of entrepreneurship by score. It does not provide a comparison in terms of sub-dimensions, nor any details on the clustering and distribution of similar universities.

RESEARCH MODEL

The contribution of this study to the theoretical framework is to conduct a multidimensional positional analysis of universities beyond a linear ranking. It does this analysis by factoring in URAP ranking scores, university status, and being a research university in addition to the sub-dimensions of the EIUI. The study expands on the Helix approach, which is its theoretical basis, with a quantitative analysis within the framework of the EIUI. The research model of the study is shown in the figure as follows.

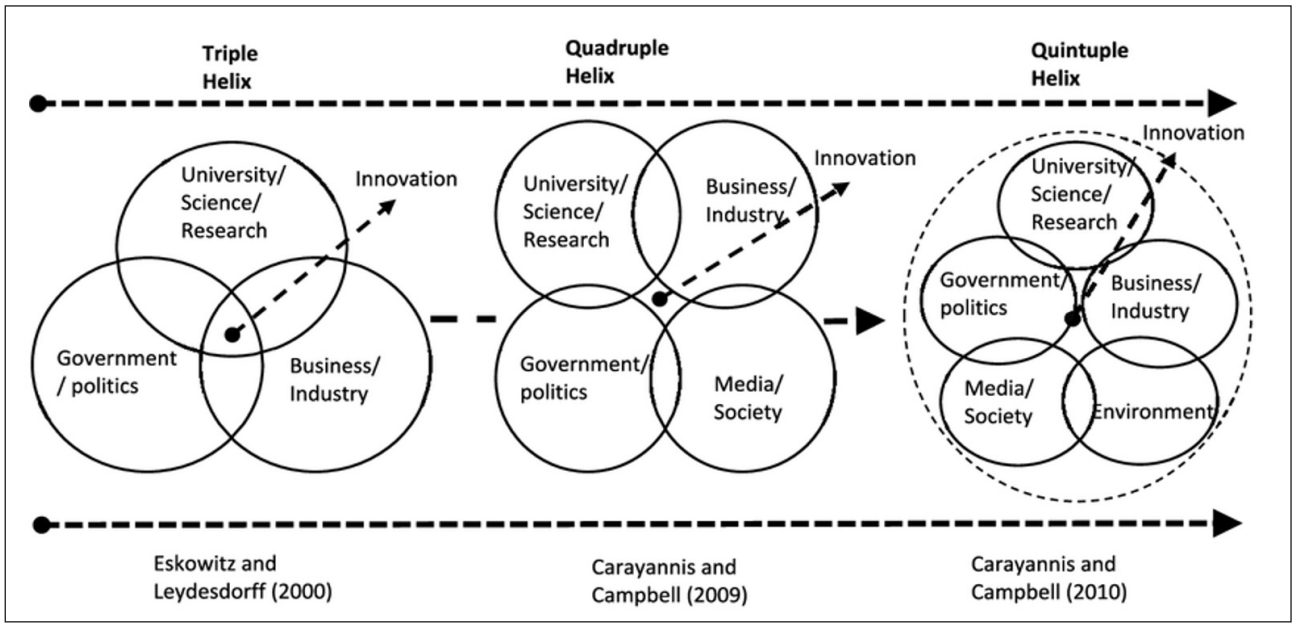

Figure 1: Helix structure of Entrepreneur universities (Barth, 2013)

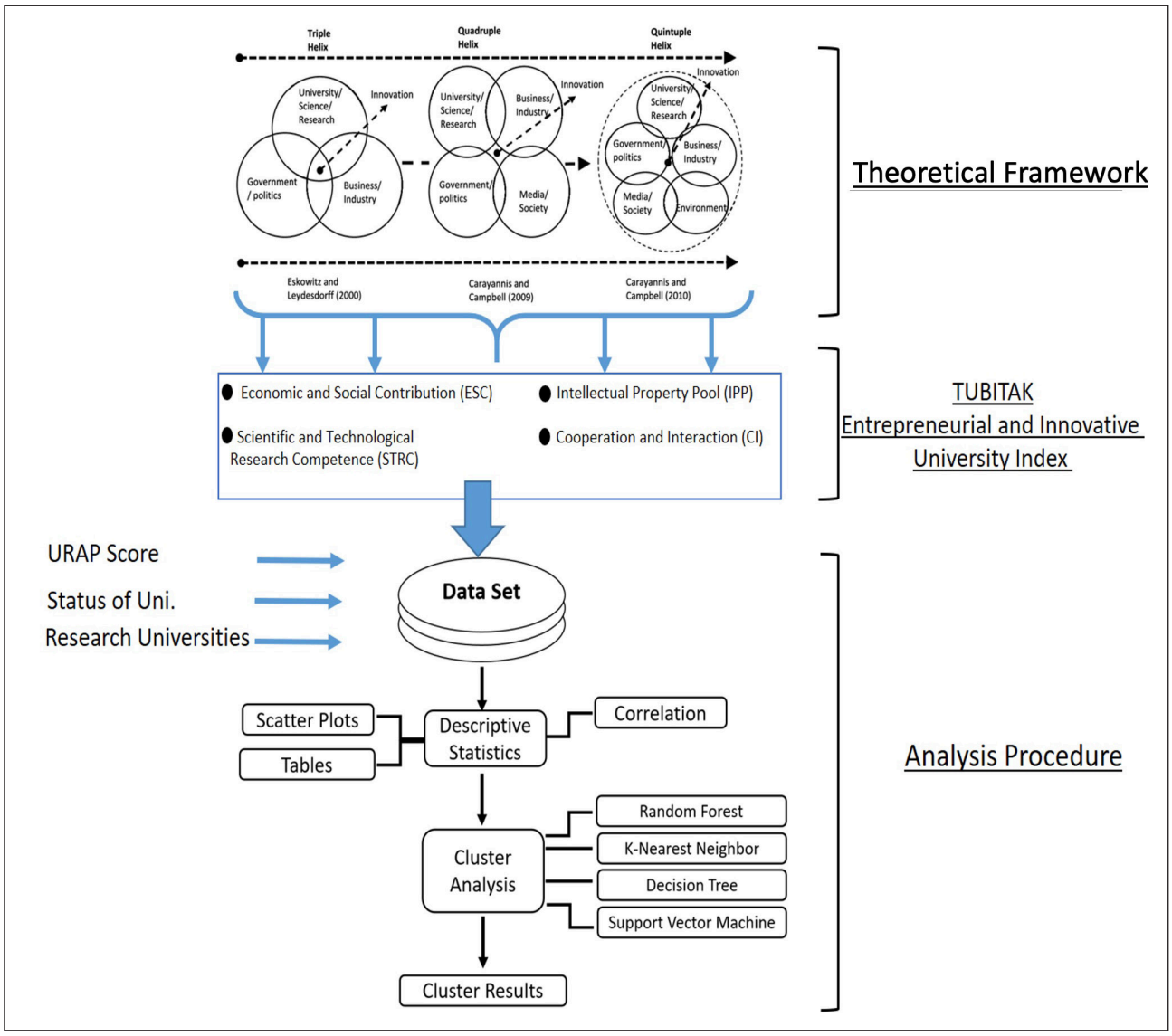

Figure 2: Theoretical Framework, Analysis Procedure of Research Model

The methods used in the study are similar to some of those used in the entrepreneurial university literature shown in the analysis procedure diagram. Erdoğmuş and Esen (2016), Shin, J. C. (2009), and Valadkhani and Worthington (2006) were categorized universities using hierarchical cluster analysis. The two-step clustering algorithm, a different clustering method, was used in the analysis. However, scatter plots, artificial intelligence-based clustering methods, and correlations with other parameters have not been sufficiently studied.

There are very few studies examining the relationship between universities with an Entrepreneurial and Innovative University (EIU) vision and success parameters. In addition, there is a significant gap in the literature regarding the categorization of this relationship according to different variables. The study aims to provide answers to the following questions for this reason:

- How are the universities in our country distributed in terms of the sub-factors that make up the EIUI score?
- What is the position of research universities in the EIUI?
- How is the distribution of the EIUI according to the status of universities (Foundation - State)?
- Is there a relationship between universities entrepreneurship and innovation activities and URAP ranking?

Within the framework of the answers to these questions, we aim to offer strategic planning suggestions to universities. Clustering on the axis of parameters will provide information about the position of universities and guide them on which issues they should focus on to be more successful.

The study limitations include the fact that the data set comprises 50 universities and 4 parameters. The clustering analysis includes these variables, but decision-makers can position other possible universities by the interpolation method. Another limitation is that the intangible outputs that constitute organizational identities are not included in a quantitative-based classification system.

The theoretical motivation of the study is that the approach developed around entrepreneurial and innovative universities will be instructive for other universities. This positioning study aims to determine the universities that other universities in our country can take as a reference according to their competencies and goals.

The literature section of the study gives information about previous studies, while the methodology section explains the variables and data used in the analysis. In the findings section, the results of the analysis are shown and interpreted with tables and graphs. In the discussion section, evaluations are made by comparing the relationship between the studies in the literature and the findings part.

LITERATURE

Tosun H. (2020) analyzed the effectiveness of 52 foundation universities founded between 1984 and 2010 in his study and offered some recommendations for the institutions. Analysis of the study's findings reveals that foundation universities are not uniformly different from public universities. In addition, it was found that the foundation universities were not productive, except for higher education institutions such as Sabancı, İhsan Doğramacı, Özyeğin, and Koç Universities, which showed high performance. Through the exception of the top five universities identified in the context of EIUI, it is evident that the majority of the foundation universities included in the study lack a culture of research and development.

Tekin, E. (2021) examined the effect of the universities' index scores on URAP performances by panel data regression method by using the data of EIUI for the years 2012-2017. The study's findings showed that institutions with a focus on entrepreneurship and innovation had students who performed better academically. Additionally, it was discovered that while the intellectual property pool dimension has a negative and significant impact on university academic performance, the other pillars of entrepreneurship and innovation—cooperation and interaction, economic contribution, and commercialization—have a positive and significant impact. Entrepreneurship and innovation culture do not affect the academic performance of universities.

There are numerous studies in the literature that use various techniques to evaluate how effective universities are. (Günay et al. (2017), Işıldak et al. (2018), Arslan&Güven (2018), Ertuğrul & Sarı (2017), Kutlar&Babacan (2008)). While the data envelopment analysis is mostly preferred for efficiency measurement in the literature, data on the number of researchers, budget and expenditure variables, number of students, and university infrastructure are used as input variables. As efficiency outputs, the number of academic activities, educational activity outputs (number of graduates, master's and doctoral degrees, etc.), and outputs related to university financial infrastructure are taken as reference (Çağlar and Gürler 2020).

Orhan and Yalçın (2021) analyzed the entrepreneurship and innovation efficiency of universities in Turkey and ranked them according to their relative efficiency. They also identified the universities that inefficient universities can take as references. The Data Envelopment Analysis (DEA) method was used in the study and the criteria to be taken into account in the ranking were also determined.

Using multi-criteria decision-making methods, Ömür and Karataş (2018) analyzed the results of 50 entrepreneurial universities in Turkey in 2016. The Entropy weight method was used to compute the criteria weights for the universities assessed using the 2016 data and the EIU index criteria, and the MAUT and SAW methodologies were then used to assess performance. Significant consistencies were found between the success rankings obtained as a result of the study and the classifications of our study. However, no inferences were made about the modeling success of the MAUT and SAW methods used in the study.

Geçgil et al. (2018) developed a new index for measuring university entrepreneurship levels in their study. The content, validity, reliability, and factor analyses of the developed scale were made and the scale was introduced to the literature.

Turkish universities were categorized using hierarchical cluster analysis by Erdoğmuş and Esen (2016). The CoHE and URAP rankings, EIU index rankings, and CoHE yearly reports made up the study's data. Universities are split into two major groups based on their institutional size and performance, according to the analysis's findings.

Using the Two-Step Clustering algorithm, one of the traditional approaches, Gözükara, İzlem. (2015) did a clustering analysis of 72 foundation universities in Turkey in terms of academic criteria. The study used

data on undergraduate and associate degree students, faculty and program numbers, faculty members, master's and doctoral program numbers, and the number of papers and projects. As a result of the study, foundation universities were generally divided into two clusters in terms of each parameter. The study does not suggest any improvement policy other than the current clustering of foundation universities.

In the study conducted by Yıldırım and Yıldırım (2020), the period 2012-2017 was determined as the study period. Using the EIUI scores published yearly for 50 universities, an alternative ranking method was developed by calculating interval-valued gray numbers to represent this period and analyzing them with the ARAS method. It is seen that the approach proposed in the study is consistent with the results of the studies conducted both with single annual studies where near-term analyzes are made and with the results of the studies conducted by combining all published period data.

In their study conducted in 2018, Er and Yıldız examined the index values published for 2016 and 2017 with the help of the ORESTE method and factor analysis. In this study, unlike TÜBITAK's point of view, the ORESTE method was applied to the EIUI data by considering both dimensions as criteria instead of assigning weights and using university evaluation scores by prioritizing these criteria. The two-factor models provide the chance to compare the conventional university structures and their views on entrepreneurship and innovation culture as a result of the factor analysis. These structures make it simpler for colleges to identify the factors that will help them rise in the rankings.

Alma et al. (2016) investigated global university rankings and attempted to create a field-based ranking system for Turkish universities. Raponi et al. (2016) used the binary-clustering method to compare the commonalities between the economics faculties of 55 Italian institutions. The main criteria used in clustering are education, productivity, research ability, and internationalization opportunities. As a result of the study, while classifications were made according to different criteria, it was seen that the status of the universities (State - Foundation) was the most prominent clustering distinction.

Shin, J. C. (2009) used a hierarchical cluster analysis to categorize universities in South Korea according to the number of publications, the number of doctoral graduates, and projects with outside funding. Among the results of the study, it was emphasized that in the classification of universities, attention should be paid to the research, education, social, or engineering missions of universities.

By using a hierarchical clustering analysis between 1998 and 2002, Valadkhani and Worthington (2006) categorized the research output of 37 Australian universities based on the number of PhDs, the number of academic staff, the number of prizes and scholarships, and the number of publications. Different categorization approaches and models weren't compared because the study is one of the pioneering studies in the literature.

In the study by Karahan and Kızkapan (2022), the entrepreneurial and innovative university index data of 2021 were used to calculate the performances of the universities. Their own institution, Firat University, was compared to the successful universities using the Promethee Gaia method.

Saygın et al. (2020) used the EIU Index data from 2012 to 2017 to measure the efficiency of universities using Data Envelopment Analysis, and they attempted to track changes in efficiency values over time using the Malmquist Total Factor Productivity Index.

In his study, YüzbaşıKünç, G. (2021) examined the performance of 41 state universities established within the scope of the "one university for each province" policy in Turkey by using the data of the 2009- 2019 periods with multidimensional scaling analysis. As a result of the study, it was concluded that the universities have progressed in terms of variables such as the number of publications, number of students, and staff, but remain below expectations. The positioning comparison was made according to the top 14 successful universities in the URAP ranking and it was determined that universities other than Giresun University, Burdur Mehmet AkifErsoy University, and TekirdağNamık Kemal University were not very successful.

DATA AND METHODOLOGY

The study population comprises 50 universities included in the TÜBİTAK-EIUI 2022 ranking. Along with the sub-factors of the relevant universities, the total scores of the EIUI, URAP ranking score, whether they are research universities or not, and their status (State - Foundation) were included in the study as variables.

The Index (EIUI), which is the main parameter of the study, was announced by TÜBİTAK (The Scientific and Technological Research Institution of Turkey) in 2012 and is calculated every year and the information of the

top 50 universities shared with the public. With this index's assistance, universities' scientific activities, patent studies, entrepreneurship, and innovation culture, as well as their industrial relations, can be analyzed and their success in producing high-value-added products can be monitored.

TÜBİTAK has identified a total of four pillars within the EIUI. These are Economic and Social Contribution (ESC), Cooperation and Interaction (CI), Scientific and Technological Research Competence (STRC) and Intellectual Property Pool (IPP), Universities are evaluated according to a total of 23 different indicators in the pillars of the index (TÜBİTAK 2022). The Ministry of Science, Industry, and Technology, TPE (The Turkish Patent and Trademark Office), the Ministry of Development, KOSGEB (Small and Medium Enterprises Development Organization), TTGV (The Technology Development Foundation of Turkey), TÜBA (The Turkish Academy of Sciences), and the universities are the sources of the data announced by TÜBİTAK.

The other performance indicators evaluated with the EIUI are the status of the universities (foundation-state), URAP ranking score, and whether they are research universities or not. Every year, the METU Graduate School of Informatics's URAP (University Ranking by Academic Performance) Research Laboratory conducts university rankings in Turkey and around the globe (URAP, 2022). The Council of Higher Education (CoHE) announced the "Research and Candidate Research Universities" on September 26, 2017, using a total of 33 criteria and 3 main titles. The determination of these universities was carried out within the scope of the "Specialization and Mission Differentiation Project" carried out by CoHE(YÖK 2022).

Since the data set of the study includes many variables (performance criteria) and units (universities), multivariate statistical analyses for example factor analysis, principal component analysis clustering analysis, and discriminant analysis can be used. Cluster analysis was chosen because the location of universities was the main inspiration for the study.

Cluster analysis aims to classify observations according to their similarity or distance. In other words, the main objective is to form groups of each individual (observation) with other individuals who are most similar to him/her or whose distance to him/her is the least in line with the characteristic or characteristics examined. The groups obtained should be homogeneous within themselves and heterogeneous to each other (Orhunbilge, 2011).

Clustering methods may vary according to the structure of the variables and the characteristics of the objects to be classified. The methods used vary according to criteria such as the appropriate distance method, error evaluation criterion, and model suitability.

Various cluster validity methods have been developed and utilized for the evaluation of algorithms in clustering methods. In this way, cluster accuracy, validity and the appropriate number of clusters can be determined in clustering analyses and clustering processes can provide much more appropriate and quality results. However, in recent years, technological developments such as machine learning and artificial intelligence have enabled the development of new methods and/or approaches.

In this study, we combined traditional classification techniques like Decision Tree and K-Nearest Neighbor (k-NN) with approaches based on artificial intelligence, such Random Forest (RF) and Support Vector Machine (SVM). In order to do classification, Support Vector Machine seeks out the hyperplane that optimizes the boundary between two classes. (Özkan et al., 2015). The main axis in the study is the Random Forest method, which shows better classification success.

The Random Forest algorithm is a machine learning-based approach that can be easily used for categorical, continuous data sets, or both. Machine learning methods are non-parametric as they do not rely on any assumptions about the distribution of the data. They are data-driven methods and learn the relationships between the predictor and the corresponding responses (Breiman 2001).

The Random Forest method offers the opportunity to obtain a margin of error without a deviation rate, provides the opportunity to obtain the original data set as a whole without dividing it into learning and test data sets, and enables the determination of the relationship and distance between the variables that make up the model thanks to the proximity command. However, the disadvantages are that a confidence interval is not given for the result after the model is created and the result is not in the form of a tree structure. Since the model is created in a complex way, the result's process is presented as a black box (Breiman, 2001, Cutler et al., 2007, Evans et al., 2011).

The classification and regression tree (CART) technique is used to build trees in the Random Forest Method. When the CART method is applied, the variable from which the data set will be divided into branches is chosen using

"information gain," but the proper test criterion (cut-off value) of the variable chosen for branching is determined by the "Gini index." (Akman et al., 2011). The GINI index measures class homogeneity and can be expressed by the following formula (1).

$$\sum\sum_{j\neq i}\left(f\left(C_i,T\right)/|T|\right)\left(f\left(C_i,T\right)/|T|\right) \quad (1)$$

Where T is the training dataset, C_i is the class to which a randomly selected university belongs and $f\left(C_i,T\right)/|T|$ is the probability that the selected university belongs to class C_i.

Applying the bootstrap approach, a sample is chosen from the data set for each tree in the Random Forest method, and a classification is made by utilizing a tree made up of 2/3 of the selected data. This category receives a "vote." The random forest method uses its categorization to choose the tree in the 'forest' that has received the most votes out of all the trees. The more accurate classifier is the tree with a lower error rate.

Random Forest has a similar approach to the Decision Tree. However, by growing trees, Random Forest adds more randomness to the model. When splitting a node, it seeks for the best feature among a randomly selected subset of features rather than the most crucial one. This generates a wide range of trees that are frequently expressed in a better model.

FINDINGS

In the study, for each of the EIUI, the total score of the index for the year 2022, the Scientific and Technological Research Competence score (STRC), the Intellectual Property Pool score (IPP), the Cooperation and Interaction score (CI), the Economic and Social Contribution score (ESC) and the URAP ranking scores of the relevant year were examined. In addition, categorical information on whether universities are research universities or not and their status (Foundation - State) was also included in the modeling.

While analyzing the distribution of Entrepreneurial and Innovative Universities, we observed that 23 of the 50 universities are research universities. While analyzing the status of these universities, we see that 34 of them are state universities and 16 of them are foundation universities. The cross table created according to the parameters is as follows.

Table 1. Distribution of the EIUI's top 50 universities

		University Status		
		State	Foundation	Total
Research Uni.	No	14	13	28
	Yes	20	3	23
	Total	34	16	50

Table 1 shows that three universities are both research universities and foundation universities (Koç University, Sabancı University, İhsanDoğramacıBilkent University), while 20 universities are both research universities and state universities. Among the 129 institutions that are state universities, there are a total of 34 EIUs with a rate of 26.3%. This rate is 21% among foundation universities.

While analyzing the descriptive statistics of the variables, we observed that the university with the highest score in the EIUI was Middle East Technical University with 83.6 points, while the university with the

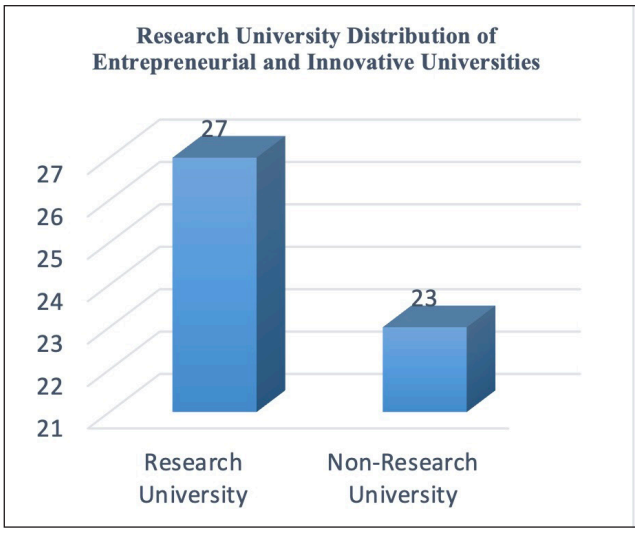

Figure 3. Research Universities with the EIUI

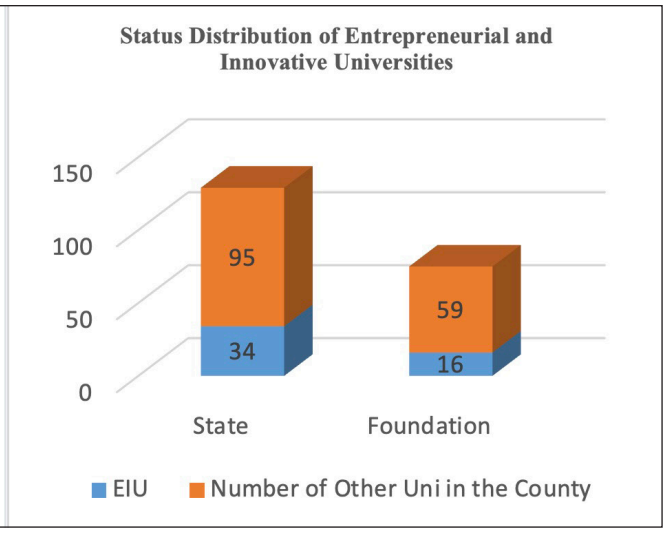

Figure 4. Status of Universities with the EIUI

Table 2. General Statistics of the Variables

Variables	N	Mean	S.d	Min.	Max.	University with Min Score	University with Max Score
Scientific and Technological Research Competence (STRC)	50	7,79	2,05	4,34	12,25	İst. OkanUni.	METU
Intellectual Property Pool (IPP)	50	7,95	3,67	1,82	17,28	Kadir Has Uni.	ÖzyeğinUni
Cooperation and Interaction (CI)	50	14,16	4,03	0,19	23,54	Hasan Kal. Uni.	SabancıUni.
Economic and Social Contribution (ESC)	50	20,85	5	8,79	34,4	Bursa Teknik Uni.	METU
EIUI TotalScore	50	50,74	11,76	36,27	83,6	Hasan Kalyoncu Uni.	METU
URAP Score	50	802,9	152,36	444,27	1097,7	İst. OkanUni.	KoçUni.

lowest score was Hasan Kalyoncu University with 36.27 points. While the mean of the total score of the EIUI was 47.6, the standard deviation was 12.22.

While analyzing URAP scores of the universities, we observed that Koç University has the highest score with 1097.73 points, while Istanbul Okan University has the lowest score with 444.27 points. The average score of the entire sample was 800.96 with a standard deviation of 154.49.

The significant relationship between the indexes scores used in the study will inferentially help to give an idea about the positioning similarities of the universities. The relationship between the total index scores of entrepreneurial and innovative universities and other variables was analyzed with Pearson and Spearman's rho coefficient. A moderate (Pearson: 68%, p value<0.05) positive correlation was found between the total score of the universities' EIUI and URAP score, and similarly, a positive and significant correlation

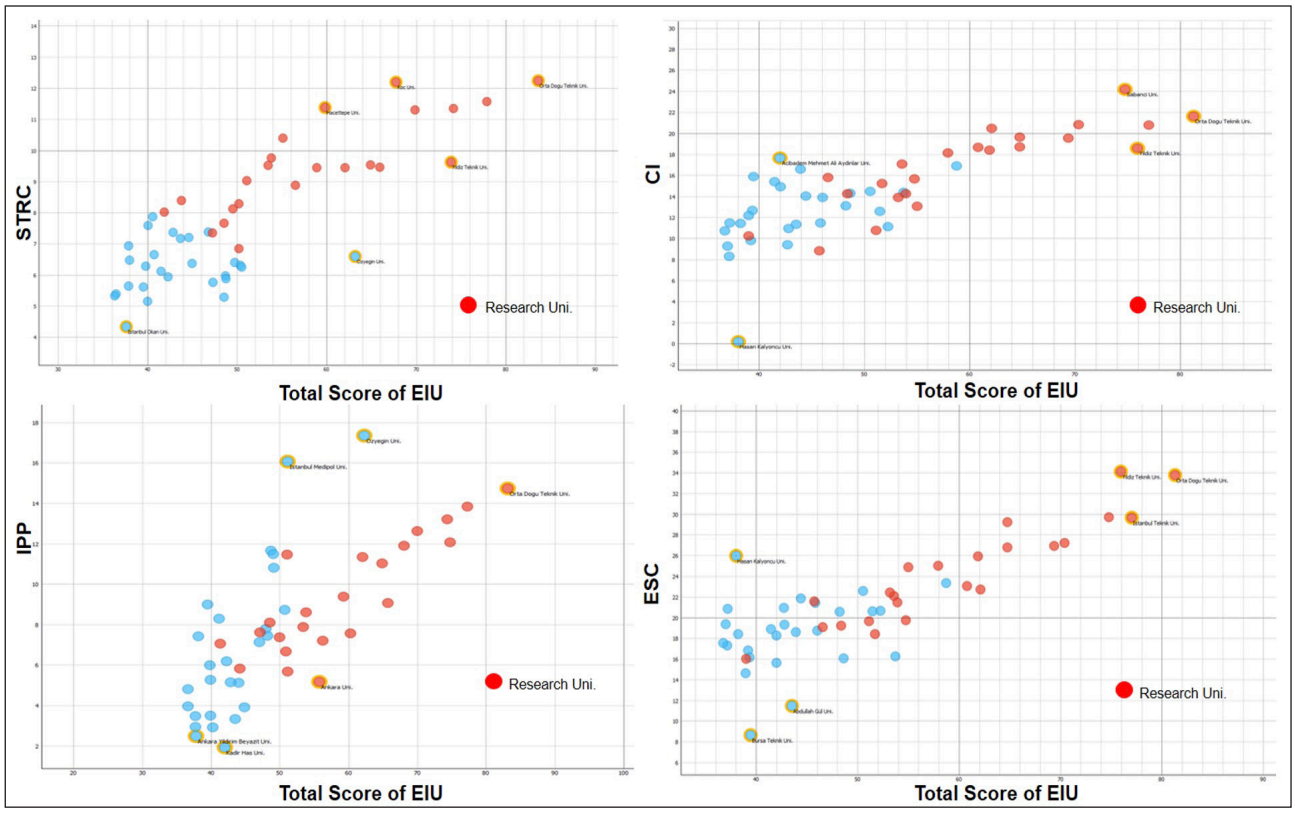

Figure 5. The Distribution of the Total EIUI Score and the Pillars

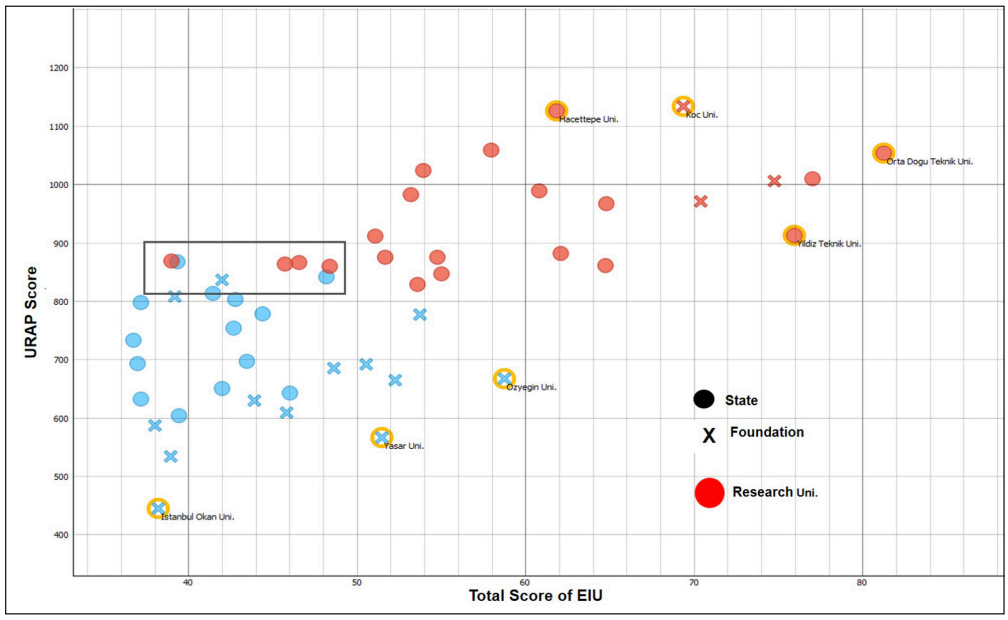

Figure 6. The Distribution of URAP Ranking Score with the Total EIUI Score

was found with the status of being a research university (Spearman's rho: 70%, p value<0.05). A linear relationship was found between URAP ranking score and being a research university at a high level (Spearman's rho: 85%, p value<0.05). In other words, this significant relationship between these variables should be considered together in policy development. If being a research university is among the institutional goals of the universities, some of the criteria to be followed are to strive for a high URAP ranking score and entrepreneurial university score to realize this goal.

While examining the scatterplot distribution showing the relationship between Entrepreneurial and Innovative Universities and the sub-components of the total score, we observed that there is a positive relationship in general, while universities that are research universities are more successful than other universities in both pillars and total score. These graphs also provide information about university-based positioning. For example, while METU was successful in all sub-dimensions, Hasan Kalyoncu University scored low in cooperation and interaction. Likewise, although their total index score is relatively low, Istanbul Medipol University and Özyeğin University exhibit significant success in the Intellectual Property score.

While analyzing the distribution of universities' total index scores and URAP achievement scores, we observe that there is a positive correlation. We can conclude that the entrepreneurial and innovative nature of universities is closely related to their academic success and that they affect each other positively. While analyzing the graph in detail, we observed that the index scores of institutions that are research universities and state universities are also high. There is an unstable region with a URAP score of 800 and above and an EIUI score between 35 and 50. Acıbadem Mehmet Ali Aydınlar Uni., Çankaya Uni., Ondokuz Mayıs Uni, Selçuk Uni, Akdeniz Uni, EskişehirOsmangazi Uni, Kocaeli Uni, and Sakarya Uni, which are located in this threshold region, can show the same success performance as research universities if they exhibit small improvements in terms of both parameters. Özyeğin University, on the other hand, has the potential to significantly increase its success if it reflects its high entrepreneurship and innovation score to its URAP ranking.

CLUSTER ANALYSIS

In order the classification of entrepreneurial and innovative universities based on their overall index score, URAP ranking score, status as a research university, and status as either a state or foundation university, we used traditional methods like Decision Tree and K-Nearest Neighbor (k-NN) and artificial intelligence-based methods like SVM and Random Forest.. As a result of the analysis, the first 50 Entrepreneurial and Innovative Universities were divided into 4 clusters. The universities in the clusters are shown in the table below.

Table 3. The Clustering of Universities and Their Distribution

1. Cluster	2. Cluster	**3. Cluster**	**4. Cluster**
Middle East Technical Uni.	Boğaziçi Uni.	Akdeniz Uni.	ÖzyeğinUni.
Sabancı Uni.	Gebze Technical Uni.	Kocaeli Uni.	Istanbul Medipol Uni.
Istanbul Technical Uni.	Izmir Yüksek Teknoloji Ens.	Eskişehir Osmangazi Uni.	TOBB Ekonomi ve Teknoloji Uni.
Yıldız Technical Uni.	Hacettepe Uni.	Sakarya Uni.	EskişehirTechnicalUni.
Ihsan Doğramacı Bilkent Uni.	Ege Uni.	Ondokuz Mayıs Uni.	Bahceşehir Uni.
Koç Uni.	Erciyes Uni.	Süleyman Demirel Uni.	YeditepeUni.
	Ankara Uni.	Selçuk Uni.	Yasar Uni.
	Istanbul Uni.	Konya Technical Uni.	AtılımUni.
	Gazi Uni.	Ankara Yıldırım Beyazıt Uni.	Acıbadem Mehmet Ali Aydınlar Uni.
	Istanbul Uni. - Cerrahpaşa	Pamukkale Uni.	Kadir Has Uni.
	Bursa Uludag Uni.	Çanakkale Onsekiz Mart Uni.	Abdullah GülUni.
	Marmara Uni.	Hasan Kalyoncu Uni.	Izmir EkonomiUni.
	Dokuz Eylül Uni.		Bursa TechnicalUni.
	Karadeniz Technical Uni.		ÇankayaUni.
	Çukurova Uni.		Istanbul OkanUni.
	Fırat Uni.		
	Atatürk Uni.		

Table 4. The Statistics of Clusters

	1. Cluster		**2. Cluster**		**3. Cluster**		**4. Cluster**	
	EIUI Score	URAP Ranking Score	EIUI Score	URAP Ranking Score	EIUI Score	URAP Ranking Score	EIUI Score	URAP Ranking Score
Mean	74,52	1000,91	53,68	910,29	40,98	740,38	45,74	652,02
S.D.	5,7	76,64	6,96	76,45	3,53	83,61	6,8	91,82

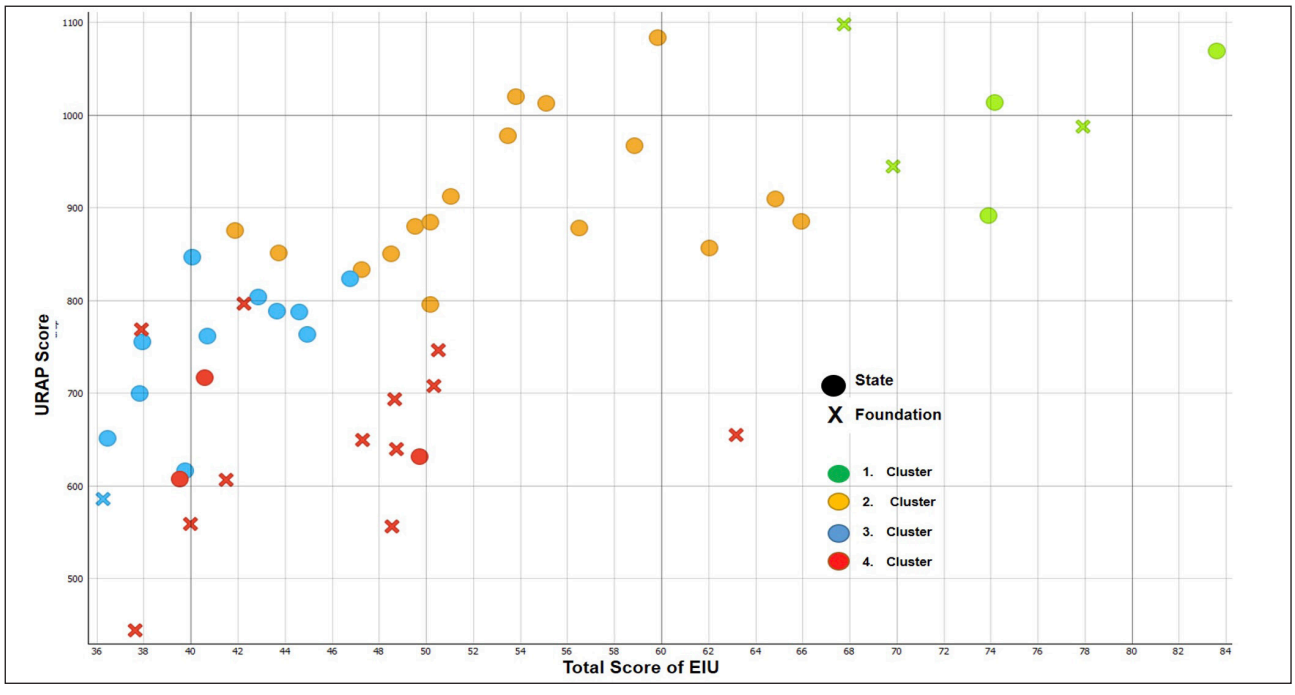

Figure 7. The Distribution of the Clusters of EIUI Total Score and URAP Ranking Score

While analyzing the distribution of entrepreneurial universities to clusters and the locations of the clusters, we observe that in Cluster 1 there are universities with high scores in both parameters (Middle East Technical Uni. Sabancı Uni., Istanbul Technical Uni., İhsanDoğramacıBilkent Uni., Koç Uni., Yıldız Technical Uni.), and while 3 of these universities are foundation universities and 3 are state universities.

While the universities in Cluster 2 are spread over a wide area, their proximity to Cluster 1 is noteworthy. In other words, strategic improvements to be made on an institutional basis can lead to cluster upgrading. The fact that all universities in this cluster are state universities is also an important output.

Cluster 3 universities are characterized by relatively low total index scores. Although their URAP achievement scores are as high as those in Cluster 2, their low index scores position them closer to Cluster 4. The fact that the universities in this cluster (Atatürk Uni., Bursa Uludağ Uni., Fırat Uni., Ondokuz Mayıs Uni.,) are relatively distant from entrepreneurship ecosystems or have limited interaction with them lowers their total index score. Setting targets to improve the current situation in the strategic plans of universities will pave the way for institutions to better utilize their potential.

Cluster 4 consists of universities with lower URAP ranking scores and index total scores compared to other clusters. However, it was observed that the EIUI index score was higher than Cluster 3. It is noteworthy that there are many foundation universities in the cluster with sparse unit densities. Both the in-house training plans of foundation universities and the high connection of graduates with entrepreneurial and innovative ecosystems have brought them to the top in terms of this index.

Orange, an open-source software, was used in the analysis. The table below displays a comparison of the classification methods' levels of accuracy.

Tablo 5. The Evaluation Criteria for Clustering Methods

Model	RMSE	MAE	R2
Random Forest	4,16	2,92	0,87
Decision Tree	5,67	4,05	0,76
K-NN	7,6	6,08	0,57
SVM	7,92	5,49	0,54

The three main performance metrics that are utilized to evaluate the efficacy of the methods are the Root Mean Square Error (RMSE), Coefficient of Determination (R2) and Mean Absolute Error (MAE). The Coefficient of Determination (R2) is one of these performance indicators, and it is well known that values of 0.70 and above suggest superior performance outcomes (Alpar, 2011). R2 quantifies how well the model fits the data. Lower values suggest higher performance because RMSE and MAE are error measures.

The investigation showed that, in comparison to other methods, the performance results achieved utilizing the Random Forest method produced better outcomes. The other artificial intelligence-based method, Support Vector Machine, has a determination percentage of 54%, while the classical method, K-NN, has a determination percentage of 57%. The closest result to the results of the Random Forest method belongs to the Decision Tree method with a determination percentage of 76%. The smallest RMSE value was found in the Random Forest method at 4.16. The results show that RF has a higher classification accuracy than the other methods.

DISCUSSION

In terms of the variables used in the study, the method of analysis and recent analysis techniques, it focuses on a different point than many other studies in the literature. However, similar results have been obtained with some studies as follows.

While the study is similar in content to clustering studies in the literature, it also provides information about the positioning of universities in terms of different variables. However, when compared with the results of our study, it can be concluded that foundation universities do not have the targeted performance in terms of the index, while some foundation universities are successful in terms of EIUI pillars, contrary to Tosun H. (2020).

When compared with Tekin, E. (2021) our study, it can be said that similar results were obtained despite the use of different methods. On the other hand, it does not include an output on which areas universities are competent in based on their positioning and which universities are similar to them. Another similar result is the paper of Erdoğmuş and Esen (2016). The universities grouped in Cluster 1 in our study's clustering results were found to be comparable to the cluster in their work.

CONCLUSION

This study studied data from the TÜBITAK EIU Index and the concept of entrepreneurial universities, which is gaining importance today. The universities are clustered by evaluating criteria such as URAP ranking score, university status (Foundation - State), and whether they are research universities or not. The data set emerges as multivariate data due to its structure. For this reason, analyses were made with multivariate classification methods and different artificial intelligence-based statistical techniques.

As a result, the study includes recommendations for clustering universities in terms of relevant criteria and identifying areas with development potential. In the analysis, it is explained with examples that some universities in the index rankings can move to higher clusters as a result of little improvements. For example, Ist. Medipol University and Özyeğin University exhibited significant success in the Intellectual Property score, while they achieved relatively lower scores in other pillars. On the other hand, there is an unstable region in terms of URAP score and index score. Acıbadem Mehmet Ali Aydınlar Uni., Çankaya Uni., Ondokuz Mayıs Uni, Selçuk Uni, Akdeniz Uni, EskişehirOsmangazi Uni, Kocaeli Uni, and Sakarya Uni located in this region will gain significant advantages in research university application processes if they show small improvements in both parameters.

Another outcome of the study is the high correlation between the URAP ranking score and the status of being a research university and the index scores. In addition, the different clustering of foundation universities and public universities on a positioning basis is another noteworthy result. It can be stated that the basis of this phenomenon is the difference in the vision of universities' career development centers and graduate profiles.

The fact that the results of the study have similar results with the limited number of studies in the literature contributes to the development of consistent policies for decision-makers. On the other hand, the first 50 universities of the EIU index are announced. This study provides guidance in terms of location and clustering for other universities outside the index that calculate their scores in terms of other indicators and pillars related to the index.

RECOMMENDATIONS

The first parameter that stands out in the success performance of universities is ranking systems. However, the problems experienced by institutions with different specialization areas, scales, and sizes in these rankings bring different evaluation criteria to the agenda. One of the important results of the study is that the use of clustering, scaling, etc. in addition to ranking systems in the evaluation of the success performance of universities will give more accurate results.

On the other hand, although there are differences in the rankings of universities, it is thought that the common aspects of homogeneous clusters that emerge as a result of cluster analysis will be more helpful for universities in terms of positioning. Considering university ranking systems holistically with clustering approaches provides important support to policymakers in decision-making.

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Assessment of Hospital Managers' Sustainable Leadership Levels

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ABSTRACT

This study aims to evaluate the sustainable leadership levels of hospital managers with the participation of healthcare professionals working in public hospitals in Bitlis province. The cross-sectional and descriptive study was conducted on 354 healthcare professionals and the information form and Sustainable Management Behaviors Scale were used as data collection tools. The demographic analysis of the study shows that the majority of the participants are male, under the age of 30 and have a bachelor's degree. In terms of occupational groups, it was observed that other health personnel and nurses were predominant. The findings revealed that the participants generally evaluated the sustainable leadership behaviors of the managers at a level above medium. Especially environmental sensitivity and conservation sensitivity dimensions have high mean values. Nurses were found to have the most negative opinions about managers' sustainable leadership levels, while administrative staff had the most positive opinions. It was determined that positive perceptions were higher for managers who are experienced, act in accordance with ethical principles and adopt the philosophy of continuous learning. The study draws attention to the importance of sustainable leadership practices in the healthcare sector and offers strategic recommendations to increase the leadership capacity of hospital managers.

Keywords: Sustainable Leadership, Hospital Managers, Leadership Behaviors, Healthcare, Sustainability.

JEL Classification Codes: M10, Q56, K32

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INTRODUCTION

The health sector possesses a dynamic structure that is continuously changing and evolving, thereby increasing the significance of effective leadership practice in this field. Leaders in this domain are compelled to develop flexible and holistic strategies in response to both internal and external factors. The adoption of sustainable leadership approaches should be considered a strategic step aimed at ensuring the long-term success of healthcare institutions and improving the overall health status of the community. In this context, the effective management of healthcare services and the proper utilization of resources significantly impact a country's level of development and the general well-being of its population.

The level of development of a country and the welfare of its population are directly associated with the performance of healthcare services and the efficiency of resource utilization in this field (Ilıman Yaltagil, 2023).

The objective of this study is to comprehensively assess and analyze the sustainable leadership levels of hospital managers. Sustainable leadership encompasses leadership approaches and strategies that support the long-term success and resilience of institutions. In this context, the study examines the leadership practices of hospital managers, the impacts of these practices, and how they support sustainability in the healthcare services sector. The research will scrutinize the effects of leadership behaviors on the quality of patient care, employee satisfaction, and institutional sustainability, while also addressing the challenges faced by hospital managers and strategies for enhancing their sustainable leadership competencies. The outcome of this study aims to provide recommendations and strategies for increasing the sustainable leadership capacities of hospital managers.

Sustainable Leadership

Leadership can be defined as the ability to unite individuals around specific goals and to motivate them

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to achieve these goals. In this process, the internalization and desire of the objectives set by the leader among group members enhance the leader's capacity to influence and strengthen their ability to mobilize the group members. A leader's demonstration of belief and commitment to the goals they set, ensuring the loyalty and motivation of group members, encourages them to exert the necessary effort to achieve these goals. Therefore, leadership is not limited to merely setting goals but also encompasses the skill of effectively managing group dynamics and human resources required to achieve these goals (Eren, 2011; Koçel, 2014; Allio, 2012). Sustainability practices present both risks and opportunities for organizations, and clear and direct leadership is required to improve these processes (Boeske, 2023).

Healthcare institutions are high-energy-consuming entities that produce harmful and toxic waste. Simultaneously, experts from various disciplines work within this shared ecosystem. Furthermore, considering the increasing costs due to the need for high technology and high-paid labor in the health sector, the concept of social, environmental, and financial sustainability becomes indispensable in healthcare institutions. Studies in the literature emphasize the critical importance of leadership in organizations being sustainable (McSherry and Pearce 2016; Sagha Zadeh et al. 2016).

Lindsey and Mitchell (2012) categorize the essential characteristics that effective health leaders must possess under five main headings. These characteristics are presented as qualities that will contribute to the development of leaders who will shape the future of the health sector. These five core qualities are:

- Leaders in healthcare services must have the capacity to foresee and accurately interpret the continuously changing structure and needs of the health sector.
- They must demonstrate sensitivity to the needs of healthcare service recipients and possess the ability to provide quick and effective responses to these needs.
- They should have a vision capable of managing change processes within institutions and organizations, centering these changes.
- They must embody leadership qualities that can motivate themselves and those around them and serve as a source of inspiration.
- Health leaders should possess management skills that ensure the operation of organizations in a straightforward and high-quality manner.

The concept of sustainable leadership denotes a management philosophy that considers the needs of future generations. This leadership style prioritizes long-term impacts and institutional resilience over short-term successes. Sustainable leaders integrate various dimensions such as social justice, environmental balance, and economic stability to ethically and responsibly manage their organizations. They aim for the long-term welfare of the institution by balancing the interests of internal and external stakeholders while ensuring the efficient use and renewal of resources (Mısırdalı Yangil, 2016). Sustainable leadership has benefits such as focusing on the situation, demonstrating moral courage and high self-awareness, having a long-term vision, meeting stakeholders' needs, creating sustainable shared value and creating collective impact (Liao, 2022).

Sustainable leadership is based on a clear and sustainability-focused business vision, long-term goals, and a comprehensive sense of responsibility towards individuals, groups, organizations, and society. This leadership approach develops a strong organizational culture that supports sustainable organizational development and encourages collective efforts based on mutual assistance rather than individual endeavors. Operating with high levels of trust and goodwill, sustainable leadership emphasizes the synergy of team members' efforts and supports innovation and creativity by reusing the organization's current resources. Teamwork aims to achieve and maintain quality through a sustainability-focused organizational culture and to foster employee loyalty and professional development by adhering to sustainability principles (Šimanskienė and Župerkienė, 2014).

Factors Affecting Sustainable Leadership

There are internal and external factors that influence sustainable leadership, which can be conceptualized into three main groups: stakeholder assessments, institutional processes, and the external environment. These elements represent a grouping of factors necessary for achieving a sustainable culture and sustainable leadership. This conceptualization demonstrates the various elements and factors affecting an institution's sustainable culture and leadership. By developing this conceptualization of sustainable leadership, connections can be established within the literature, and the potential effects of sustainable leadership can be explored (Gerard et al.,

2017). The vision, credibility, collaboration, accountability, and orientation towards action of leaders are significant factors in achieving sustainable development (Tomšič, Markič, & Bojnec, 2016).

Dimensions of Sustainable Leadership

Sustainable leadership encompasses three dimensions: environmental sustainability, economic sustainability, and social sustainability (McCann and Holt, 2010).

Environmental sustainability refers to leadership practices focused on preserving environmental resources and maintaining the integrity of ecosystems. Environmentally sustainable leadership aims to leave a healthy environment for future generations through responsible use of natural resources and minimization of environmental impacts. This approach requires strategic decisions to preserve ecological balance and promote environmental sustainability (Morelli, 2011).

Economic sustainability describes leadership that targets the efficient use of resources and long-term financial stability. This dimension prioritizes economic growth as well as cost-effectiveness, return on investment, and financial sustainability. Economically sustainable leaders support the future success of organizations by ensuring efficiency and equity in resource allocation (Harris, 2000). Organizations assess processes to maintain control over costs while conducting their operations effectively and efficiently (Orhan and Kafes, 2021).

Social sustainability emphasizes leadership practices that contribute to the welfare of society and the promotion of social justice. This dimension focuses on meeting the needs of individuals and communities and promoting social cohesion and equality. Socially sustainable leaders foster an inclusive and fair society by placing a strong emphasis on ethical values and social responsibility (McKenzie, 2004).

Models of Sustainable Leadership

Sustainable leadership models include the Hargreaves and Fink model, Lambert's sustainable leadership model, the Russell Reynolds sustainable leadership model, Šimanskienė and Zuperkiene's sustainable leadership model, Avery and Bergsteiner's sustainable leadership model, and the Cambridge sustainable leadership model.

Hargreaves and Fink Model

This model emphasizes the diversity of educational environments, the importance of idea exchange, the necessity of active participation in successful practices that share continuous development and learning, alongside various forces affecting the type of leadership. In this study, sustainability in leadership is specifically focused on the characteristics and needs of the education sector (Hargreaves and Fink, 2003).

Lambert's Sustainable Leadership Model

Developed in 2011, Lambert's Sustainable Leadership Model comprehensively examines six fundamental elements of leadership. These elements include building staff capacity, strategic deployment, consolidation, transition from short-term to long-term objectives, diversity, and preservation. This model details the sustainable leadership concept, highlighting the contribution of each element to organizational success (Lambert, 2011).

Russell Reynolds Sustainable Leadership Model

In this model, sustainable leadership is defined as organizations developing long-term strategies beyond short-term gains and addressing social, environmental, and financial performance in a balanced manner. Sustainable leaders in this model are individuals who understand the system holistically and consider the broader context beyond the organization. They also focus on building long-term relationships by viewing diversity as an opportunity (Jansen and Ligthart, 2015).

Šimanskienė and Zuperkiene's Sustainable Leadership Model

This model addresses sustainability in four fundamental areas: individual, team, organization, and society. These categories represent different aspects of leadership and various dimensions of sustainability. The individual dimension emphasizes leaders' personal awareness and acceptance of responsibility. The team dimension focuses on the need for qualified workforce and establishing sustainable relationships among employees. The organizational dimension involves strengthening sustainable ideas at the corporate level and shaping organizational culture (Šimanskienė and Zuperkiene, 2014).

Davies' Sustainable Leadership Model

Developed by Davies (2007), the "Nine Key Factors" sustainable leadership model identifies fundamental principles supporting long-term development. This model emphasizes that leadership culture should be shaped by achieving accessible successes based on moral purposes. Among the key elements of sustainable leadership are measuring not only outputs but

outcomes; balancing short and long-term goals; focusing on processes rather than plans; having a passion for continuous improvement and development; building long-term leadership capacity through personal humility and professional will; the importance of strategic timing and strategic implementation in enhancing capacity and encouraging participation; and developing strategic success metrics.

Avery and Bergsteiner's Sustainable Leadership Model

Under the "Honeybee and Locust Approach," this model examines the impacts of leadership approaches on environmental and social sustainability. It is based on two fundamental metaphors: the honeybee, representing a sustainable approach that benefits society, and the locust, symbolizing a leadership style focused on short-term gains and unsustainable. This theoretical framework evaluates the effects of leaders' decision-making processes on their organizations' long-term success and the overall welfare of society. The model emphasizes that leaders acting with sustainable methods contribute to creating a more livable world for future generations by supporting ecological balance and social justice (Avery and Bergsteiner, 2011).

Cambridge Sustainable Leadership Model

This model represents an approach focused on integrating sustainability into business strategies by leaders. It aims to support the long-term success of organizations and environmental, social, and economic sustainability. Its core principles include meeting the needs of all stakeholders in a balanced manner, promoting the efficient use of resources, and developing innovative solutions. The Cambridge Sustainable Leadership Model emphasizes prioritizing ethical values and sustainable practices in leaders' decision-making processes. It requires organizations to assess their decisions not only in terms of financial results but also considering social and environmental impacts. Leaders, with this model, aim to make responsible and informed decisions considering the welfare of future generations (Visser and Courtice, 2011).

METHOD

This cross-sectional and descriptive study's population consists of health workers employed at public hospitals in Bitlis province. The sample size was calculated using the formula for known population sizes, employing the calculator available on surveymonkey.com. It was determined that data needed to be collected from 384 individuals, considering a 95% confidence interval (z=1.96) with a 4% margin of error. However, 354 health workers voluntarily participated in the study. The research included the participation of doctors, nurses, midwives, other health personnel, and administrative staff working in 7 public hospitals in the province.

For data collection, a questionnaire comprising a 4-question information form prepared by the researchers and the Sustainable Management Behaviors Scale was used. The scale, developed by Demirbilek and Çetin (2021), includes 50 statements related to dimensions of Institutional Functioning, Economic Efficiency, Environmental Sensitivity, and Protection Sensitivity Behaviors. Research data were collected online via Google Forms. The measurements were conducted using a 5-point Likert scale.

For the analysis of research data, SPSS 25.0 and SPPS AMOS 24.0 were utilized. Within this context, confirmatory factor analysis was conducted to determine the validity and reliability of the scale developed for the education sector in the health sector. Internal consistency coefficient was calculated to test structural reliability. Furthermore, mean tests related to the scale and its dimensions were conducted according to the study's control variables, and differences were analyzed with parametric tests since the assumptions of normal distribution were met.

Before commencing data collection for the study, institutional permission numbered E-93515114-605.99-212780087 from the relevant institution and ethical approval numbered 2023/04-04 and E.3668 from the Ethical Principles and Ethics Committee of Bitlis Eren University were obtained.

FINDINGS

This study examines the sustainable leadership behaviors of managers in healthcare institutions from the perspective of employees. In the section below, findings related to the demographic characteristics of the participants and their opinions about their leaders, as well as validity and reliability analyses of the scale, average values, and comparisons of these values between groups are presented.

Table 1 presents the distribution of participant profiles according to demographic and various variables. The study examines several variables including gender, age, education level, profession, duration of employment at the institution, experience status of the institution's managers, whether participants believe managers act in accordance with ethical principles, and whether they

Table 1: Distribution of Employees' Demographic Characteristics and Their Opinions About Their Leaders

Variables		n	%
Gender	Female	141	39,8
	Male	213	60.2
Age	*≤ 30*	170	48,0
	31-40	129	36,4
	41-50	45	12,7
	≥ 51	10	2,8
Education	Primary and Secondary Education	45	12,8
	Associate Degree	87	24,7
	Bachelor's Degree	194	55,1
	Graduate Degree	26	7,4
Profession	Physician	56	15,8
	Nurse	93	26,3
	Midwife	23	6,5
	Other Health Personnel	135	38,1
	Administrative Staff	47	13,3
Duration of Employment at the Institution	*≤ 1 Year*	50	14,1
	1-3 Year	84	23,7
	≥ 3 Year	220	62,1
Experience Status of the Institution's Managers	Inexperienced	60	16,9
	Moderately Experienced	140	39,5
	Experienced	154	43,5
Whether Employees Believe Managers Act in Accordance with Ethical Principles	*No*	73	20,6
	Partially	125	35,3
	Yes	156	44,1
Whether Employees Think Managers Embrace a Philosophy of Continuous Learning	*No*	74	20,9
	Partially	119	33,6
	Yes	161	45,5
TOTAL		**354**	**100,0**

think managers embrace a philosophy of continuous learning.

When examining gender distribution, it is observed that 60.2% of the participants are male, and 39.8% are female. Looking at the age distribution, a significant portion of the participants are under 30 years old (48.0%), while the proportion of participants aged 51 and above is only 2.8%. In terms of education level, the highest rate is observed among participants with a bachelor's degree (55.1%). In the profession distribution, a large part of the participants are identified as other health personnel (38.1%) and nurses (26.3%). When examining the duration of employment at the institution, it is observed that 62.1% of the participants have been working at the same institution for 3 years or more.

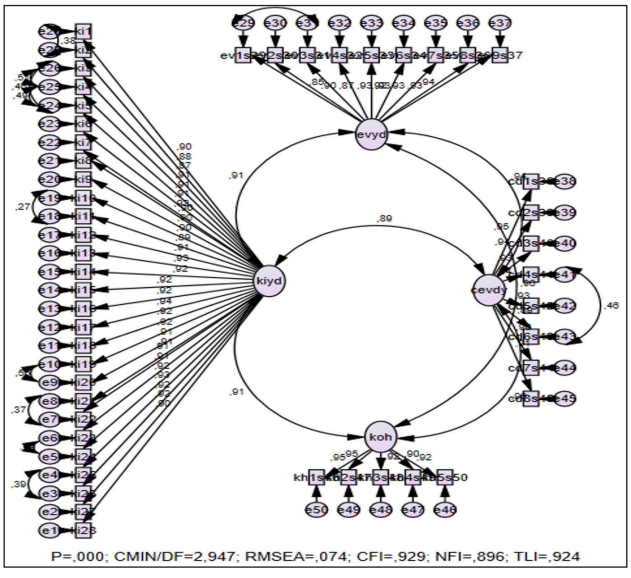

Figure 1: Confirmatory Factor Analysis of the Sustainable Leadership Behaviors Scale

Table 2: Statistical Values Related to the Sustainable Leadership Scale and Its Statements

The Sustainable Leadership Scale Statements and Dimensions	x	sd	Kurt.	Skew.	a
Efforts to reduce inequalities.	3,25	1,50	-0,32	-1,28	
Cares for marginalized individuals.	3,32	1,51	-0,36	-1,28	
Fosters unity and solidarity among employees in the institution.	3,29	1,51	-0,32	-1,32	
Embraces social justice.	3,29	1,51	-0,28	-1,34	
Supports democratic governance.	3,22	1,49	-0,23	-1,31	
Rejects discrimination.	3,25	1,54	-0,20	-1,42	
Strives to increase employee satisfaction in the institution.	3,35	1,49	-0,37	-1,26	
Values equal opportunities.	3,28	1,46	-0,27	-1,23	
Clarifies uncertainties.	3,30	1,45	-0,30	-1,22	
Ensures employees have equal access to necessary resources.	3,41	1,46	-0,46	-1,12	
Works to maintain employee continuity in the institution.	3,43	1,47	-0,45	-1,18	
Manages emerging risks effectively.	3,46	1,46	-0,45	-1,12	
Considers diversity in the institution.	3,40	1,42	-0,39	-1,12	
Has a clear vision.	3,36	1,45	-0,34	-1,20	
Thinks more of the well-being of everyone in the institution than their own interests.	3,21	1,53	-0,21	-1,38	**0,993**
Establishes dialogues that inspire the future of society.	3,33	1,47	-0,33	-1,26	
Creates lasting unity in the institution by ensuring stakeholder participation.	3,30	1,48	-0,30	-1,27	
Acts responsibly towards meeting employee needs.	3,38	1,45	-0,34	-1,21	
Develops a vision for the long-term development of the institution.	3,33	1,48	-0,29	-1,28	
Sets permanent development goals.	3,32	1,45	-0,32	-1,22	
Mobilizes resources to sustain employee development.	3,31	1,45	-0,33	-1,20	
Develops strategies aimed at maintaining institutional efficiency.	3,39	1,45	-0,36	-1,20	
Engages in long-term planning.	3,34	1,47	-0,32	-1,25	
Directs the future of the institution by reducing uncertainty.	3,31	1,45	-0,30	-1,23	
Collaborates with employees for the effective use of resources.	3,38	1,44	-0,34	-1,19	
Fights to protect elements that carry the institution into the future.	3,41	1,40	-0,38	-1,08	
Takes care to distribute the resources owned by the institution fairly among stakeholders.	3,28	1,50	-0,29	-1,32	
Considers the activity-resource status balance.	3,38	1,43	-0,37	-1,16	
Behaviors Related to Institutional Functioning (BRIF):	3,33	1,34	**-0,31**	**-1,17**	
Prefers to effectively utilize existing materials instead of purchasing new ones for the institution.	3,59	1,32	-0,53	-0,83	
Dislikes wastage of institutional resources.	3,61	1,42	-0,60	-0,94	
Transforms and reuses old materials of the institution.	3,47	1,35	-0,48	-0,88	
Makes balanced expenditures.	3,40	1,40	-0,35	-1,10	
Knows how to evaluate existing resources well.	3,52	1,37	-0,48	-0,97	**0,977**
Ensures economical use of the budget in planning.	3,53	1,39	-0,50	-0,96	
Saves costs by using resources efficiently.	3,53	1,39	-0,48	-1,02	
Eliminates practices that cause resource waste.	3,52	1,40	-0,49	-1,00	
Takes care to preserve the institutional heritage.	3,48	1,37	-0,46	-0,93	
Behaviors Related to Economic Efficiency (BREE):	3,52	1,27	**-0,47**	**-0,88**	

Encourages projects related to the environment.	3,39	1,42	-0,36	-1,14	
Has sensitivity towards environmental protection.	3,47	1,39	-0,47	-1,00	
Engages in initiatives aimed at preserving nature.	3,52	1,35	-0,46	-0,96	
Has sensitivity towards the separation of waste.	3,75	1,26	-0,72	-0,49	
Works to increase environmental awareness in the institution.	3,51	1,38	-0,46	-1,00	**0,976**
Supports recycling practices.	3,64	1,31	-0,57	-0,77	
Partners with NGOs related to the environment.	3,42	1,38	-0,36	-1,05	
Rejects initiatives that may harm the environment.	3,62	1,35	-0,58	-0,82	
Behaviors Related to Environmental Sensitivity (BRES):	3,54	1,25	**-0,45**	**-0,88**	
Has sensitivity towards the preservation of institutional resources.	3,58	1,31	-0,53	-0,81	
Uses resources within the institution's limits efficiently.	3,54	1,35	-0,53	-0,88	
Thinks not only about today but also about the future.	3,46	1,42	-0,46	-1,07	
Desires to maintain positive conditions in the institution.	3,63	1,33	-0,62	-0,73	**0,968**
Encourages employees to use resources sparingly.	3,55	1,36	-0,52	-0,89	
Behaviors Related to Conservation Sensitivity (BCS):	3,55	1,28	**-0,45**	**-0,92**	
Sustainable Leadership Behaviors Scale (Overall)	3,42	1,27	**-0,34**	**-1,05**	0,995

The study also finds that a majority of managers are experienced (43.5%), participants generally believe their managers act according to ethical principles (44.1%), and most think that their managers adopt a philosophy of continuous learning (45.5%).

Figure 1 schematizes the Confirmatory Factor Analysis model conducted to determine if the Sustainable Leadership Behaviors Scale, developed for the education sector, provides valid and reliable measurement in the health sector.

Based on the information provided in Figure 1, considering the factor loadings of the statements onto dimensions and the model fit indices, it has been determined that the scale provides valid measurement. The figure at the bottom shows the p-value, Chi-Square/Degrees of Freedom value (CMIN/DF), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and the Root Mean Square of the Residuals (RMR) values, indicating that they are at good and acceptable levels (Karagöz et al., 2016).

Table 2 contains scale statements, dimensions, and overall scale-related mean and standard deviation values, kurtosis and skewness values, and Cronbach's alpha internal consistency coefficients. The internal consistency coefficients for the overall scale and its dimensions are found to be quite high according to Kılıç (2016). The research data's adherence to the assumption of normal distribution has been tested with kurtosis and skewness values. Accordingly, since the kurtosis and skewness values for the dimensions and overall scale are between -1.5 and +1.5, it is stated that the assumption of normal distribution is met (Tabachnick and Fidell, 2013).

Table 2 also presents measured values related to the Sustainable Leadership Behaviors Scale, its dimensions, and statements. According to the opinions of the participants, the levels of sustainable behavior among health managers are seen to be above the medium level (x=3.42, s:1.27). When examining the average values by dimensions, the dimension with the lowest level is found to be Behaviors Related to Institutional Functioning (BRIF), while the dimension with the highest average is related to the sensitivity of resource preservation, namely Conservation Sensitivity Behaviors (CSB). When examining the averages for the statements, the two statements with the lowest averages are "Thinks more of the well-being of everyone in the institution than their own interests" (x=3.21) and "Supports democratic governance" (x=3.22), while the statements with the highest averages are "Supports recycling practices" (x=3.64) and "Has sensitivity towards the separation of waste" (x=3.75). From this, it can be inferred that corporate and social sustainability are somewhat low, while behaviors related to environmental sustainability are somewhat high.

Table 3 presents the group averages for Sustainable Leadership Behavior and its sub-dimensions based on demographic and some other variables. However, socio-demographic variables that did not show statistically significant differences are not included in this table. The study found that female employees tend to have more negative opinions about their managers' sustainable leadership behavior levels ($p<0.05$). When examining the thoughts of participants on their managers' sustainable leadership behaviors based on their education levels,

Table 3: Group Differences in Sustainable Leadership Behavior Level

Variables	N 354	BRIF X̄ \s	BREE X̄\s	BRES X̄\s	BCS X̄\s	Sustainable Leadership X̄\s
Gender						
Female	141	3,04\1,26	3,30\1,20	3,35\1,19	3,37\1,22	3,17\1,17
Male	213	3,51\1,36	3,65\1,29	3,65\1,28	3,67\1,29	3,57\1,30
T Test (p)		0,001	0,001	0,002	0,003	0,003
Education Level						
Primary and Secondary Education	47	3,99\1,22	4,07\1,2	4,14\1,06	4,19\1,11	4,05\1,13
Associate Degree	87	3,37\1,34	3,63\1,30	3,78\1,23	3,71\1,31	3,52\1,26
Bachelor's Degree	194	3,10\1,31	3,27\1,25	3,78\1,14	3,27\1,25	3,17\1,24
Graduate Degree	26	3,63\1,35	3,88\0,99	3,53\1,25	3,96\0,97	3,73\1,16
ANOVA Test (p)		0,001	0,001	0,001	0,001	0,001
Post Hoc (Tukey's)		(1-3)	(1-3)	(2-1,3)	(3-1,2,4)	(1-3)
Profession						
Physician	56	3,69\0,77	3,70\0,79	3,58\0,89	3,66\0,85	3,67\0,75
Nurse	93	2,93\1,29	3,37\1,15	3,36\1,21	3,41\1,19	3,13\1,17
Midwife	23	3,24\1,39	3,25\1,27	3,33\1,22	3,40\1,27	3,27\1,30
Other Health Personnel	135	3,11\1,44	3,29\1,43	3,37\1,36	3,32\1,41	3,20\1,39
Administrative Staff	47	4,33\1,07	4,34\1,09	4,41\1,05	4,41\1,06	4,35\1,04
ANOVA Test (p)		0,009	0,001	0,001	0,001	0,001
Post Hoc (Tukey's)		(2-1,5) (4-1,2) (5-2,4)	(5-2,3,4)	(5-1,2,3,4)	(5-1,2,3,4)	(5-1,2,3,4)
Experience Status of the Managers						
Inexperienced	60	1,66\0,84	2,11\0,99	2,10\1,06	2,07\1,01	1,85\0,85
Moderately Experienced	140	2,93\1,00	3,19\1,03	3,24\1,00	3,24\1,00	3,06\0,92
Experienced	154	4,33\0,85	4,35\0,89	4,40\0,87	4,40\0,87	4,35\0,82
ANOVA Test (p)		0,009	0,001	0,001	0,001	0,001
Post Hoc (Tukey's)		(1-2-3)	(1-2-3)	(1-2-3)	(1-2-3)	(1-2-3)
The Perception of Managers Acting in Accordance with Ethical Principles						
No	73	1,66\0,73	2,29\1,15	2,32\1,13	2,22\1,09	1,93\0,80
Partially	125	2,95\0,96	3,08\1,01	3,12\0,97	3,16\0,96	3,02\0,90
Yes	156	4,41\0,72	4,43\0,75	4,43\0,75	4,48\0,75	4,42\0,70
ANOVA Test (p)		0,001	0,001	0,001	0,001	0,001
Post Hoc (Tukey's)		(1-2-3)	(1-2-3)	(1-2-3)	(1-2-3)	(1-2-3)
The Perception of Managers Adopting a Philosophy of Continuous Learning						
No	74	1,69\0,80	2,14\1,05	2,16\0,99	2,11\1,00	1,89\0,80
Partially	119	2,90\0,95	3,12\0,95	3,19\0,98	3,21\0,95	3,02\0,88
Yes	161	4,39\0,71	4,43\0,73	4,42\0,73	4,46\0,75	4,41\0,68
ANOVA Test (p)		0,009	0,001	0,001	0,001	0,001
Post Hoc (Tukey's)		(1-2-3)	(1-2-3)	(1-2-3)	(1-2-3)	(1-2-3)

it was determined that those with undergraduate education have more negative thoughts. In the context of professional groups, nurses were found to have the most negative thoughts about their managers' sustainable leadership levels, while administrative staff were observed to have the most positive thoughts.

When examining sustainable leadership behavior levels based on managers' experience, it is observed that employees have more positive thoughts about experienced managers and more negative thoughts about inexperienced managers. Additionally, employees who believe their managers act according to ethical

principles have more positive thoughts about their sustainable leadership behaviors. Similarly, positive perceptions towards sustainable leadership behavior are observed for managers believed to embrace a philosophy of continuous learning. These differences are consistent across all dimensions and the overall scale.

DISCUSSION AND CONCLUSION

This study was conducted with the participation of health personnel working in public hospitals in Bitlis province and evaluated the sustainable leadership levels of hospital managers. The research explored the relationships between demographic variables and sustainable leadership behaviors. Findings indicated that the majority of participants are young, have undergraduate education, and are male. Sustainable leadership behaviors were generally assessed at a medium level, with especially high scores in dimensions related to environmental sustainability. Nurses and highly educated employees reported more negative opinions about their managers' leadership behaviors.

An interesting finding of the study is the perception that leaders who act ethically and adopt a philosophy of continuous learning are considered more sustainable leaders. The relationship between ethics and sustainability has been proposed in other studies as well. For instance, Suriyankietkaew and Kungwanpongpun (2022) found that ethical behavior is one of the most significant predictors of sustainability outcomes. Similarly, Kantabutra (2011) in his study at Theptarin Hospital in Thailand found that the ethical behavior of health managers is one of the most effective evidence of sustainable leadership.

Kantabutra (2011) similarly emphasizes that being innovation-oriented, managing and sharing knowledge, developing management, retaining staff, and exhibiting social responsibility behaviors are strong qualities of sustainable leaders. Abid et al. (2023) also argue that social and humanistic leadership elements that consider employee well-being are very important for the health sector. This study found that managers' sustainable leadership virtues in social and individual areas are somewhat lower compared to environmental and economic dimensions.

Globally, the number of healthcare personnel is not yet at the expected level (WHO, 2021), and pressures and challenges on health systems could increase due to early retirements or quitting the profession caused by poor management practices or systemic effects. Therefore, it is necessary to consider and initiate improvements towards the social dimensions of sustainability, as much as the environmental and economic dimensions. The model developed by Lewandowska et al. (2023), which suggests that organizational sustainability behaviors are positively affected when employees actively participate in corporate social sustainability activities, can contribute to this process.

Despite being at a better level compared to other dimensions, the potential for improvement in the environmental sustainability dimension is notable. The relatively good status in the environmental sustainability area can be explained by the awareness created as a result of the Ministry of Health in Turkey leading waste disposal efforts and the construction of less resource-consuming and less waste-producing institutions, with other ministries and municipalities also taking responsibility (Regulation on Medical Waste Control Practices Circular, 2010; Ministry of Health, 2024 [saglik.gov Energy Efficiency]). Akkaya (2020) found in her qualitative study with health managers that perceptions towards waste management are positively similar between private and public institution managers due to the obligations imposed by legislation. However, this study still identifies some negative perceptions regarding health managers' levels of environmental sustainable leadership. Assessing the provided health service solely by changes made to individual and community health status, without considering environmental, economic, and social impacts, brings many problems (Yeşildağ and Esatoğlu, 2023). Therefore, it is emphasized that managers should keep environmental sustainability more prominently on the agenda, include sustainability topics in health professionals' education (Shaw et al., 2021), and display lean management in supply and production processes (Zhu et al., 2018).

Managers with above-average levels in the economic sustainability dimension, which is one of the essential elements of sustainable leadership, could further enhance their skills and knowledge in this direction for individual and institutional contributions. Yılmaz et al. (2023) highlighted waste management, preference for economical products, and digitalization concepts in their qualitative study with health managers in Konya. It is considered that increasing investments in digitalization in health institutions in the region could be more efficient in the long term.

There is a limited number of measurement tools and studies on health managers' sustainable leadership skills. In the literature, a quantitative study measuring

this topic in the health sector has been encountered. Contrary to the findings of this study, Toker and Çınar (2018) determined that managers in Istanbul had below-medium level environmental sustainability skills, while their social sustainability skills were above medium.

An important contribution of this study is demonstrating that a tool measuring a broad perspective in environmental and social sustainability, as well as economic sustainable leadership areas, can be validly and reliably used in the health sector.

Sustainable leadership in health institutions, especially in the complex and dynamic environment of healthcare services, emerges as a critical element of institutional success and long-term resilience. Sustainable leadership encompasses characteristics such as adherence to ethical values, awareness of environmental and social responsibility, efficient use of resources, and a vision for the future. This leadership approach offers a structure compatible with the goals of improving the quality of patient care, enhancing employee satisfaction and loyalty, and ensuring the continuity of healthcare services. Sustainable leaders can respond quickly to the changing needs of health institutions, generate innovative solutions, and prepare the institution for the future. Additionally, these leaders support the personal and professional development of employees, providing the necessary competence and motivation for continuous improvement of healthcare services. The implementation of sustainable leadership in health institutions also positively impacts the overall health status of the community and access to healthcare services. This leadership approach allows institutions to reduce their environmental footprint, raise ethical standards, and build stronger connections with the community. Consequently, sustainable leadership in health institutions should be considered a fundamental requirement for a healthy and sustainable future at both institutional and societal levels.

Based on the findings of this study, certain recommendations have been developed. These recommendations include:

- Regular training and seminars should be organized to develop hospital managers' sustainable leadership skills.
- Policies focusing on gender equality should be developed to improve female health workers' perceptions of leadership.
- Strategies that encourage managers' ethical behaviors to enhance employees' leadership perceptions should be adopted.
- Managers who embrace a philosophy of continuous learning and development should be prioritized, and this approach should be integrated into the institutional culture.
- Mentoring and coaching programs should be implemented to increase managers' experience levels and effectively utilize these experiences.
- Special projects and initiatives should be initiated for development in institutional functioning and social sustainability areas.
- Policies that support and expand the high evaluations in the environmental sustainability area should be developed.
- Specific programs should be created to address the needs and expectations of nurses to improve their leadership perceptions.
- Special trainings should be organized for managers to support the positive leadership perceptions of administrative staff and establish effective communication with this group.
- More sophisticated leadership approaches and strategies should be developed to meet the expectations of highly educated employees.
- Comprehensive performance evaluation systems should be established to assess and improve health managers' leadership skills.
- Awareness and training campaigns should be organized across the sector to promote sustainable leadership practices in the health sector.
- Award and recognition programs should be developed to encourage health managers' sustainable leadership practices.
- Researchers interested in this area should conduct comparative studies between different health institutions or healthcare service models to examine the effectiveness and differences of sustainable leadership practices. Such comparative studies will help understand how specific leadership practices operate in different contexts and under which conditions they are more effective.

Limitations, Strengths and Future Research

An important limitation of the study is that it presents data collected in a specific period in public hospitals in only one province of Turkey. Therefore, the findings of the study cannot be evaluated beyond cross-sectional and regional estimations. However, no study was found to examine sustainable leadership in health care organizations in Turkey. It is thought that the cross-sectional and regional measurement of the study, which is unique with this strong aspect, is partially overshadowed. In addition, the presentation of a scale with validity and reliability in the health sector may pave the way for future studies on this subject. The fact that the subject is new in the literature and that there are no studies in health institutions shows that many studies can be conducted when examined from a different perspective. For this reason, studies modeling many different variables can be conducted to examine the antecedents and successors of sustainable leadership in health institutions. In this context, the findings of managerial ethics approach, continuous learning culture and experience, and the areas of low sustainability at the level of items, which are noteworthy in this study, can be instructive.

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Psychometric Properties of the Turkish Version of the Entrepreneurs' Social Identity Scale

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ABSTRACT

This study aimed to assess the psychometric properties of the Turkish adaptation of the Entrepreneurial Social Identity Scale. The factor structure (confirmatory factor analysis), construct validity (convergent and discriminant validity), and reliability (internal consistency) of the Turkish version were analyzed. Convergent validity was examined in relation to entrepreneurial self-efficacy and entrepreneurial career motivations. Discriminant validity was tested by examining its relationship with locus of control, subjective norm, risk perception, and uncertainty avoidance. A total of 216 startup founders in technoparks participated. Findings indicated acceptable goodness-of-fit indices for the scale's factor structure, supporting its three-factor structure. Confirmatory factor analysis results were as follows: $\chi 2=254$, $p < 0.01$, $\chi 2/df=2.92$, TLI= 0.91, CFI = 0.92, RMSEA= 0.09. Internal consistency within the three-factor structure (.75, .93, .89) was acceptable. In conclusion, there is substantial evidence supporting the psychometric properties of the Entrepreneurial Social Identity Scale.

Keywords: Entrepreneurship, Startup, Entrepreneurial Social Identity Scale, Validity, Reliability, Psychometric Properties, Turkish Version.

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INTRODUCTION

Identity theory is a concept that includes theories that try to explain individuals' identities and behaviors in terms of the identities of societies. The theory assumes that people have internalized meanings tied to each of their identities and that they behave to ensure that others view them in a way consistent with these meanings (Burke & Stets, 2009). Social Identity theory was put forward by Tajfel & Turner (1979) to explain the cognitive processes of individuals and the relationships of individuals between groups. The social psychology theory attempts to explain individuals' behavior toward group relations by referring to themselves. It is a theory that deals with individuals' perception of themselves as group members, their membership in a group, and the relationships regarding the group formation process. Identities contain a cognitive answer to a person's 'who am I' question about themselves. They also include the characteristics, preferences, behaviors, and goals that the individual associates with themselves (Howard, 2000: 369). Here, the answer given by individuals to define themselves to the question 'Who am I?' reflects their identities, while the answer given as 'we and others' (group membership) by defining themselves through classification reflects their social identities (Leaper, 2011).

Identity provides individuals a foundation for interpreting their social situation and behaviors (Sieger et al., 2016). In this sense, it is essential to use social identity to understand and explain entrepreneurial behavior. In recent years, social identity has been used in entrepreneurship research and has developed a growing literature (Franke et al., 2006; Fauchart & Gruber, 2011; Powell & Baker, 2014). In line with this, in the research conducted by Fauchart & Gruber (2011) to understand entrepreneurs' attitudes and behaviors, it was emphasized that entrepreneurial types differentiate based on entrepreneurs' perceptions and attitudes. Sieger et al. (2016) emphasized that starting or creating an enterprise is a social activity; therefore, the entrepreneurial self's social aspects are essential. Leitch & Harrison (2016) also state that entrepreneurs attribute meaning to their behaviors with their perceived identity. Thus, identity is a powerful element guiding entrepreneurial actions since enterprises are social structures established with social aspects aimed at the individual self (Fauchart & Gruber, 2011). Studies in the field of entrepreneurship have

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also found that there is a strong relationship between entrepreneurial identity and behavior (Alsos et al., 2016; Cardon et al., 2009; Estrada-Cruz et al., 2020; Fauchart & Gruber, 2011; Gruber & Mac Millan, 2017; Powell & Baker, 2014). The reason why so much emphasis is placed on identity and group processes is the view that '*one way to understand people is to understand identity*' (Jenkins, 2008: 20).

Introducing social identity theory in entrepreneurship research provides a better understanding of the entrepreneur and the entrepreneurship process, as entrepreneurs' social identity perceptions affect their goals, motivation, and attitudes. Therefore, Sieger et al. (2016) developed the Entrepreneurial Social Identity Scale. The researchers conducted a comprehensive study with 9,341 participants from 16 countries (Estonia, Brazil, Hungary, Germany, Italy, Mexico, Malaysia, Poland, Netherlands, Singapore, Russia, Australia, Spain, Canada, the United Kingdom, and the United States) engaged in new firm creation activities. In the first stage, nine structures were created for the three constituent social identity types, and two items were added for each structure. Thus, a pool of 18 items was created. As a result of the scale development study, the 15-item 3-factor identity type was confirmed in line with the relevant analyses. It was revealed that the fit values of the three-dimensional scale were at an acceptable level (Factor Loading ≥ 0.507; NFI = 0.936, CFI = 0.965, IFI = 0.967, TLI = 0.927, SRMR = 0.044, RMSEA = 0.06, AVE = between 0.57 and 0.73). The convergent validity of the scale was analyzed with the career motivations and entrepreneurial self-efficacy scales, and findings supporting the validity of the scale were obtained. Discriminant validity was supported by examining relationships with variables such as Locus of Control, Subjective Norm, Risk Perception, and Uncertainty Avoidance. Internal consistency values were found to be 0.78 for the Darwinian dimension, 0.82 for the Communitarian dimension, and 0.84 for the Missionary dimension. During the research process, it was observed that the scale was adapted into 16 languages (English, French, Estonian, Danish, German, Dutch, Italian, Spanish, Hebrew, Japanese, Polish, Hungarian, Russian, Portuguese, Slovenian, and Romanian) by Sieger et al. In this sense, it can be said that the scale has achieved comprehensive validity.

The scale has quantitatively demonstrated that it can be divided into three dimensions: Darwinian, Communitarian, and Missionary, and included those who were not included in these groups in the hybrid entrepreneur group. It has explained that entrepreneurs are separated according to their cognitive aspects in these three dimensions and are grouped into three groups. The characteristics of the three dimensions separated according to entrepreneurs' identity perception are explained below.

Darwinian identity: Entrepreneurs with a Darwinian identity perception consider their interests when establishing a company (Sieger et al., 2016: 546). It refers to entrepreneurs who manage profit-oriented enterprise processes within the framework of competitive conditions in the sector in which they operate. Entrepreneurs with this identity perception are motivated by their economic interests, see their competitors as a frame of reference, and evaluate themselves according to their professionalism (Fauchart & Gruber, 2011). Like classic entrepreneurs, these entrepreneurs focus mainly on establishing strong and profitable companies for economic benefit. An example of this type of entrepreneurship from Türkiye is 'Getir' (www.getir.com).

Communitarian identity: Entrepreneurs with a social identity perception care for the people around them when establishing a company. Such entrepreneurs want to support the social community they feel they belong to. They see society as the primary social reference when establishing companies to provide products and services that communities (groups) need (Sieger et al., 2016). The social benefit comes first, while material processes remain in the background. It continues its activities to benefit society in the social entrepreneurship type. The 'İçimizdeki Hazine' (www.icimdekihazine.com) (Otsimo) startup can be an example of this type of entrepreneurship. It is a platform designed for children with autism, Down Syndrome, and special education needs. It offers educational games free of charge to children with autism and Down Syndrome.

Missionary identity: Entrepreneurs with a Missionary identity perception start enterprise for a better and more prosperous world. They want to increase the welfare of societies and support them by solving their problems. They see society as the primary reference in the social field (Sieger et al., 2016). They act responsibly to maintain their political vision and desire to build a better world (Fauchart & Gruber, 2011). The *'İhtiyaç Haritası'* startup can exemplify entrepreneurship with this sense of identity (www.ihtiyacharitasi.org). İhtiyaçlar Haritası was supported by the United Nations Development Program (UNDP). The mentioned startup aims to unite individuals who want to support needy people or animals on a common platform. The needs and supports of many cities are shown on a map. In this way, supporters can quickly

help many people in need. Additionally, thanks to this platform, companies, non-governmental organizations, and volunteers can meet.

Considering the global popularity of the scale and its potential use in Turkey, it has yet to be adapted to Turkish. In 2023, 3.784 million entrepreneurial activities were recorded in the industrial and service sectors in Turkey (Turkish Statistical Institute, data.tuik.gov.tr), with technology startups receiving $1.74 billion in investments in 2022 and $901 million in 2023 (StartupCentrum.com). Additionally, according to the Global Startup Ecosystem Index 2024 (www.startupblink.com), Turkey ranks 40th. In this context, it is important to elucidate the social identity perceptions and cognitive processes of entrepreneurs in Turkey, which has significant potential.

Despite the Entrepreneurs' Social Identity Scale being internationally validated and widely used in various cultural contexts, there is a notable gap in its application within Turkey. Existing studies on entrepreneurship in Turkey generally focus on economic, institutional, and individual factors (Akarsu & Döven, 2022), but there is limited research examining the social identity of entrepreneurs. This gap hinders a comprehensive understanding of the entrepreneurial landscape in Turkey, as social identity can significantly influence entrepreneurial motivations, behaviors, and success. By adapting and validating this scale for the Turkish context, this study aims to fill this gap and contribute to a more holistic understanding of Turkish entrepreneurship.

In other words, the purpose of this study is to adapt the Entrepreneurs' Social Identity Scale, developed by Sieger, Gruber, Fauchart, and Zellweger (2016), to the Turkish context. This adaptation aims to provide a reliable and valid tool for measuring the social identity of entrepreneurs within Turkey and to offer deeper insights into how social identity influences entrepreneurial behaviors and outcomes in the Turkish entrepreneurial ecosystem.

In order to test the validity and reliability of the Entrepreneurs' Social Identity Scale Turkish form, it must meet certain expectations. The variables and expectations used by Sieger et al. (2016) in developing the scale should be met similarly in the Turkish adaptation study. As the first method to test the scale's validity, the factor structure is expected to be three-dimensional, similar to the original scale, and the fit indices in Confirmatory Factor Analysis (CFA) will be acceptable. The second method is to analyze convergent validity for construct validity. Therefore, a significant relationship is expected between our identity types, career motivations, and entrepreneurial self-efficacy scale. In other words, career choice reasons will differ among identity types because career motivations reveal what motivates individuals to become entrepreneurs. For example, among career motivations, the desire to gain power and money is higher concerning Darwinian among entrepreneurs' social identity types. Entrepreneurs with a Darwinian social identity focus on gaining competitive advantage and dominating the industry. Communitarian and Missionary social identities, on the other hand, tend to be much less concerned about power because they want to support society or help make the world a better place. Their general feature is that they create enterprises that are beneficial to a social group (Communitarian) or society in general (Missionary) (Fauchart & Gruber, 2011).

On the other hand, a higher level of relationship between creativity motivation and missionary identity is expected. Missionaries aspire to engage in organizational innovation processes and enhance them; thus, their motivation to become entrepreneurs is rooted in their desire to apply their creativity (Sieger et al., 2016). The motivation to benefit society and relatives is also expected to be related to the Missionary and Communitarian identity types, as they have their own characteristics. The Entrepreneurial Self-Efficacy scale was also used for convergent validity. A significant relationship with the scale is expected since entrepreneurial self-efficacy expresses individuals' perceptions of their entrepreneurial skills and abilities (McGee et al., 2009; Zhao et al., 2005).

For discriminant validity, Sieger et al. (2016) also found either non-significant or significantly low relationships between the scale and the variables they used for discriminant validity, such as Levenson Locus of Control (Levenson, 1973), subjective norm (Liñán & Chen, 2009), risk perception (Pennings & Wansink, 2004), and avoidance of uncertainty (Hofstede, 2001). Likewise, the Turkish adaptation study expects no relationship with these variables. Thus, the fact that expected similar conditions are met mainly with the developed scale indicates that the scale's psychometric properties are satisfactory.

To adapt the entrepreneur's social identity scale to Turkish, reliability analysis (Cronbach's alphas), factor validity (CFAs), and construct validity (convergent and discriminant validity) were tested. In order to test the convergent and discriminant validity of the entrepreneurs' social identity scale, the Levenson control scale (Levenson, 1973), subjective norm (Liñán & Chen, 2009), risk perception (Pennings & Wansink, 2004),

uncertainty avoidance (Hofstede, 2001), entrepreneurial self-efficacy (De Noble et al., 1999) and entrepreneurial career intentions (Sezer, 2013) scales were used.

Sieger et al. (2016), who developed the scale, employed the variables used for convergent and discriminant validity to test the adapted scale's validity. In this context, a positive relationship was expected with the social identities of entrepreneurs scale using Turkish adaptations of the scales for convergent validity. To test convergent validity, relationships between entrepreneurial career intentions dimensions and entrepreneurial social identities (according to the three identity types) were expected. For example, entrepreneurs with a Darwinian identity perception engage in entrepreneurship to make money and gain status. On the other hand, an entrepreneur with a missionary identity perception has become an entrepreneur with the career intention of benefiting society. However, the entrepreneurial self-efficacy and social identity scales are expected to be related because they contain success goal beliefs (Sieger et al., 2016).

For discriminant validity, low correlation is expected with the locus of control, subjective norm, risk perception, uncertainty avoidance, and social identities of entrepreneurs. Previous studies have revealed that locus of control based on others and chance and other subjective norms, risk perception, and uncertainty avoidance have a low or no relationship between entrepreneurs (Sieger et al., 2016).

Finally, the fit index between the factor structures of the adapted entrepreneurial social identity scale and the factor structures of the original scale was expected to be at an acceptable level. Thus, the developed scale meets the expected conditions to a large extent, and the scale's psychometric properties are satisfactory.

INSTRUMENTS

Entrepreneurs' Social Identity Scale developed by Sieger et al. (2016) consists of three dimensions: Darwinian *("e.g., I will create my firm in order… to advance my career in the business world")*, Communitarian (*"e.g., I will create my firm in order…to solve a specific problem for a group of people that I strongly identify with (e.g., friends, colleagues, club, community)"*), and Missionary (*"e.g., As a firm founder, it will be very important to me…to be a highly responsible citizen of our world"),* and 5 items in each dimension. The scale is a 7-point Likert type ranging from 1 = 'Strongly Disagree' to 7 = 'Strongly Agree', and participants were asked to indicate the extent to which they agreed with the items. The translation process of the scale into Turkish was planned from this study.

During the scale adaptation process, initial contact was made with the researchers who developed the Entrepreneurs' Social Identity Scale via email to request the necessary permissions for adapting the scale. Upon receiving the required permissions, the scale text was independently translated into Turkish by a translator, two university English instructors, and a professor. These four separate Turkish translations were then evaluated by a group of academics and consolidated into a single format.

The consolidated format was presented to 30 different individuals to assess its cultural and linguistic compatibility with Turkish. Participants were asked to review the phrases and provide feedback, rather than to respond to the scale itself. Based on the feedback received, any unclear words and sentence structures were revised. The revised scale was then presented to a different group of individuals, and after incorporating the necessary revisions, the final Turkish version was established. With the elimination of any ambiguities, the back-translation phase commenced.

For the back-translation process, the final Turkish version was independently translated back into English by an English instructor and an academic. After completing the English translation, approval for the English version of the scale was sought from the original developers via email.

The Turkish version (Kıral, 2012) of the 24-item *The Locus of Control Scale* was used to evaluate the locus of control of entrepreneurs (Levenson, 1973). The scale encompasses three types of locus of control: internal locus of control *("e.g., Whether or not I get to be a leader depends mostly on my ability"),* control by powerful others (*"e.g., My life is chiefly controlled by powerful others"*), and control by chance forces (*"e.g., When I get what I want, it's usually because I'm lucky"*). The scale is a 7-point Likert type ranging from 1 = 'Strongly Disagree' to 7 = 'Strongly Agree'. Participants were instructed to respond to each item based on how well they described themselves. Score averages were taken according to focus types, and high scores represent focus type. Cronbach's α of the three dimensions in this scale are .75, .93, and .89, respectively.

The Turkish version (Ören & Bickes, 2011) of the 5-item *Risk Perception Scale* (Hisrich & Peters, 2002) was used to measure the risk perception of entrepreneurs. The scale was used as a one-dimensional (e.g., when I am afraid, I

deal with the fear.) and uses a 7-point Likert type format, ranging from 1 = 'Strongly Disagree' to 7 = 'Strongly Agree'. The average of the items in the scale shows the risk perceptions of entrepreneurs. Cronbach's α value is .66.

The Uncertainty Avoidance Dimension is one of the cultural dimensions developed by Hofstede (2001). The dimension that reflects the cultural values of societies and allows evaluation has been widely used in the field of entrepreneurship (Mueller, 2004; Swierczek & Ha, 2003). The Turkish version (Saylık, 2019) was used to measure the uncertainty avoidance of entrepreneurs with a single dimension consisting of 5 items (e.g. It is important to follow the instructions and procedures strictly). The scale was used on a 7-point Likert scale ranging from 1 = 'Strongly Disagree' to 7 = 'Strongly Agree'. Cronbach's α value is .90.

Liñán & Chen (2009) developed a four-dimensional scale (personal attitude, subjective norm, perceived behavioral control, and entrepreneurial intention) to measure entrepreneurial intention, drawing upon the theory of planned behavior. *Subjective norm dimension* was used for discriminant validity in our research. The Turkish version (Kalkan, 2011) of the three-item subjective norm dimension (e.g., My circle of friends approves of my decision to start a new job) was used. The scale was used on a 7-point Likert scale ranging from 1 = 'Strongly Disagree' to 7 = 'Strongly Agree'. Participants were instructed to respond to each item based on how well they described themselves. Score averages were taken based on the answers given, and high scores represent the subjective norm. In the study, Cronbach's α value was determined as .81.

The Turkish version (Naktiyok et al., 2010) of the 35-item *Entrepreneurial Self-efficacy Scale* (De Noble et al., 1999) was used to evaluate the self-efficacy of entrepreneurs. The scale consists of six dimensions, including developing new product and market opportunities (*"e.g., I can discover new ways to improve existing products"*), coping with unexpected challenges (*"e.g., I can tolerate unexpected changes in business conditions"*), developing critical human resources (*"e.g., I can identify and build management teams"*), defining core purpose (*"e.g., I can convince other to join with me in pursuit of my vision"*), building an innovative environment ("*e.g., I can create a working environment that encourages people to try out something new"*), and initiating investor relationships (*"e.g., I can identify potential sources of funding for investment"*). The scale is a 7-point Likert type ranging from 1 = 'Strongly Disagree' to 7 = 'Strongly Agree'. Participants were instructed to respond to each item based on how well they described themselves. Score averages of the entrepreneurial self-efficacy scale were taken and high scores represent high entrepreneurial self-efficacy. Cronbach's α value of the scale was calculated as .95.

The Turkish version of the 44-item *Entrepreneurship Career Intention Scale* (Sezer, 2013) was used to evaluate the reasons why entrepreneurs chose their careers. The scale consists of 12 dimensions, namely, desire for status, desire for independence, desire for earnings, desire to own one's own business, desire to succeed, obligation, being useful to relatives and society, personal history, continuous learning, development and innovation, desire for power, self-confidence and risk appetite, active business life and close relationships. In the study, the dimensions of desire for status, desire for earnings, and being useful to relatives and society were used for convergent validity. The scale is a 7-point Likert type ranging from 1 = 'Strongly Disagree' to 7 = 'Strongly Agree'. The average scores for each dimension were calculated, and high scores represent the reasons why they chose an entrepreneurial career. Cronbach's α value of the dimensions was calculated as desire for status .95, desire for earnings .78, and being useful to relatives and society .75.

Materials and methods

Participants and Procedures

Pilot Study

For the pilot study, the population consists of undergraduate students enrolled in entrepreneurship courses at the Faculties of Economics and Administrative Sciences and the Business Faculties of Sakarya University, Aydın Adnan Menderes University, and Süleyman Demirel University in Turkey. These universities were chosen due to the higher number of students taking entrepreneurship courses in these faculties and time and cost constraints. Participants were selected using convenience and purposive sampling methods, focusing on students taking entrepreneurship courses who have indicated a positive response to entrepreneurial plans.

The rationale for selecting students enrolled in entrepreneurship courses is to ensure the pilot study sample closely represents the broader population of potential entrepreneurs. By focusing on students who are engaged in entrepreneurship education and have entrepreneurial aspirations post-graduation, we aim to gather data from individuals whose goals and motivations closely mirror those of actual entrepreneurs. This approach is intended to maximize the relevance and

applicability of the adaptation analysis before collecting data from the broader population of established entrepreneurs.

The survey form containing the scales was sent to the undergraduate students online. It was emphasized that participation in the survey was voluntary. After completing the survey, the surveys that took an entrepreneurship course, answered yes to the entrepreneurship plan, and were thought to be completed properly were taken into consideration. As a result, data was collected from 200 participants who took an entrepreneurship course, 68 participants who did not have any plans for entrepreneurship in the future were excluded. Ultimately, 132 surveys were used in the relevant analysis. The data collected within the scope of the pilot study was analyzed for reliability for internal consistency and factor analysis for validity. As a result of the analyses, after evaluating the psychometric properties, it was observed that the data were appropriate and it was decided to collect data in the final version of the scale in the population of the research.

Participants: 57% of the undergraduate students were male, while 43% were female. In terms of class standing, 83% were in their final year (fourth year), with the remaining 17% being in the third year. The average age was 65% in the 24-27 age range, and 35% in the 20-23 age range.

STUDY

For the adaptation analyses of the scale, a survey was prepared that included the pre-translated scales, the scale to be adapted, and an informed consent form for voluntary participation provided to the participants. The study population consists of startup founders operating in the technoparks of Izmir Dokuz Eylul University and Istanbul Yildiz Technical University in Turkey. These technoparks were chosen because they are among the largest in Turkey in terms of the number of startups, providing easier access to the startup founders.

Participants for the study were determined using snowball and convenience sampling methods, as time and cost constraints play a significant role in reaching technological entrepreneurs. The surveys were collected both face-to-face and online from startups operating in the technoparks between March and May 2022. A total of 238 surveys were completed, with incomplete and careless responses removed, resulting in 216 surveys being subjected to the relevant analysis.

Participants: Among the startup founders, 84% (181) were male, and the average age was 36. In terms of education levels, 0.5% (1 founder) had completed primary school, 2.3% (5 founders) had completed high school, 48.6% (105 founders) had a bachelor's degree, 31.9% (69 founders) had a master's degree, and 16.7% (36 founders) had a doctoral degree.

Figure 1 illustrates the overall process of the adaptation study. Initially, after obtaining permission for the scale to be adapted, it was translated by four different translators. The translated formats were then evaluated to consolidate them into a single format. This consolidated format was subsequently presented to 30 different individuals to assess its cultural and linguistic compatibility with Turkish.

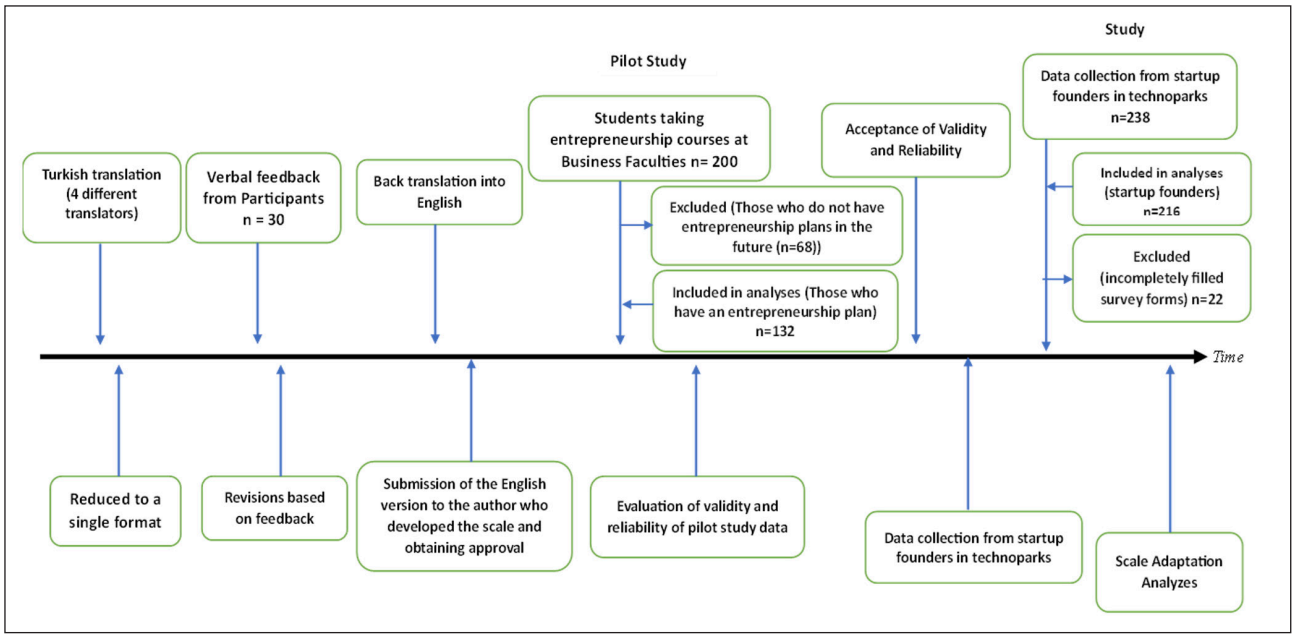

Figure 1: Flow-chart of procedures.

Table 1: EFA item loadings with three dominants

	Pilot Study			Study		
Item	DAR	COM	MIS	DAR	COM	MIS
DAR1	**0.325**			**0.600**		
DAR2	**0.841**			**0.757**		
DAR3	**0.720**			**0.824**		
DAR4	**0.916**			**0.805**		
DAR5	**0.920**			**0.659**		
COM1		**0.774**			**0.943**	
COM2		**0.865**			**0.945**	
COM3		**0.673**			**0.899**	
COM4		**0.848**			**0.883**	
COM5		**0.750**			**0.775**	
MIS1			**0.650**			**0.811**
MIS2			**0.715**			**0.886**
MIS3			**0.671**			**0.942**
MIS4			**0.603**			**0.734**
MIS5			**0.776**			**0.771**
	Total Variance Explained: % 64.65			Total Variance Explained: % 69.93		

DAR: Darwinian; COM: Communitarian; MIS: Missionary

Based on the feedback received ambiguous words and sentence structures were revised. The revised scale was then presented to a different group of individuals, and after incorporating the necessary revisions, the final Turkish version was established. In the next phase, the scale was back-translated into English using the back-translation technique and sent to the original author for approval. Upon receiving approval, the scale's structure was examined through a pilot study. Following the confirmation of the scale's validity and reliability in the pilot study, data were collected from startup founders operating in technoparks. The findings from the collected and analyzed data are presented in the following section.

FINDINGS

For pilot study and study, the exploratory factor analysis (EFA) of the Entrepreneurial Social Identity Scale is presented in the table. According to EFA results of pilot study, determined that the scale has three dimensions, similar to the original. Cronbach's α value of the scale was calculated as Darwinian .88, Communitarian .87, Missionary .83. Analyzes for pilot study show that the scale is reliable. According to the results, it was decided to collect data from startup founders operating in Technoparks (Study). In the following process, the internal consistency, convergent, and discriminant validity of the scale were tested with the data taken from the sample.

Exploratory factor analysis was conducted on study to retest the construct validity of the scale. The analysis results confirmed the three-dimensional structure of the social identity scale and the explained variance value was determined as 69.93% (Table 1). According to the results of the analysis of the responses received from the participants (study), the internal consistency values of the scales (max 0.93 - min 0.66) are shown in parentheses in Table 2. Confirmatory factor analysis was applied to test the factor structure of the entrepreneurs' social identity scale. The analysis results indicate that in the scale consisting of three dimensions, the goodness-of-fit statistics are as follows: $\chi 2=254$, $p < 0.001$, $\chi 2/df=2.92$, TLI (Tucker–Lewis index) =.91, CFI (Comparative Fit Index) = .92, RMSEA (Root Mean Square Error of Approximation) = .09, which demonstrates good model fit. Factor loadings (in terms of standardized regression weights) vary between .35 and .92 (The 1st item of the Darwinian dimension, "I will establish my own company to improve my career in the business world," has a value of .35, and other factor loadings are between .64 and .92). Descriptive statistics and internal consistency values of the variables in the study were calculated (Table 2). The correlation analysis for convergent and discriminant validity is also presented in Table 2.

Table 2: Descriptive statistics, internal consistency and correlation analysis findings

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	15	16	17
1. Entrepreneurs' Social Identity Scale	5.45	1.01	(.89)															
2. Darwinian	6.46	0.72	.48**	(.75)														
3. Communitarian	4.52	1.78	.86**	.17*	(.93)													
4. Missionary	5.38	1.40	.83**	.31**	.51**	(.89)												
5.Locus of Control	3.78	0.64	.14*	.02	.18**	.07	(.75)											
6. Internal locus of control	4.90	0.80	.22**	.23**	.11	.22**	.53**	(.71)										
7. Control by chance forces	2.79	1.11	-.08	-.19**	.06	-.15*	.68**	-.08	(.76)									
8. Control by powerful others	3.12	1.05	.12	-.04	.18**	.06	.79**	.07	.51**	(.73)								
9. Uncertainty avoidance	5.22	1.27	.31**	.23**	.22**	.29**	.22**	.19**	.01	.22**	(.90)							
10. Risk Perception	4.44	1.24	.18**	-.05	.13	.26**	.14*	.00	.00	.27**	.11	(.66)						
11. Subjective Norm	5.66	1.32	.06	.15*	.04	.01	.07	.08	.12	-.06	.09	-.17*	(.81)					
12. Entrepreneurial self-efficacy	5.91	0.72	.38**	.35**	.19**	.39**	-.04	.26**	-.29**	-.09	.29**	.34**	.24**	(.95)				
13. Desire for status	4.55	1.56	.18**	.13*	.12	.17*	.27**	.15*	.15*	.24**	.19**	.27**	.08	.17*	(.86)			
15. Desire for earnings	5.51	1.30	-.07	.12	-.01	-.19**	.13	.09	.10	.06	-.08	-.12	.12	.08	.27**	(.78)		
16. Being useful to relatives and society	4.74	1.47	.27**	.02	.20**	.33**	.20**	.17*	.07	.15*	.20**	.25**	-.08	.15*	.32**	.05	(.75)	
17. Continuous learning, development and innovation	6.34	0.85	.24**	.09	.16*	.27**	.03	.08	-.05	.03	.22**	.25**	.03	.31**	.09	-.09	.32**	(.79)

N: 216, ** $p < 0.01$, * $p < 0.05$, M: Mean, SD: Standard Deviation, Values in parentheses indicate Cronbach Alpha reliability coefficient

In Table 2, the convergent validity (the extent to which the scale is related to other measurements designed to assess similar constructs) and discriminant validity (the extent to which the scale does not correlate significantly with different measurements) were examined to assess the construct validity (Hinkin, 2005, 1995). Therefore, the study investigated whether the dimensions of the social identity scale (Darwinian, Communitarian, and Missionary, each consisting of 5 items) were related to the existing scales as specified. Table 2 shows that in line with the original scale, profit motive showed a non-significant but positive relationship (p>0.05, .12) with profit-focused Darwinian identity. In contrast, a negative relationship was observed with Missionary (p <0.01, -.19) and Communitarian (p>0.05, -.01) identities. Status desire was found to have a low relationship with Darwinian (p< 0.05, .13) and Missionary (.17*) identities. The dimension of continuous learning and innovation showed a positive relationship with Missionary (p <0.01, .27) and Communitarian (p< 0.05, .16) identities, except for Darwinian. In the dimension of benefiting their families and society, Communitarian (p <0.01, .20) and Missionary (p <0.01, .33) identities were found to have a positive and significant relationship in line with their definitions. Although correlation values below 0.3 are small, they are sufficient to ensure convergent validity (Tang et al., 2012). Additionally, the entrepreneurial self-efficacy scale was found to have a higher relationship (p <0.01, .38) with the social identities of entrepreneurs. The relationship between the Entrepreneurial Social Identity Scale and entrepreneurial self-efficacy indicates a higher level of convergent validity.

The correlation between the locus of control variable and the entrepreneurs' social identity scale was examined to evaluate the discriminant validity of the scale. While the relationship of internal locus of control with Darwinian (p <0.01, .23) and Missionary (p <0.01, .22) identity types was observed, its relationship with the Communitarian identity type was not determined. In control by powerful others variable, while there was no relationship between the Darwinian and Missionary identity types, a significant relationship was found with the Communitarian (p <0.01, .18) identity type. Due to the characteristic of the Communitarian identity type, there is a relationship that creates initiative towards the people around it. In the control by-chance forces, relationships are at a negative level. A low relationship was found between the uncertainty avoidance dimension and three identity types. At the same time, the risk perception variable had no relationship with the Darwinian and Communitarian identity types; a positive relationship was found with the Missionary identity type (p<0.01, .26). The dimension of subjective norm shows a positive and low relationship with the Darwinian identity type (p < 0.05, .15), while no relationship is found with the Communitarian and Missionary identity types. Sieger and colleagues (2016) have stated that the low level of relationship is acceptable for discriminant validity.

DISCUSSION AND CONCLUSION

Supporting findings were obtained that the entrepreneurs' social identity scale is reliable and valid. The internal consistencies of the scales used in the study are satisfactory and reasonable (with the lowest α value among variables being .66). It was observed that the CFA fit values and factor loadings of the Social Identity Scale adapted to Turkish were at reasonable levels. The relationship between the scales used according to the characteristics of the entrepreneurs' identity types was expected to have convergent validity. For example, while a positive relationship exists between the Darwinian identity, which creates an enterprise to make money, and the desire for profit, a negative and meaningless relationship is found with the Communitarian identity, which starts an enterprise to benefit the environment. On the other hand, a negative relationship (p<0.01, -.19) was detected between the Missionary identity, which initiates enterprises to make the world a better place, and the desire for profit. Again, while there was no relationship with Darwinian identity in the dimension of being helpful to relatives and society, a positive and significant relationship was found in line with the definitions of Communitarian and Missionary identities.

In summary, different levels of relationships were found between entrepreneurial career intentions according to the identity types of entrepreneurs. This situation provides convergent validity consistent with the study conducted by Sieger et al. (2016) on developing the entrepreneurs' social identity scale. Another variable used for convergent validity, the entrepreneurial self-efficacy scale, was found to have a strong relationship with the social identities of entrepreneurs. Since self-efficacy for entrepreneurs refers to perceptions of their abilities, it was expected to show a consistent correlation with the scale. As a result, the values revealed in the convergent validity correlation analysis were similar to previous studies' findings (Brändle et al., 2018; Sieger et al., 2016) and supported convergent validity.

According to the correlation analysis findings, discriminant validity was supported. It was used to evaluate whether the locus of control is empirically

different and whether it varies with identity types. No relationship was expected between the Social Identity scale of entrepreneurs and their locus of control dimensions, control by powerful others, and control by chance forces. As a result of the analysis, there was a relationship with the internal locus of control, which is characteristic of entrepreneurs, in three dimensions. In contrast, there was a negative or insignificant relationship between the dimensions of control by powerful others and control by chance forces in Darwinian and Missionary entrepreneurs. In contrast, a significantly positive but low relationship was found with the Communitarian identity. This is because Communitarian entrepreneurs carry out entrepreneurial activities by taking the people or groups of people around them as a reference, and a relationship is likely to arise.

The other variable, subjective norm, refers to the individual's perceptions of the pressures in his environment to exhibit or not to exhibit a behavior. In this context, correlation was expected to be low in the structure of identity types, as in the original scale. According to the results, similar to the findings of the original scale, while Subjective norm was not significantly related to Communitarian and Missionary identities, a significant and positive relationship was found with Darwinian identity. Because Sieger et al. (2016) stated, they have internalized what it means to be the founder of a business.

Although the risk perception variable is related to entrepreneurship, it has been stated that there is no relationship with identity evaluations (Sieger et al., 2016). According to the findings of the correlation analysis, a positive significant relationship was found in Missionary identity, unlike the results of the original scale. The level of this relationship is below 0.3 (values below 0.3 are considered low relationships), so it is considered acceptable for discriminant validity (Ratner, 2009).

Finally, the uncertainty avoidance variable was used to support discriminant validity. According to the correlation results of the original scale, a significant and positive but low relationship was found between uncertainty avoidance and entrepreneurs' social identity types with Darwinian, Communitarian, and Missionary identity types. The reason why there is a relationship is due to the cultural structure of the society. According to Hofstede's cultural analysis, Türkiye has the highest uncertainty avoidance dimension (Insights, 2020). Since this relationship value is low, it can be considered sufficient to support discriminant validity.

This adaptation study, which has acceptable levels of validity and reliability, will make several important contributions to the field of entrepreneurship research in Turkey:

By providing a culturally adapted and validated Entrepreneurs' Social Identity Scale, this study offers a robust tool for researchers to accurately measure the social identity of Turkish entrepreneurs. This will enable more precise and relevant data collection and analysis in future studies.

The adapted scale will help uncover the social identity perceptions and cognitive processes of Turkish entrepreneurs, which are crucial for understanding their motivations, behaviors, and success. This, in turn, will contribute to a more holistic understanding of the Turkish entrepreneurial ecosystem.

Insights gained from this study can inform policymakers and support organizations in designing targeted interventions and support programs that align with the social identities and needs of entrepreneurs. This can enhance the effectiveness of initiatives aimed at fostering entrepreneurship in Turkey.

Additionally, the successful adaptation of the scale will contribute to the broader literature on cross-cultural validation of psychological and behavioral scales. It will demonstrate the applicability of the Entrepreneurs' Social Identity Scale in a non-Western context, supporting its use in diverse cultural settings.

By addressing these aspects, the adaptation study will significantly enrich the academic and practical understanding of entrepreneurship in Turkey, providing valuable insights for researchers, practitioners, and policymakers.

Limitations and Future Research

The number of samples in the study constitutes the limitation of the research. The sample size can be increased more comprehensively in future studies. Additionally, using the scale in future research will strengthen its validity in Türkiye. In the study, data was collected from the founders of startups operating in technoparks. Within the scope of the research, data can be collected from different types of entrepreneurs (e.g., classical entrepreneurs, social entrepreneurship, start-ups, scale-ups, etc.).

Additionally, examining the financial situations of entrepreneurs according to their identity types will contribute to understanding entrepreneurs. In addition,

entrepreneurs' identity types and cognitive processes can be examined. For example, the well-being levels of identity types can be investigated.

Furthermore, the data collected using the adapted scale can be used for comparative studies between Turkish entrepreneurs and those from other cultural contexts. This will enrich the global discourse on entrepreneurial identity and behavior by providing empirical evidence from Turkey.

As a result, the social identity scale, adapted to 16 languages, has been adapted to Turkish for the first time in this study and brought to the literature. Thus, it is expected to contribute to studies in the field of entrepreneurship in Türkiye and increase the number of entrepreneurship research. It is expected to contribute to understanding entrepreneurs in Türkiye, which has a developing economy of 80 million. The Turkish adaptation study obtained broadly similar results to the original scale. Therefore, their convergent and discriminant validity and factor structures are highly satisfactory. For this reason, the psychometric properties of the study are at a level that can be applied to the Turkish sample.

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APPENDIX

Girişimcilerin Sosyal Kimlik Ölçeği								
DAR1	İş dünyasında kariyerimi geliştirmek için kendi firmamı kurdum/kuracağım.	1	2	3	4	5	6	7
DAR2	Bir firma kurucusu olarak, firmamı doğru yönetim uygulamaları temelinde yönetmek benim için çok önemlidir.	1	2	3	4	5	6	7
DAR3	Bir firma kurucusu olarak, işimin finansal beklentilerini derinlemesine analiz etmek benim için çok önemlidir.	1	2	3	4	5	6	7
DAR4	Firmamı yönetirken, firmamın rekabet ortamında başarabileceği hususlara yakından odaklanmak benim için çok önemlidir.	1	2	3	4	5	6	7
DAR5	Firmamı yönetirken, güçlü bir rekabet avantajı oluşturmak ve rakiplerime göre daha yüksek performans sergilemek benim için çok önemlidir.	1	2	3	4	5	6	7
COM1	Firmamı, güçlü bir şekilde özdeşleştiğim bir grup insanın (örneğin arkadaşlarım, meslektaşlarım, üye olduğum kulüpler/dernekler/topluluklar) belirli bir sorununu çözmek üzere kuracağım.	1	2	3	4	5	6	7
COM2	Firmamı, güçlü bir şekilde özdeşleştiğim bir grup insanın faaliyetlerini şekillendirmede proaktif bir rol oynamak için kuracağım.	1	2	3	4	5	6	7
COM3	Bir firma kurucusu olarak, güçlü bir şekilde özdeşleştiğim bir grup insana (örneğin arkadaşlarım, meslektaşlarım, üye olduğum kulüpler/dernekler/topluluklar) faydalı olacak bir ürün/hizmet sunmak benim için çok önemlidir.	1	2	3	4	5	6	7
COM4	Firmamı yönetirken, güçlü bir şekilde özdeşleştiğim bir grup insana (örneğin arkadaşlarım, meslektaşlarım, üye olduğum kulüpler/dernekler/topluluklar) yakından odaklanmak benim için çok önemlidir.	1	2	3	4	5	6	7
COM5	Firmamı yönetirken, güçlü bir şekilde özdeşleştiğim bir grup insanı (örneğin arkadaşlarım, meslektaşlarım, üye olduğum kulüpler/dernekler/topluluklar) desteklemek ve geliştirmek benim için çok önemlidir.	1	2	3	4	5	6	7
MIS1	Dünyanın işleyişini değiştirmede proaktif bir rol oynamak için kendi firmamı kuracağım.	1	2	3	4	5	6	7
MIS2	Bir firma kurucusu olarak, son derece sorumlu bir dünya vatandaşı olmak benim için çok önemlidir.	1	2	3	4	5	6	7
MIS3	Bir firma kurucusu olarak, dünyanın daha iyi bir yer haline gelmesine katkı sağlamak benim için çok önemlidir.	1	2	3	4	5	6	7
MIS4	Firmamı yönetirken, firmamın toplumun geneli için neler başarabileceğine yakından odaklanmak benim için çok önemlidir.	1	2	3	4	5	6	7
MIS5	Firmamı yönetirken, önemsediğimiz toplumsal sorunları (sosyal adalet, çevresel koruma gibi) diğer firmaların da önemsemesi gerektiği konusunda onları ikna etmek benim için önemlidir.	1	2	3	4	5	6	7

7'li Likert, 1: Kesinlikle Katılmıyorum- 7: Kesinlikle Katılıyorum

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Determinants of Exchange Rate Jumps in Türkiye

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ABSTRACT

This study examines the exchange rate jumps in Türkiye between 2013 and 2021 and the factors influencing these jumps. The Turkish Lira experienced a consistent depreciation against other currencies during this period. A closer examination of the depreciation timeline revealed that the Turkish Lira's depreciation was occasionally abrupt and exceedingly pronounced. The primary objective of this research is to identify these episodes of spikes, which can be characterized as jumps in exchange rates amid regular increases. To achieve this, the Pruned Exact Linear Time (PELT) algorithm was employed to detect sudden shifts in the exchange rate. Taking these points as dependent variables, a rare event logistic regression model was utilized to determine the probability of an exchange rate jump. The findings indicate that increased dollarization raises the likelihood of an exchange rate jump, while higher deposit rates and central bank reserves reduce the probability of a jump.

Keywords: Exchange Rate, Dollarization, PELT Algorithm, Logistic Regression, Jump Point.

JEL Classification Codes: B22, C22, F31

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INTRODUCTION

Numerous studies have examined the adverse effects of continuous fluctuations in exchange rates on economic growth. Rodrik (2009) demonstrated that overvalued national currencies in developing countries negatively impacted economic growth. Likewise, Gala and Libânio (2010), Chen (2012), and Habib et al. (2017) highlighted the detrimental consequences of national currency depreciation in developing countries on economic growth. Ağaslan and Alkan (2021) found that although exchange rate volatility in developing countries negatively affected economic growth, its impact on developed countries was considerably smaller. The prevailing conclusion is that exchange rate fluctuations adversely influence economic growth and macroeconomic variables. Consequently, sudden and substantial changes (jumps) in exchange rates, rather than steady shifts, signify a difficult situation for an economy.

In fragile economies, particularly those classified as developing and emerging, such as Türkiye, the production structure heavily relies on imported raw materials and intermediate goods. Exchange rate jumps negatively impact the decision-making processes of economic agents and hinder the establishment of a stable price determination policy for each production unit. In countries with high intermediate imports like Türkiye, sudden exchange rate increases are reflected in manufacturer prices through the pass-through mechanism, causing cost inflation and subsequently affecting consumer prices. This study aims to identify the jump points in the exchange rate against the Turkish Lira and examine how macroeconomic variables influencing the likelihood of currency jumps affect this probability under specific scenarios.

Estimating and predicting exchange rates have long been prominent in international financial markets. Exchange rate markets are continuously traded 24 hours a day across different regions worldwide and are heavily influenced by economic, political, military, and psychological factors. Econometric models and operational research methods are commonly employed in exchange rate estimation and prediction. The prediction of exchange rates began with Brown's

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(1963) moving average method and continued with the exponential smoothing and adaptive exponential smoothing methods proposed by Trigg and Leach (1967). The autoregressive moving average process introduced by Box-Jenkins in the 1970s became one of the most popular methods in exchange rate predictions until the mid-1980s. Although these models aim to predict a specific exchange rate trajectory, they do not account for sudden increases that could be considered extreme observations regarding multiple standard deviations. While it seems implausible to accurately predict such increases, certain variables and parameters within an economy could rapidly depreciate the exchange rate against national currencies.

In the literature, the variables employed in modeling sudden increases (jumps) in financial assets primarily focus on the returns of these assets. A limited number of studies have addressed excessive increases in exchange rates. Andersen et al. (2003) explored the relationship between abrupt exchange rate movements and news, revealing that news has an asymmetric effect on sudden exchange rate shifts. Duffie et al. (2000), Liu et al. (2003), Eraker et al. (2003), and Piazzesi (2005) discussed how jump information influences financial management, while Lee and Mykland (2008) and Tauchen and Zhou (2011) attempted to explain how characterizing the distribution and causes of jumps could improve asset pricing models. Lahaye et al. (2011), Andersen et al. (2007), Lee and Mykland (2008), and Boudt et al. (2011) sought to detect jumps in exchange rates, stock index futures, and US bond futures using the non-parametric statistics they proposed in their studies, correlating the identified jumps with macroeconomic news. Andersen et al. (2010) suggested a test to detect jumps in return series for high-frequency finance data, and Chatrath et al. (2014) examined the impact of macro news on exchange rate jumps. Uzun et al. (2023) explore using machine learning algorithms to forecast jumps in the foreign exchange (FX) market, addressing the challenges posed by currency fluctuations under floating exchange rate regimes. The study identifies jumps using the return ratio to estimated volatility, distinguishing between average high volatility and jumps. The authors highlight the importance of predicting jumps for traders, financial risk managers, and policymakers, given the difficulty in hedging jump risks and the implications for derivative pricing and asset allocation. Ayadi et al. (2024) investigate severe intraday price movements or jumps in emerging financial markets during economic expansion. They focus on identifying jumps in emerging foreign exchange markets and simultaneous jumps in multiple currency markets, known as cojumps. Utilizing data from four emerging currencies across Africa, Asia, Europe, and South America, spanning from 2010 to 2017 with 5-minute frequency quotes, their study reveals that intraday currency jumps and cojumps are notably more frequent and larger compared to developed markets. Manner et al. (2024) explore the risks faced by commodity-exporting countries in Latin America, focusing on fluctuations in commodity prices and exchange rates. The study applies changepoint analysis to endogenously determine dates of changing risks, specifically unconditional volatility and risk spillovers measured by copula-based dependence. The analysis includes the stock markets of Argentina, Brazil, Chile, Mexico, and Peru, identifying how these risks evolve and are influenced by macroeconomic factors. Chae-Deug (2024) investigates the volatile dynamics and discontinuous jumps in the Korean won–US dollar exchange rate during the 2010s, driven by global economic uncertainties and geopolitical tensions. The study addresses the critical need to estimate return volatility accurately and jumps using robust, nonparametric approaches, considering the limitations of traditional parametric models in capturing discontinuous jump components. The empirical analysis uses high-frequency five-minute returns data for the Korean won–US dollar exchange rates from 2010 to 2021. The study employs various jump statistics, including the standard normal Z-type jump statistics, the realized outlying weighted quarticity (ROWQ) jump statistics, and the Gumbel distribution, to determine the occurrence of significant daily jumps. The findings reveal that the severe volatility and frequent jumps in the Korean won–US dollar exchange rates during the 2010s necessitate using non-Gaussian distribution models for accurate jump estimation.

The common focus of these studies is the calculation of jumps over return series. However, the Pruned Exact Linear Time (PELT) algorithm proposed by Killick et al. (2012) enables the detection of sudden change points in datasets, allowing for jump points to be identified without any variable transformations. Using the PELT algorithm, this study detects jump points in their nominal form, without altering the exchange rate series, thereby preserving information.

This research makes two significant contributions to the literature. First, it focuses on detecting exchange rate jumps in Türkiye, and second, it is the first study to identify jump points using the PELT algorithm without transforming the exchange rate series. Moreover, while most studies on jump points concentrate on the

effects of macro news, this research investigates how macroeconomic variables influence jump points in exchange rates.

The remainder of this article is organized as follows: Section 2 provides an overview of the factors determining exchange rates; Section 3 outlines the methodology; Section 4 discusses the data; Section 5 presents the empirical evidence; and Section 6 offers conclusions.

FACTORS DETERMINING EXCHANGE RATE

Besides the fact that the exchange rate is an indicator that expresses the value of one country's currency in other countries' currencies, it is a unique asset value. Thus, the economic principles that govern and guide the movements of the different asset prices also apply to the movements of exchange rates (Krugman et al. 2014).

Since the 1970s, due to the acceleration of capital movements and transition to a flexible exchange rate system and with large fluctuations in the exchange rates, the explanation of the changes that took place in exchange rates in the short run came to the fore. In the 1970s, problems such as exchange rate volatility created by flexible exchange rate systems, uncertainty, and which criteria should be considered necessary in the parity formation between countries led both the academics and those working in practice to focus on which economic variables are significant in determining the exchange rate. In this context, while international goods flow that was put forward before 1970 as the main factor determining exchange rates lost importance, the idea that global capital movements were a more explanatory variable in determining the exchange rate began to gain acceptance (Frankel et al. 1996).

Real exchange rate changes may result from changes in the real side of the economy. However, there are many studies on modelling and testing the deviation in Purchasing Power Parity Gelbard and Nagayasu (2004). Purchasing Power Parity (PPP) theory, one of the most accepted approaches in determining the exchange rate, was first introduced in the early 20th century by Gustav Cassel. The PPP approach, which is a theory that aims to determine the exchange rate by establishing a direct relationship between the exchange rate and prices, argues that changes in the exchange rate at any time will be determined by the changes in the relative price levels of countries (Cassel, 1918). Purchasing Parity is a theory to determine the exchange rate by establishing a direct relationship between the exchange rate and prices. Considering exchange rate models especially for the 1970s and 1980s, it is seen that the relationship between Purchasing Power Parity and exchange rate was used intensely in these models. PPP, which claims that the nominal exchange rate is determined according to the difference between domestic and foreign inflation rates, suggests that there may be deviations from the PPP in the short term since it is a long-term approach in determining the equilibrium exchange rate. However, there is no consensus on the validity of PPP in the long term (Mussa, 1986).

Another exchange rate determination model, the Interest Rate Parity (IRP) theorem, differs from the PPP theorem in that it takes into account the macroeconomic structure. It includes the financial account of the balance of payments in the analysis. With its variation in the interest rates, IRP plays a vital role in determining exchange rates since it constitutes a link between the spot and forward exchange rates and speculators' expectations. IRP assumes perfect substitution between domestic and international financial assets. This assumption equalizes various asset return rates, and this equality is known as IRP. While PPP establishes the connection between exchange rates and prices with goods markets, IRP establishes the connection between exchange rates and interest rates through financial markets (Claasen, 1996). In developed and stable financial markets, IRP theory gives more effective results in countries where controls over capital movements, transaction costs and political and national risks are low, investors avoid irrational behaviors, flexible exchange rates are applied, markets are more integrated to each other and borrowing costs and speculative investment movements are low. In underdeveloped countries, new establishment or non-existence of futures markets limited the testing of the theory for these countries (Copeland, 1989).

The fact that changes in only national price levels, money supplies, or current transactions cannot explain exchange rate behavior necessitated financial market approaches to be established. Currencies act more like other financial assets whose prices are determined in organized markets. In addition to the fact that currency changes are highly unpredictable, money supply and demand appears to be the most essential factor in explaining the behavior in exchange rates since the exchange rate is the relative price of two financial assets. It is possible to collect and examine Financial Asset Models in three groups. These models are the Monetary Model, Portfolio Equilibrium Model, and Currency Substitution Model. The most crucial factor in this distinction is whether the investors completely substitute domestic and foreign financial assets in their portfolio (Obstfeld et al. 1995).

According to the Monetary Model, the exchange rate is accepted as the price of a foreign currency in terms of the national currency. Like other relative prices, the exchange rate is determined by national currency stocks' relative supply and demand. This approach suggests that relative supply and demand in capital markets determines the exchange rate, the most basic assumption is that capital movements are free. In other words, there are no obstacles and restrictions in capital movements, nor transaction costs in purchases. If the assumption that national and international bonds are completely substitutable is added to these assumptions, the portfolios will always be in balance. Interest rates in the country will be equal to the total expectation of the international interest rate and the depreciation rate of the national currency. Thus, domestic and foreign capital markets will be reduced to a common market, and only national and international money markets will determine the exchange rate. The Monetary Model, based on market developments, is examined in two different ways according to flexible and sticky prices (Bilson, 1978). In many countries, practical studies for the Flexible Price Model or the Sticky Price Model did not result. This is because the money demand function was not as stable as the Monetarists claim. The assumption that complete substitution exists among financial assets and the assumption regarding PPP was not realistic (Meese and Rose, 1990).

An essential difference between the Monetary Approach and the Portfolio Balance Model is that the Monetary Approach is risk-neutral. Under these conditions, Monetary Approach has been insufficient regarding exchange rate expectations. Portfolio Balance Approach suppressed this shortcoming of the Monetary Approach. In the Portfolio Balance Model, while economic agents create a portfolio with various currencies to minimize exchange rate risks, international investors want to hold non-monetary financial assets based on the risk/return factor. Therefore, the Portfolio Balance Model is based on the distribution of individuals' fixed wealth at a given time among various financial assets consisting of domestic and foreign securities. The Portfolio Balance Model shows how exchange rates are determined more complexly. Although interest rate parity is also valid in this approach, unlike the Monetary Approach, a risk premium is added to the risk avoiders among the total assets in the portfolio. Risk-avoiding individuals hold non-risky domestic assets and risky foreign assets in their portfolios to maximize their benefits. Here, the necessary condition for the individuals' earnings is that the expected return of foreign investments should be higher than the expected return on domestic assets (Claasen, 1996). In summary, Portfolio Balance Approach is a theory that tries to explain fluctuations in exchange rates with changes in the supply and demand of domestic and foreign securities. According to this theory, the demand for money in the foreign exchange market is derived from the demand for financial assets.

In the models examined, economic agents have been assumed to demand only their own countries' currencies. Therefore, the elasticity of substitution between currencies has been assumed to be zero. However, economic agents in one country demand another country's money for many reasons. Empirical studies show that the power of the currency substitution model is low in explaining the exchange rate movements between the currencies of developed countries with low inflation processes and relatively stable currencies. For countries with unstable money and high inflation, the currency substitution model seems to be more appropriate. In these countries experiencing currency substitution, first the currency's function of store of value, then the national currency's feature of being a unit of account, and finally its feature of being a medium of exchange is substituted. This process is not a situation that occurs suddenly but is a process that generally spreads over time. The main reason is the lack of confidence in the economic policies implemented in the country. Besides destabilizing the exchange rate in these countries, money substitution causes fundamental problems such as the decrease in the seigniorage income of the country arising from the prerogative right of coining money. On the other hand, it is challenging to plan and execute monetary policy under these conditions (McKinnon, 1982).

In the statements so far within the framework of the financial markets approach, we have stated that the changes in the exchange rates are driven by the fundamentals such as money stock, interest rates, inflation, real income, and growth rate. However, as a result of the developments that emerged after the 1970s, we can see that the macroeconomic variables observed standardly are insufficient to explain the changes in exchange rates. The situation seems more appropriate, especially for short-term currency movements. Economists have two different views on these developments. The first one concentrates on how unexplained short-term changes are caused by tastes and preferences and by changes arising from technology. The second view is explained by the Speculative Bubbles Theory (Bulut, 2005).

According to this view, exchange rates do not result from a change in fundamental variables but a process formed due to self-fulfilling market expectations. Speculators increase the rate of increase in the exchange rate due to demanding the money that they see as overvalued because they expect that the funds will continue to gain value in the short term before it loses value in line with the fundamental factors and believe to sell the money before the rapid decline begins (Bulut, 2005).

Given the models studied so far, we can see the difficulty of predicting future exchange rates. Although economists have developed some models to explain the systematical changes in the exchange rates, due to the possibility of unexpected events, the success of these models in estimating exchange rates is limited. The real world is full of unforeseen shocks and surprises. When an unexpected event occurs, this is called "news" in literature. Since macroeconomics variables, such as interest rates, general price level, and output amount, are generally affected by the news, the exchange rates are also affected by them. Short-term movements in exchange rates are sometimes due to unexpected news. As unforeseen events partially determine the exchange rates, the future spot rates get challenging to predict. On the other hand, announcements on key economic variables, like the news effect, cause movements in exchange rates (Peruga, 1996).

In the exchange rate determination models, we have examined, common features like economic agents are homogeneous, complete knowledge is assumed, and economic transactions are done without cost. On the other hand, in these macro models, there were some unrealistic assumptions like information was known by everyone and spread instantly. In exchange rate determination models based on these basic assumptions, exchange rate movements were explained in macroeconomic variables. However, in recent years, Studies on the microstructure of the exchange market have been carried out frequently. Because the current approaches had some shortcomings in determining the exchange rates and the exchange rate movements and the criticism on this was getting more and more intense. For example, the change in exchange rates was much more considerable than the change in economic variables. This situation undermined the reliability of existing exchange rate determination models. Empirical studies made also supported this situation. This movement in exchange rates brought to the fore the view advocating that the microstructure of the exchange market should be examined. Thus, the behaviour of economic agents trading in the exchange market, the organizational structure of institutions and the market, and their relations have become very important. Since the microstructure approach reveals transparency in economic transactions, the unorganized structure of the market, the role of brokers, the place of the exchange market, the efficiency of exchange transactions and the relations between spot and derivative markets, it has brought a new spirit to exchange rate determination models (Bulut, 2005).

Although progress has been made in understanding the exchange rate's long-term movements, the general failure of the models based on rational expectations in terms of macroeconomic variables in the short run to explain exchange rate fluctuations is known as the exchange rate deviation paradox. The disconnection between the exchange rate and macroeconomic indicators is an important issue known and emphasized in international macroeconomics. The macroeconomic determinants of the exchange rate have been discussed since (Meese and Rogoff, 1983) suggested a weak relationship between the exchange rate and essential macroeconomic variables. According to (Meese and Rogoff, 1983), the exchange rates of the exchange rates are highly volatile compared to any model with fundamental variables, such as production amount and money supply. They stated that the predictions produced by traditional exchange rate models were not better than a random walk model.

Since exchange rate determination models were found unsuccessful in terms of short-term exchange rate estimation and that exchange rates are heavily influenced by political developments, especially in developing countries, most developing countries have become a two-money economy. On the other hand, doubts about the independence and transparency of central banks have become one of the main problems in developing countries. In Türkiye, which is a developing country, Fed's tightening monetary policies in 2013 annihilated the independence of the Central Bank of the Republic of Türkiye (CBRT), which was trying to follow policies focused on growth instead of inflation, increased dollarization and reserves were used to stabilize the exchange rate instead of interest rate. In this context, in the study covering the period of 2013-2021, dollarization rate, Central Bank gross reserves, and deposit interest rates that directly impact the residents' savings, were discussed.

METHODOLOGY

PELT (The Pruned Exact Linear Time) Algorithm

The changepoint analysis is defined as determining the points at which statistical characteristics change within a data set. Choosing the change points in a data set has been a significant challenge for many fields and researchers. Changepoint analysis has been used for many different purposes, such as financial modeling (Talih and Hengartner, 2005), bioinformatics for identifying genes associated with specific cancers and other diseases (Muggeo and Adelfio, 2011), detection of credit card fraud (Bolton and Hand, 2002), classification of data in data mining (Mampaey et al. 2011) and signal processing (Kim et al. 2009). There are two different approaches for detecting change points in a data set: exact and approximate. In general, exact methods have more computational complexity than approximate methods, whereas definite methods are more accurate as they seek optimal results (Truong et al., 2020). For example, in the binary partitioning algorithm (Scott and Knott, 1974), a single change point method is used in the entire data set. Still, the mismatch between adjacent windows is measured in the window-based search method (Truong et al., 2020). Both approaches have low computation complexity. On the other hand, the partition neighbour search method (Auger and Lawrance, 1989), which is a precise method that searches the entire partition space using dynamic programming, gives much more accurate results than approximate methods (Bian et al., 2020). However, the most significant disadvantage of the second method is the heavy computational complexity because as the observed data increase, the number of change points increases linearly. In addition to this, (Killick et al., 2012) proposed the PELT method specified as an entirely linear time algorithm, which is an efficient and precise search method in terms of calculation. The primary assumption in PELT is that the number of change points increases linearly with the size of the data and that the change points are not limited to a portion of the data.

Let a time series $\{y_t; t = 1,2,3, \dots, n\}$ and m change point $\tau_1, \tau_2, \tau_3, \dots, \tau_m$ be given. Considering the cost function for fragmentation, (Yao, 1984) and (Jackson et al., 2005) used equation (1) to minimize the method to determine the change points, which they named the optimal fragmentation (OP) algorithm.

$$\sum_{i=1}^{m+1} \left[C\left(y_{(\tau_{i-1}+1):\tau_i}\right) \right] + \beta \qquad (1)$$

Let (1) be the minimum values obtained from equation (1) and $\tau_s = \{\tau{:}0 = \tau_0 < \tau_{1<} \dots \tau_m < \tau_{m+1} = s\}$ the possible change points for these $F(s)y_{1:s}$ observations. The $F(0)$ initial value of can be taken as $-\beta$, with a penalty constant β that does not depend on the number or location of the exchange points. When applied as iterations of steps 1-2, change points can be obtained according to the OP algorithm.

Step 1	$F(\tau^*) = \min_{0 \le \tau < \tau^*} \left[F(\tau) + C\left(y_{(\tau+1):\tau^*}\right) + \beta \right]$ calculated.
Step 2	Change points $cp(\tau^*) = (cp(\tau'), \tau')$ founds by $\tau' = \arg\left\{ \min_{0 \le \tau < \tau^*} \left[F(\tau) + C\left(y_{(\tau+1):\tau^*}\right) + \beta \right] \right\}$

The basis of the PELT method is the OP algorithm. PELT algorithm modifies the OP algorithm with a change called pruning. The essence of pruning is to remove τ values that can never be minimum from the minimization performed at each iteration of step (1) in the OP algorithm. After pruning, the PELT algorithm is implemented as steps 1-4:

Step 1	$F(\tau^*) = \min_{\tau \in R_{\tau^*}} \left[F(\tau) + C\left(y_{(\tau+1):\tau^*}\right) + \beta \right]$ value calculated.
Step 2	$\tau^l = \arg\left\{ \min_{\tau \in R_{\tau^*}} \left[F(\tau) + C\left(y_{(\tau+1):\tau^*}\right) + \beta \right] \right\}$
Step 3	$cp(\tau^*) = [cp(\tau^l), \tau^l]$ change points are taken
Step 4	$R_{\tau^*+1} = \left\{ \tau^* \cap \{\tau \in R_{\tau^*} : F(\tau) + C\left(y_{\tau+1:\tau^*}\right) + K < F(\tau^*) \} \right\}$ in the last case, the points obtained in Step 3 are pruned and the final change points are obtained.

(Killick et al. 2012) demonstrated that the PELT algorithm is superior to all other methods in detecting multiple changes due to their simulation study.

Rare Event Logistic Regression Method

One of the most used models in modelling a system consisting of dependent and independent variables is linear regression analysis. One of the most critical constraints of linear regression analysis is that the dependent variable takes continuous values. In the case of discrete values, the logistic regression model is used in the literature. Logistic regression, especially for the circumstances in which the dependent variable takes binary values, is one of the most important statistical and data mining techniques used by statisticians and researchers for analysis of relationships between variables (Arita, 2003; Agresti, 2007; Hastie et al. 2009; Hilbe, 2009; Kleinbaum et al. 2007). One of the most critical advantages of logistic regression is that the value of the dependent variable can predict probability because of the model estimation (Hastie et al. 2009; Karsmakers et al., 2007). Another advantage is that most of the methods

used in the logistic regression model analysis follow the same principles used in linear regression (Hosmer and Lemeshow, 2000). Moreover, most unconstrained optimization techniques apply to logistic regression analysis (Lin et al. 2007). Logistic regression model does not need a linear relationship between the dependent and independent variables, normal distribution of error terms, and assumptions such as constant variance requirement. However, the logistic regression model has a significant limitation. The number of realized events "1" and the number of unrealized events "0" observed should be close to each other. If this does not occur, the estimates obtained will not be effective. There are many different approaches regarding determining the optimum number of events. In their studies, (Peduzzi et al., 1996) found that the optimal number of events per variable should be ten or more. In addition, in their simulation study, Bujang et al. (2017) performed the Monte Carlo test using the formula (2).

$$event = 100 + EVP\ x\ Size_{\beta}$$

In this equation, EVP represents the number of events per variable and the total number of explanatory variables. As a result of the failure to reach the required minimum number of events in both studies, it was determined that the Ordinary Rare Event Logistic Regression method was the appropriate method. The ordinary logistic model can be written as (3).

$$p_i = \left(1 + e^{-\left(\hat{\alpha}+\sum_{i=1}^{k}\beta_i X_i\right)}\right)^{-1} \quad (3)$$

Here, p_i which is a function of k number independent variables, representing the probability of I events' occurrence. α and β are unknown parameters obtained mainly from the likelihood method. This equation is usually linearized by performing a logit transformation. The natural logarithm of an odd number, the ratio of the probability of events, is divided by the probability of unrealized events. The logit form of the model can be expressed as (4) (Kleinbaum and Klein, 2010).

$$\text{logit}\ p_i = \ln \frac{p_i}{1-p_i} = \hat{\alpha} + \sum_{i=1}^{k} \hat{\beta}_i X_i \quad (4)$$

As expected, events related to the exchange rate jumps occupy an extremely small place in the total data. The low ratio of events to unrealized events will cause the constant term to be significantly biased. Therefore, the first correction on the known logistic regression method has been made on the constant term to avoid sample bias. The corrected constant term a_0 is based on the predicted $\hat{a}$. The corrected model estimation with τ representing the share of events in the total population and $\bar{\gamma}$ expressing their share in the sample are given in equation (5).

$$\alpha_0 = \hat{\alpha} - \ln\left[\left(\frac{1-\tau}{\tau}\right)\left(\frac{\bar{\gamma}}{1-\bar{\tau}}\right)\right] \quad (5)$$

Following the correction for the constant term, the undercalculated probability is corrected by adding the correction factor C_i to the estimated probability (5).

$$p_i = \tilde{p}_i + C_i \quad (6)$$

$$C_i = (0.5 - \tilde{p}_i)\tilde{p}_i(1-\tilde{p}_i)(X_0 V(\beta) X_0' \quad (7)$$

where $\tilde{p}_i$ is the event probability estimated using a_0 with bias correction. X_0 represents the value vector created for each explanatory variable with 1 x $(m + 1)$ dimension, X'_0 represents the transpose of this vector, and $V(\beta)$ represents the variance-covariance matrix.

DATA SETS AND VARIABLES

In the present study, weekly data from December 28, 2012, to September 13, 2021, were collected, yielding a total of 454 observations. As discussed in Section 2, gross foreign exchange reserves, weighted average deposit interest rates, and the ratio of gross foreign exchange reserves to M2 were employed as measures of dollarization to explain currency fluctuations. To identify exchange rate jumps, transactions were conducted using the average buying and selling rates for USD/TRY and EUR/TRY currency pairs, which formed the currency basket. The direct quotation method was applied to calculate the Turkish Lira equivalent for one unit of foreign currency.

When constructing the currency basket, the Turkish Lira equivalent of one US dollar and one Euro were summed and divided by two. Two of the four variables were transformed from their level versions: the percentage change in gross foreign exchange reserves compared to the previous period and the difference in deposit interest rates relative to the prior period. Analyses were conducted using the dollarization and exchange rate jumps levels.

After transformation, we take the abbreviations of variables: Exchange rate jumps, gross foreing exchange reserves, deposit interest rates and dollarization as ERJ, $RSRV_t$, $DLRD_t$, respectively.

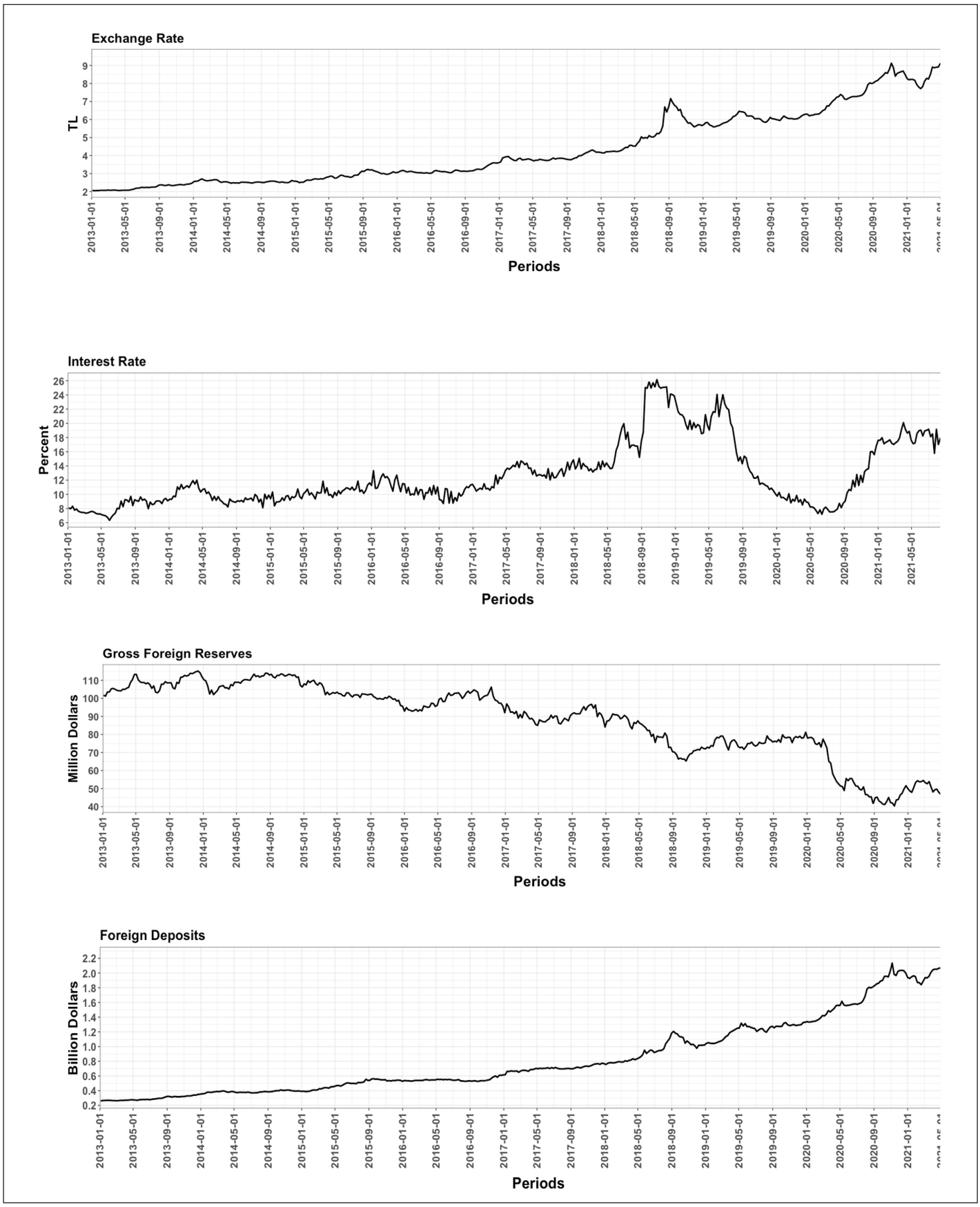

Figure 1: The trend of the variables at the level over time

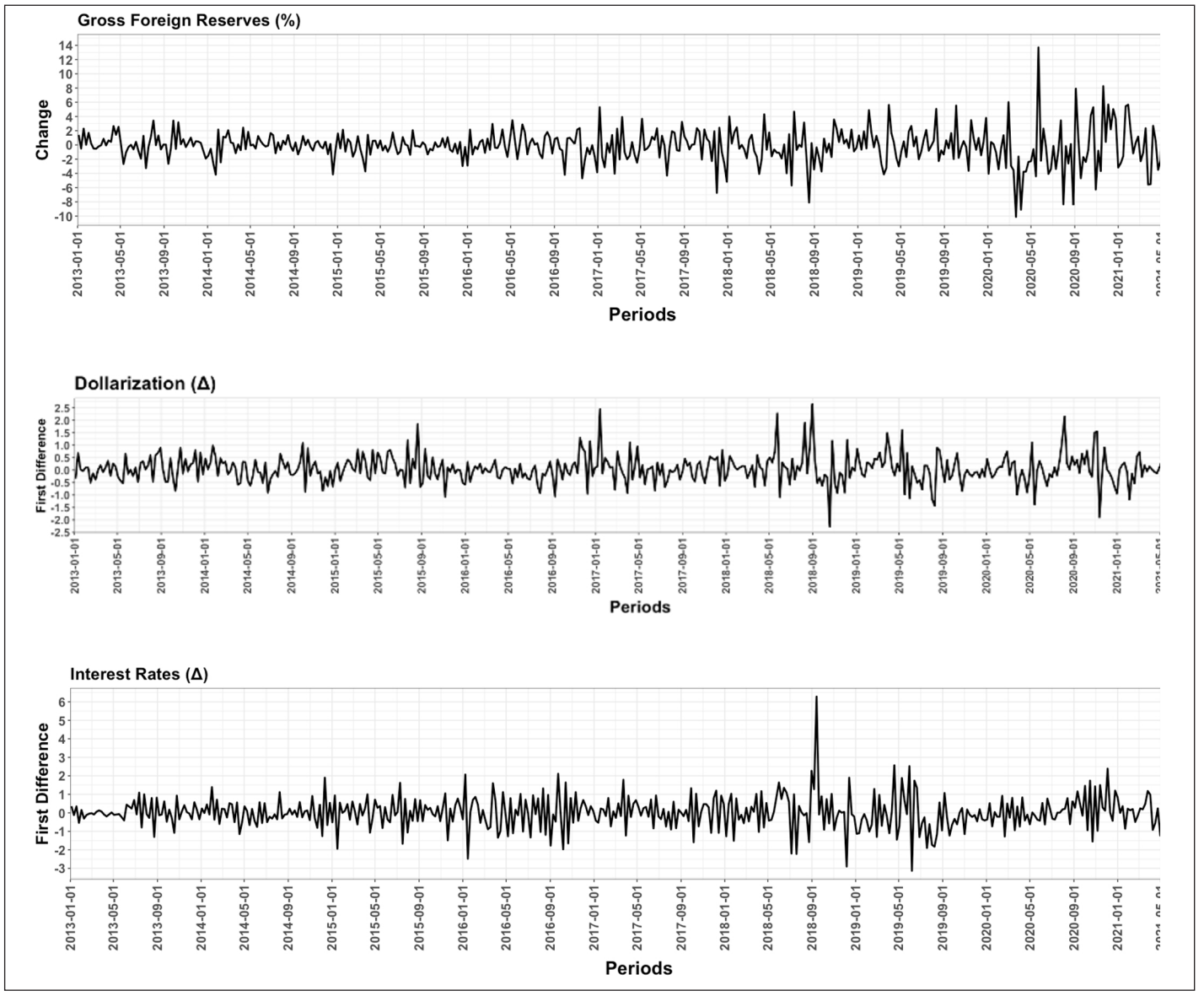

Figure 2: Trend of the variables after transformation over time

In Fig. 1 and Fig. 2, changes of the variables at the level and after transformation over time are shown, respectively.

Determining Dollarization

Ratio of foreign currency deposits to M2 was used in obtaining the dollarization variable (Ağaslan and Gayaker, 2019). The phenomenon of dollarization is a frequently encountered situation in developing economies. Especially in high inflation countries, the US dollar undertakes the functions of both being a medium of exchange, determining the unit of account and being an instrument of a store of value (Fuentes, 2009). The trend of the variable obtained over time is shown in Figure 3.

Determining the Exchange Rate Jumps

The exchange rate jump (*ERJ*) used in the study was essentially created by detecting the points where sudden changes (jumps) occur in the exchange rate series. The PELT algorithm suggested by (Killick et al., 2012) was used to determine the points where the statistical properties of the exchange rate series change. This algorithm is used to determine the optimal points where the statistical properties of a data set change. The exchange rate jumps were determined with Algorithm 1.

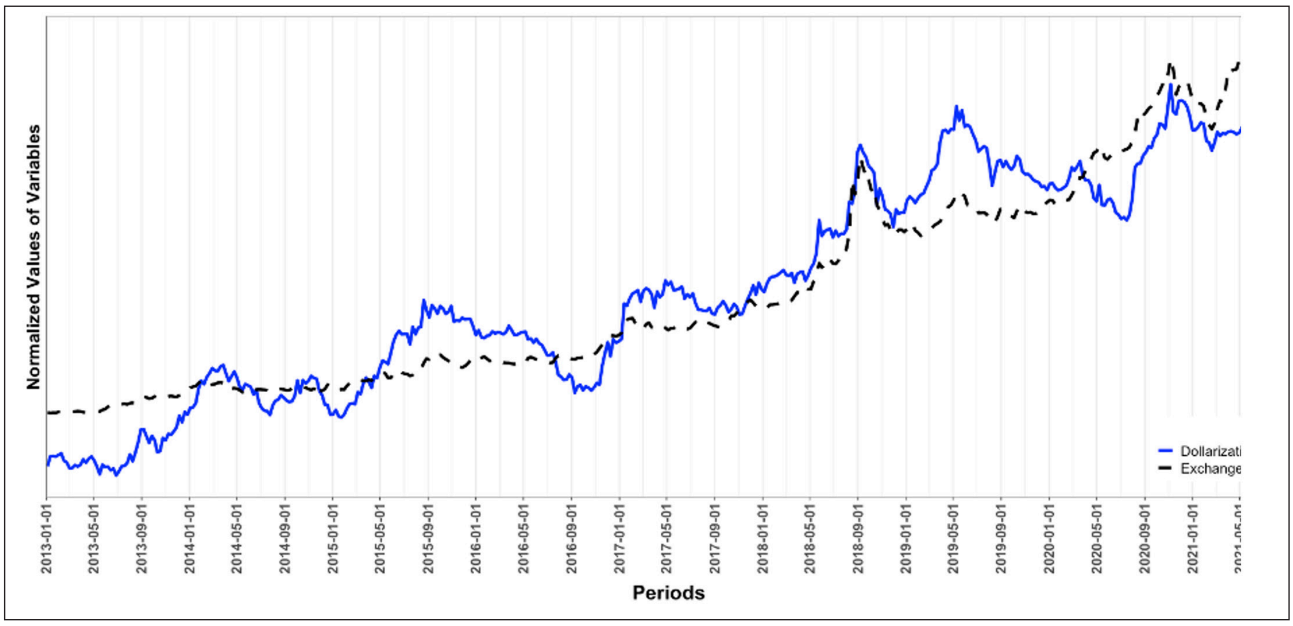

Figure 3: The trend of dollarization and exchange rate variables over time

Algorithm 1:	**Creating the Exchange Rate Jumps**
Step 1	Optimal change points were determined by applying the PELT algorithm to the Exchange Rate.
Step 2	Among the determined change points, those with an upward change were chosen.

Since the study aims to detect the exchange rate jumps in Türkiye, Algorithm 1 was applied to the daily exchange rate series, and then the resulting change points were reported weekly. This way, it was tried to determine jump points more in detail. The 2nd Stage in Algorithm 1 is also crucial in creating the exchange rate jumps. Because the PELT algorithm also detects downstream transformations in the data set. With the use of the 2nd stage, it is ensured that only the upward changes from the downward change point of the exchange rate jumps remain. In the light of this information, the *ERJ* is defined as follows:

$$ERJ_i = \begin{cases} 1 & \text{If time } i \text{ is the change point obtained as a result of Algorithm 1} \\ 0 & \text{in other cases} \end{cases}$$

The exchange rate jumps and the currency variable created after Algorithm 1 are given together in Fig. 4. In addition, jump points are seen in detail in Table 1.

The Turkish economy went through a period of improvement since it strengthened the banking sector after the crisis in 2001, ensured political stability, started full membership negotiations with the European Union, and the abundance of capital flows across the world. These developments stabilized exchange rates until the 2008 USA mortgage crisis. Although Türkiye experienced economic difficulties during the 2008 USA crisis, with the low interest rate and abundant monetary policy of the developed countries, there was no significant volatility in exchange rates until the middle of 2013 the CBRT was able to increase its reserves.

Starting from the day May 22, 2013, the Fed announced that it would reduce its bond purchases and increase interest rates in the future, the era of abundant money in the world came to an end. This process lasted until the Covid-19 epidemic in 2020, and with the pandemic in the world, low interest rate and abundant money period began again. However, it seems as if the threat of inflation emerging in the world will reintroduce the countries to the contractionary monetary policy process from 2022.

Exchange rates in Türkiye have shown a continuous upward trend since 2013. It is possible to say that this is due to some domestic and foreign economic and political developments. The study's start date was 2013 because of the emergence of currency jumps in Türkiye and many developing countries since that date. Dollarization, the CBRT reserves, and deposit rates discussed as variables in the study are the critical factors that determine the level and volatility of exchange rates. It is possible to say that these variables were affected by domestic and foreign

Table 1: Jump points calculated daily between 2013 and 2021

Jump Point	Exc Rate	**Jump Point**	Exc Rate	**Jump Point**	Exc Rate
21-06-2013	2.226	**20-03-2018**	4.388	**14-04-2020**	7.084
20-12-2013	2.442	**16-05-2018**	4.819	**07-08-2020**	7.829
05-03-2015	2.687	**31-07-2018**	5.298	**29-09-2020**	8.396
17-08-2015	2.997	**13-08-2018**	6.379	**28-10-2020**	8.867
08-11-2016	3.323	**09-04-2019**	6.023	**01-03-2021**	8.163
06-01-2017	3.690	**18-12-2019**	6.198	**23-03-2021**	8.663
24-10-2017	4.025	**13-03-2020**	6.626	**26-04-2021**	9.121

political developments, and therefore they are essential variables in observing political instability.

Table 1 shows the emerging jumps in exchange rates from 2013 to mid-2021. In the emergence of these jumps, the impact of domestic and international economic and political developments is very high. Now let's briefly summarize the reasons for the jump dates at the exchange rate given in the Table 1, respectively.

The date of 21.06.2021 was after 22.05.2013 when the Fed announced that it would reduce its bond purchases and coincides with the period when street demonstrations protesting the government in the country known as "Gezi Park Events" were intense. In the same way, the date of 20.12.2013 also coincides with a date after the Fed and Gezi events.

The date of 05.03.2015 coincided with the period when the political tension before the general elections in June 2015 was high and when the CBRT kept the policy rate low, although exchange rates tended to increase. The date of 17.08.2015 is significant in coinciding with the period when the government's power of being in control alone was lost after the June elections. The coalition government could not be formed. The decision to renew the elections was made, and the terrorist events increased.

08.11.2016 is after the failed military coup attempt in the country in July. On the other hand, efforts the CBRT, whose exchange rates continued to increase, reserves started to melt, having problems in its foreign capital entrances, to keep interest rates low through political interventions were effective in currency jumps in this period despite the Fed's decision to start interest rate hike in December 2015.

In the same way, the decrease in the reserves of the CBRT, keeping the policy interest rate low, the CBRT using its reserves instead of interest rate to stabilize the exchange rates, worsening of expectations in the country, increase in dollarization and the tension created by the referendum for the transition from the parliamentary system to the country-specific presidential system in April 2017 were influential in the exchange rate jump on 06.01.2017. In addition to the conditions as mentioned earlier, the public's acceptance of the presidential system with the referendum was effective in the exchange rate jump on 24.10.2017.

In the exchange rate jumps on 20.03.2018 and 16.05.2018, the presidential election that would be held in June 2018, the CBRT's keeping policy interest rates low against rising inflation and risks, declining gross reserves, and hardening in political rhetoric towards international investors were effective. The exchange rate jump on 13.08.2018 was the highest among the currency jumps we have mentioned so far. The main reason for this was the political debate called "priest Brunson between the USA under the leadership of Trump and Türkiye.

The most important reason for the exchange rate jump on 09.04.2019 was the efforts of the Government to cancel the Istanbul municipal elections as a result of the local elections held in March 2019. Another effect was the government's prohibiting significantly Turkish banks' TL lending limits to the London swap market after the exchange rate jump on 13.08.2018. The foreign investors perceived this as abolition of the convertibility of TL and capital control.

The exchange rate jump on 18.12.2019 was entirely due to domestic political developments. Because before this date, while deterioration of Türkiye's relations with the United States and the European Union continued, unlike the world, the CBRT started to decrease policy rates with political pressure and instead of using the interest weapon to prevent exchange rate increase it realized its reserve sales in a non-transparent manner through public banks. Domestic and foreign investors perceived these developments as

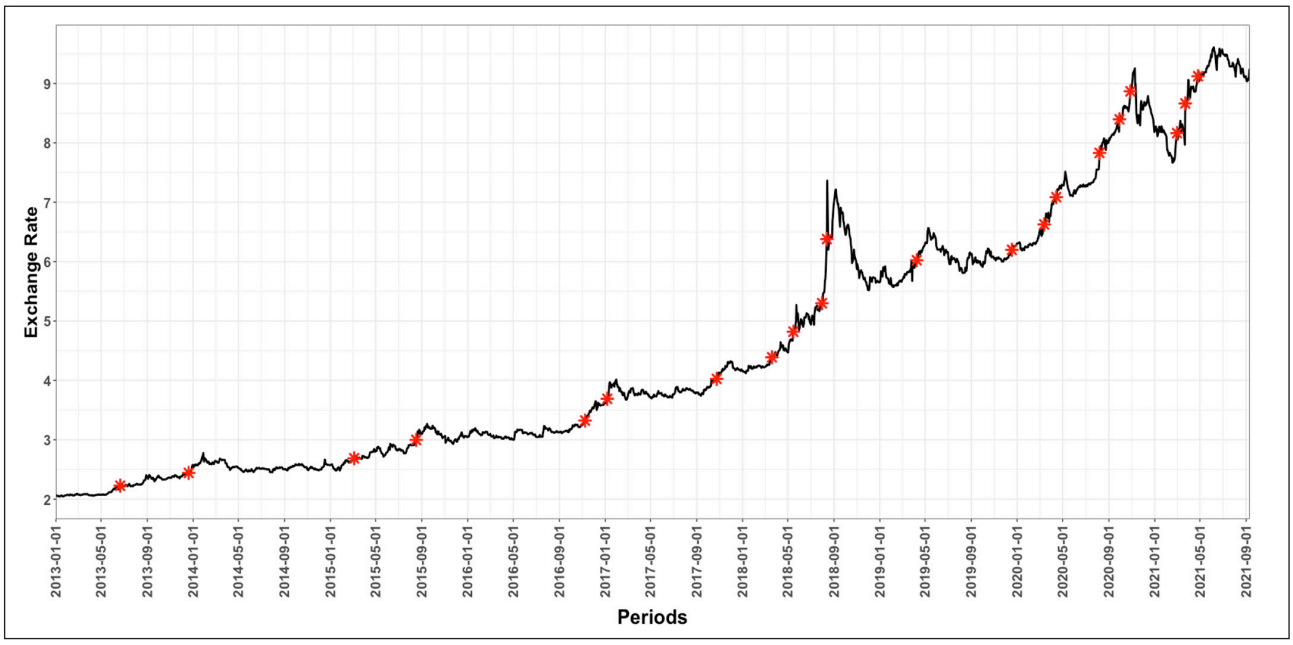

Figure 4: Exchange rate and Jump Points

the country's priority was not to reduce inflation but grow instead. The CBRT started to follow a growth-oriented monetary policy with political pressures instead of its duty of price stability. These developments further increased the belief that the CBRT was not independent. The currency jumps on 13.03.2020, 14.04.2020, 07.08.2020, 29.09.2020, 28.10.2020, and 01.03.2021 took place due to the effects of the Covid-19 epidemic.

During this period, while the gross reserves of the CBRT melted, its net reserves decreased to negative. Besides, in this period, the CBRT governors and the managers of the Bank were frequently dismissed as a result of political interventions. This caused the country not to attract foreign capital, although there was plenty of money in the world due to the pandemic.

Finally, the most crucial reason for the exchange rate jumps on 23.03.2021 and 26.04.2021 was the dismissal of the former finance minister, who was appointed as the head of the CBRT in November 2020 and whose relative credibility was high, with the political intervention at midnight on 20.03.2021. The new president appointed in November 2020 took over a CBRT without independence and credibility due to political pressures, whose net reserves were negative and policy interest was low. On the other hand, dollarization increased in the country, and inflation rates increased due to the exchange rate pass-through, and inflation expectations deteriorated. The dismissal of a relatively credible the CBRT governor and appointment of a governor that prioritizes growth rather than low interest and inflation with political intervention led to an increase in exchange rate jumps.

When Fig. 4 is examined, the optimal change points are determined before the sudden changes. The numbers of 1 and 0 related to the obtained ERJ variable are given in 2.

When Table 2 is examined, it is seen that data number qualified as "1" in the ERJ covers a part of 4.63%.in the total number of data.

Table 2. Rate of jump points to total data

	Classification		
	1 (Jump Points)	0 (Regular Point)	Total
Frequency	21	433	454
Percent	4.63	95.37	100

EMPIRICAL RESULTS

In the study, equation (1) was estimated. Since the dependent variable *ERJ* was categorically created here, it should be estimated by the logistic regression model. Besides, there should be a balance between the number

of realized events and the number of unrealized events in logistic regression. The number of realized events in the study was 21. In other words, it constitutes approximately 4.63% of the entire data set. In such cases, estimating logistic regression in the classical sense will result in biased estimates. On the other hand, (King and Zeng, 2001) proposed a correction for a small number of unrealized events. Model (1) is estimated by applying this correction suggestion and the results obtained are presented in Table 3.

$$ERJ_t = \beta_0 + \beta_1 RSRV_t + \beta_2 IR_t + \beta_3 DLRD_t + \varepsilon_t \quad t = 1,2,\dots,454 \tag{1}$$

Table 3. Estimation results for model 1

Dependent Variable (ERJ)	Coefficients	Robust Std Error	Z	P>|z|	Odds ratio
IR	-0.191*	0.113	-1.688	0.091	0.826
RSRV	-0.181**	0.091	-1.979	0.048	0.835
DLRD	0.849***	0.340	2.494	0.013	2.337
Constant	-3.209	0.261	-12.293	0.000	0.040

When Table 3 is examined, it is seen that the estimations obtained regarding the coefficients of the IR, RSRV, and DLRD variables are statistically significant at 10%, 5%, and 1% significance levels. According to the results obtained, while a decrease of 100 basis points in deposit rates increases the probability of a currency jump (1/0.826) = 1.211 times, a 1% reduction in the reserves of the CBRT similarly increase the probability of a currency jump (1/0.835) = 1.198 times. On the other hand, an increase of 1% in dollarization increases the probability of currency jumps 2.337 times.

Examining the Risk of Currency Jump under Different Situations

In this part of the study, using the estimates obtained from model (1), six different scenarios were set for currency jump risk under the reserves of the CBRT and different values of deposit interest rates. These scenarios reveal the possibility of an upward jump in the exchange rate in an optimistic, a pessimistic and a normal course. Among the variables in the study, except for dollarization, The CBRT has a direct effect on the change of other variables. As dollarization is shaped according to trust to the national currency, the effect of the CBRT on this variable is indirect. At this point, optimistic, pessimistic and normal situations are based on the increase or decrease in dollarization. Weekly highest increase in dollarization in the time period covered by the study is 2.64%. This value is considered as the worst possible situation (pessimistic). On the other hand, the biggest decrease in dollarization in the same period was 2.26%. This is considered as the best possible condition (optimistic). Finally, according to the current situation the absence of any change in dollarization was considered as the normal situation. The scenarios created were designed to be a total of six on two different variables and by constructing three different events. Here, brief information about the scenarios is given in Table 4.

If Table 4 is to be explained in detail, it is useful to go through an example. For instance, Scenario 1 states that:

If the increase in dollarization is 2.64% weekly and there is no change in deposit interest, it shows how the weekly change in gross reserves changes the exchange

Table 4. Created Scenarios

Scenarios		Definition of Scenario	Variable that changes jump probability
1	Pessimistic	2.64% increase in dollarization	
2	Normal	No change in dollarization	
3	Optimistic	2.26% decrease in dollarization	Gross Foreign Reserves
4	Pessimistic	2.64% increase in dollarization	
5	Normal	No change in dollarization	
6	Optimistic	2.26% decrease in dollarization	Interest Rate (Deposit)

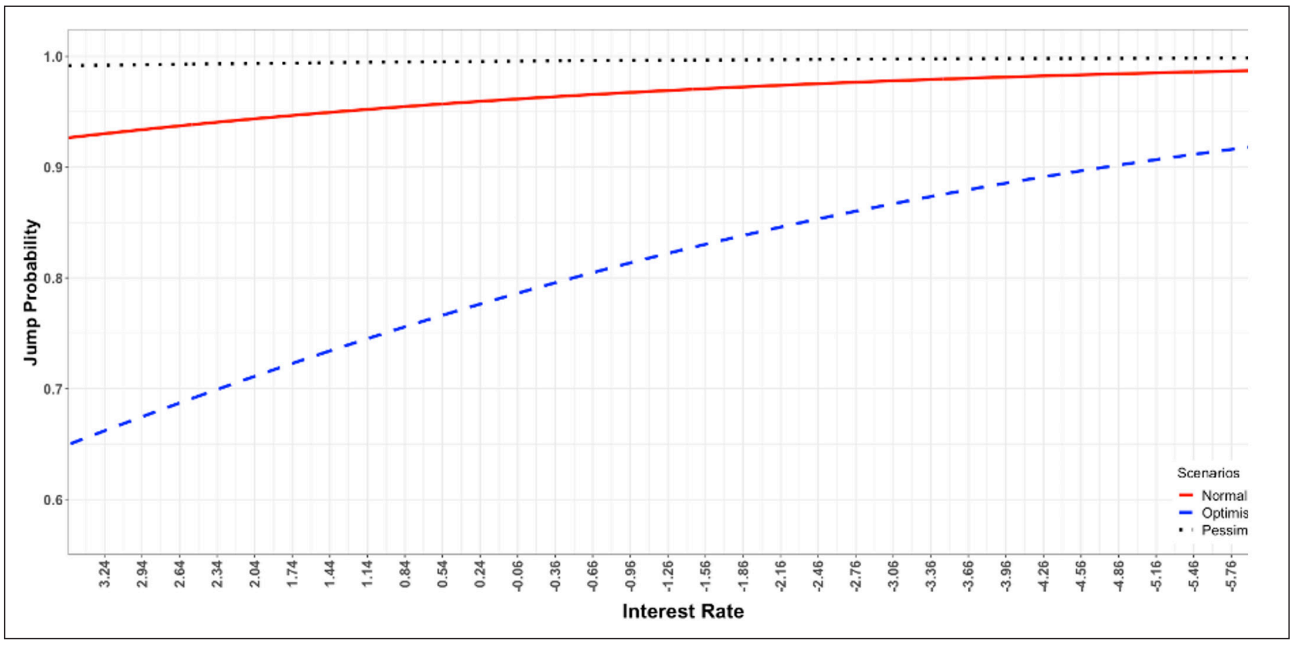

Figure 5: Graphs for scenarios 1,2 and 3 (probability of the exchange rate jumps of change in deposit interest in response to the change in constant and gross reserves)

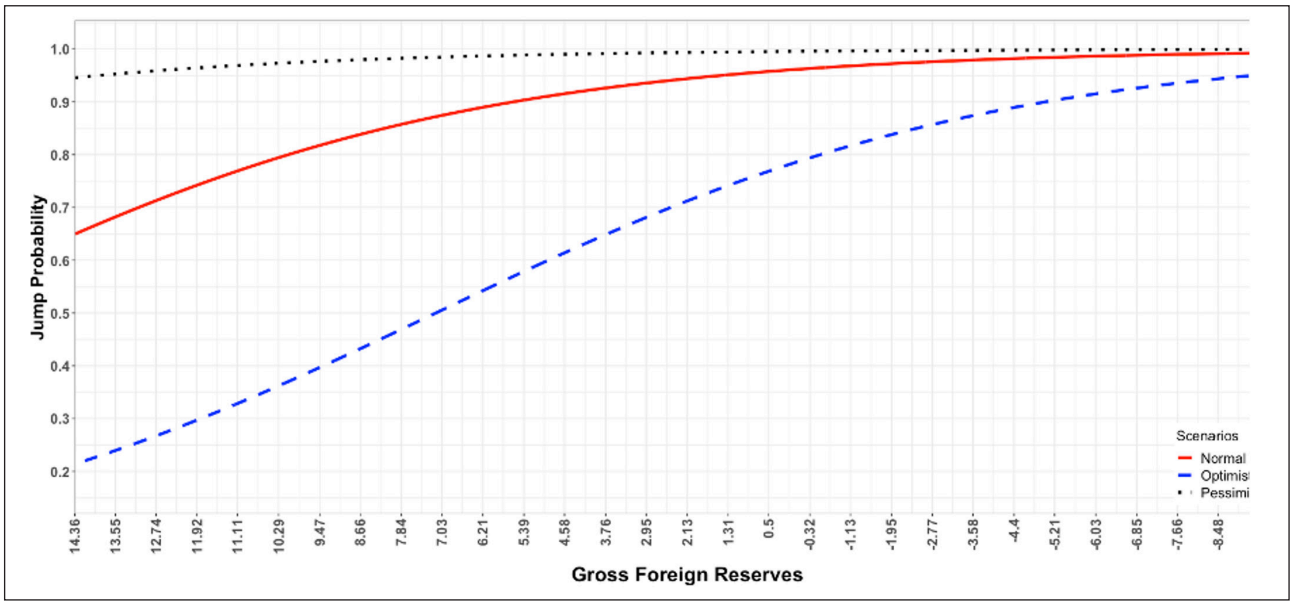

Figure 6: Graphs for scenarios 4.5 and 6 (probability of currency jump of change in reserves in response to change in constant and deposit interest rate)

rate jump risks. On the other hand, scenario 6 states the following:

In cases where the decrease in dollarization is 2.26% weekly, and there is no change in gross reserves, it expresses how the weekly change in the deposit rate changes the exchange jump risk. When Fig. 5 is examined, how the first three scenarios affect the jump risk is seen. In other words, Fig. 5 shows how the probability of a currency jump changes compared to weekly changes in gross reserves when interest is held constant. When all cases are examined, it is seen that the decrease in gross reserves increases the risk of currency jump quite rapidly. Despite that, in the pessimistic situation, even if the weekly increase in gross reserves is 14.36%, the probability of an exchange rate jump is above 0.90. In the optimistic scenario, the case that the probability of a currency jump exceeds 0.50 is the case that the increase in reserves is below 6.46%.

When Fig. 6 is examined, it is seen that the change in reserves is constant. Under a pessimistic scenario, regardless of the change in deposit rates, the country's probability of a currency jump is close to 1. However, in

the optimistic scenario, even if there is a high increase in deposit rates, the risk of a currency jump is above 0.60. This means that the probability of a currency jump is affected by gross reserves rather than changes in interest rates.

CONCLUSION

This study examines the factors behind sudden upward fluctuations in exchange rates in Türkiye from 2013 to 2021. A logistic regression model incorporating exchange rate, dollarization, deposit interest rates, and CBRT's gross foreign reserves was established, with the PELT algorithm detecting exchange rate fluctuations. Results indicate that increased dollarization raises the likelihood of exchange rate jumps, while higher deposit rates and CBRT reserves reduce this probability.

Analyses under optimistic, normal, and pessimistic scenarios reveal that decreasing gross reserves substantially raises the risk of currency jumps. The most critical factor affecting exchange rate jumps was identified as a decline in gross reserves. During the study period, the Turkish Lira depreciated steadily, with both external and internal factors contributing to its negative differentiation compared to other developing countries' currencies. Frequent changes in CBRT leadership, low interest rates to defend the Lira, and non-transparent sale of CBRT reserves were among the most significant causes of exchange rate jumps. Furthermore, the government's imposition of a growth-priority monetary policy undermined CBRT's independence, leading to capital outflows and increased vulnerability of the Turkish Lira.

To address these challenges, policies ensuring CBRT's purpose and instrument independence should be implemented, focusing on price stability and strengthening reserves. Implementing a positive real interest rate policy in line with inflation rates and providing a transparent, predictable, and safe investment environment will contribute to long-term growth. Additionally, long-term, stable, and coherent policy bundles can help eliminate dollarization, a significant issue in Türkiye's economy.

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The Effect of Corporate Governance Capacity on Herd Behavior

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ABSTRACT

Behavioral finance, which rejects the basic assumption of traditional finance and argues that individuals do not always act rationally and that psychological factors have an effect on investor behavior, reveals the effect of cognitive biases and emotional factors on the investor. Herd behavior, which is one of these emotional factors, is to imitate the behavior of others in its most general definition. In addition, herd behavior, which affects investor behavior and financial markets, is a behavioral attitude showing that investors act together. On the other hand, corporate governance, which is becoming increasingly important for businesses, is a system in which company activities are managed and controlled. Companies with the highest corporate governance rating score can be included in the Borsa Istanbul Corporate Governance Index. The main purpose of working within the framework of herd behavior and corporate governance is to reveal the possible effect of corporate governance rating on herd behavior from a different perspective. In this context, the Christie and Huang (1995) Model and the Chang, Cheng, and Khorana (2000) Model are used in the research. In terms of herd behavior, no herding behavior was found in 16 other prominent indices in Borsa Istanbul according to the results of the Christie and Huang (CH) Model, while herd behavior was detected in some indices according to the results of Chang, Cheng, and Khorana (CCK) Model. In addition, no evidence was found in favor of herd formation according to both the CH Model and the CCK Model in companies included in the Corporate Governance Index within the scope of herd behavior and grouped as high/low corporate governance score within the framework of the determined criteria.

Keywords: Behavioral Finance, Herd Behavior, Corporate Governance Rating, Borsa İstanbul.

JEL Classification Codes: G4, G41

Referencing Style: APA 7

INTRODUCTION

Traditional economics assumes that each individual has constant preferences and logically maximizes them (Rabin, 1998: 11). More than one conventional finance theory has been developed in this way, contending that individuals are rational and retain their reasoning when making investment decisions. But much more recently, behavioral finance has been the focus of numerous academic studies seeking answers to questions like whether individual investors are purely rational or can cognitive and emotional errors influence financial decisions. These studies have documented a great deal of irrational behavior and repeated mistakes in the judgments made by adult human subjects. While behavioral finance rejects the homoeconomicus assumptions accepted by traditional finance, it emphasizes homo sapiens by trying to replace anyone with a spouse, child, boss, or insight with a more realistic financial actor model. Many scholars have defined behavioral finance in various ways and have given their interpretations of these definitions. But at the core of all of them are three keywords that are psychology, sociology, and finance (Ricciardi and Simon, 2000: 27). Behavioral aspects of psychology and sociology are integral catalysts within this field of study. Behavioral finance is in sharp contradiction with the Efficient Market Hypothesis (EPH) (Shiller, 2003: 83). Moreover, Mental and emotional factors affect the way investors make decisions and evaluate. For example, people in a bad mood have more pessimistic evaluations than those in a good mood. In addition, a bad mood causes investors to engage in detailed analytical activities and have a more critical perspective (Baker and Nofsinger, 2002: 102-104). One of the most striking issues in behavioral finance is herd behavior. Social psychologists and economists explained herd behavior as momentary changes in consumer behavior (for example, fashion).

Herd behavior in financial markets occurs when investment decisions are made on a particular piece

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of information by a group of investors, ignoring other relevant information such as news or financial reports (Ricciardi and Simon, 2000: 33). Hwang and Salmon (2004) describe herd behavior as showing a correlated behavior, imitating and removing private information without referring to the fundamentals. In addition, Aytekin and Aygün (2016) explain herd behavior as a group of investors buying or selling the same security in the same period. When we review the studies conducted on this topic, statistical evidence for the existence of herd behavior has been found in many studies conducted in financial markets (Puckett and Yan, 2008; Amirat and Bouri, 2009; Dornbusch and Park, 1995; Caparrelli et al., 2004; Xu et al., 2004; Ha, 2007; Caporale, 2008; Kremer and Nautz, 2011; Nakagawa and Uchida, 2011; Somuncu and Karan, 2010; Doğukanlı and Ergün, 2015; Hwang and Salmon, 2004; Kapusuzoğlu, 2011; Kayalıdere, 2012; İç and Kahyaoğlu, 2013; Akçaalan, 2017). However, as in the empirical analysis of many theoretical approaches in the field of finance, the findings of markets where herd behavior does not exist have also been put forward by many researchers (Demirer and Kutan, 2006; Gleason et al. 2004; Demirer et al., 2007; Altay, 2008; Çoban, 2009; Miceli, 2011; Kuzu and Çelik, 2020; Çimen and Ergün, 2019; Doğukan and Ergün, 2011).

It is conceivable to discuss the existence of several elements that might lead to financial market herd behavior. The main motivation of this study is to reveal the relationship between corporate governance capacity and herd behavior, which is not very common in the literature. Within the framework of this focus, it is thought that the findings to be obtained will be able to complete a piece that is not sufficiently covered in the literature. In addition, one of the main reasons underlying the handling of corporate governance capacity in this context is the thought that corporate governance practices can contribute to the formation of fair prices in the markets and that the problem of asymmetric information among market participants may arise. In this context, it would be beneficial to mention the concept of corporate governance after mentioning the theoretical framework. Although it is stated that the term corporate governance emerged in the mid-1980s, its foundations were laid in 1940 when modern companies began to evolve. In the Cadbury Report (1992), corporate governance was first defined and explained as "the system by which companies are directed and controlled". In this report, the objectives of corporate governance are expressed as follows (Shah and Napier, 2017; Kanca, 2020: 13): Ensuring the reliability of financial reports; the board of directors complies with the act of accountability; the reliability of the reports submitted by the auditors to the company users; the board of directors of the business complies with regulations and laws and is used within the scope of company purposes; equality with shareholders and protection of shareholders' rights in management. In this manner, Corporate governance is defined as the corporate governance structure that determines the rules for decision-making and the distribution of rights and responsibilities among different participants in the organization, such as the board of directors, directors, shareholders, and other stakeholders (OECD, 2004). In addition, corporate governance is the set of rules regulating the relations between company management and shareholders, and stakeholders. In other words, it is a management philosophy that aims to protect the rights of all stakeholders (stakeholders) directly or indirectly related to the activities of the company, including the shareholders, and to reveal the responsibilities and obligations of the company management (Schleifer and Vishny, 1997: 737).

The importance given to the concept of corporate governance is increasing day by day, both nationally and internationally, the Corporate Governance Index (XKURY), was created based on corporate governance score in Borsa Istanbul. The prerequisite for companies to be listed in the Corporate Governance Index is to have a corporate governance rating score calculated by the institutions within the framework of the four principles of corporate governance (equality, accountability, responsibility, and transparency). This score (at least 7 out of 10) is also expressed as a rating activity that questions the quality of corporate governance practices of companies. The fact of the matter is that companies that effectively implement corporate governance principles may result in more realistic behavior when pricing by market participants. It can be assumed that this situation may cause differentiation in the formation of market movements such as herd behavior compared to other indices.

In light of the aforementioned, the main purpose of working within the framework of herd behavior and corporate governance is to reveal the possible effect of corporate governance rating on herd behavior from a different perspective. The reason for putting this purpose in the focus of the research is to consider the possibility that following prominent principles may cause interaction on herd behavior in finance theory. In this context, Christie and Huang (1995) and the Chang, Cheng, and Khorana (2000) models, which are prominent in the literature, are used to determine herd behavior. The

content of the study, the methodological explanations of the methods to be used in the analysis, and the data set are mentioned. Afterward, the findings will be analyzed and final evaluations will be made. It is thought that the results will gain a new perspective and present a set of information in the evaluation of herd behavior in terms of the decision-making processes of market participants.

DATASET AND METHODOLOGY

The data set and models utilized, as well as the hypotheses developed in the course of the research, are presented in this section, which will also provide thorough information on the data set, hypotheses, and the applied methodological approach.

Dataset

As previously stated, the primary goal of this research is to ascertain whether corporate governance ratings may have an impact on herd behavior. By identifying any potential herd behavior in the Corporate Governance Index and 16 important indices in Borsa Istanbul, the first sub-objective established within the scope of the research aims to ascertain whether predictable market moves have become commonplace. In keeping with the primary goal of the study, the second sub-objective was developed to identify any potential herd behavior in the XKURY companies that were assigned high or low corporate governance rating points based on the predetermined criteria. Table 1 presents comprehensive details regarding the data set produced within the parameters of the research. The necessary indices' transaction code, description, number of firms listed in the indices, analysis time interval, data period, and data source are all listed in Table 1.

In addition, companies that were a part of XKURY during the 04.01.2021-29.03.2022 timeframe and supplied data continuity at that time were considered in the research to establish the second sub-goal. These companies' corporate governance ratings are divided into two groups, low and high. Firms with a corporate governance score of 9 or more go into the "high" category, while those with a score of less than 9 fall into the "poor" category. In this case, analysis was done on a total of 55 companies, 48 of which fell into the high group and 7 of which fell into the low category. Additionally, finnet.com was used to gather all of the daily closing information for the research. According to the first sub-goal of the study, null and alternative hypotheses were developed and evaluated for several selected indices to look for potential herd behavior in XKURY and other indexes. As part of the second sub-objective of the research, companies that are included in XKURY and that are rated as having high or low corporate governance rating points according to the established criteria are also included. The null and alternative hypothesis that was developed to observe the potential existence of herd behavior in these companies

Table 1. Detailed Dataset Information

Index Code	Index Description	Numb. of Listed Firms	Data Period	Time Interval	Data Source
XUTUM	BIST All Share Index	468	04.01.2010 - 29.03.2022	Daily	finnet.com
XKURY	BIST Corporate Governance Index	53			
XU100	BIST 100 Index	100			
XUSRD	BIST Sustainability Index	73			
XUSIN	BIST Industrial Index	202			
XGIDA	BIST Food and Beverage Index	34			
XKMYA	BIST Chemical Petroleum Plastics Index	41			
XMADN	BIST Mining Index	6			
XMANA	BIST Basic Metal Index	25			
XKAGT	BIST Wood, Paper Printing Index	15			
XTEKS	BIST Textile Leather Index	21			
XUHIZ	BIST Services Index	109			
XTRZM	BIST Tourism Index	11			
XULAS	BIST Transportation Index	10			
XBANK	BIST Bank Index	12			
XSPOR	BIST Sports Index	4			
XUTEK	BIST Technology Index	32			

is also provided below. The research hypotheses are stated as follows in this context:

H_{0A}: There is no herd behavior in the XKURY index traded on Borsa Istanbul.

H_{1A}: There is herd behavior in the XKURY index traded in Borsa Istanbul.

H_{0B}: Corporate governance rating score does not affect herd behavior.

H_{1B}: Corporate governance rating score affects herd behavior.

If the anticipated statistically significant results are attained, the null hypotheses can be ruled out within the parameters of the models that were utilized, while the existence of herd behavior in the pertinent markets can be asserted. If the results were otherwise, we would conclude that markets do not, from this perspective, show herd behavior.

Last but not least, it is crucial to stress that portfolios are created when the two methodologies utilized to look for potential herd behavior within the context of this research are methodologically explained. Portfolios having at least 25 stocks and portfolio returns are determined equally weighted in these models. However, in this study, the effect of herd behavior on the returns obtained from the closing prices of the index calculated by Borsa İstanbul was investigated. Although this study was not carried out on portfolios created in an individual style, especially for the Christie and Huang (1995) Model, indices without 25 companies were not taken into account. In the Chang, Cheng, and Khorana (2000) Model, it is assumed that there will be no problem for the indices created by Borsa Istanbul and for the general application since the number of companies is not given in the reference study. In addition, it is anticipated that value-weighted indices created by Borsa Istanbul will not pose a problem as in other studies on stock markets in the literature.

METHODOLOGY

To accomplish the research's primary goal and supporting objectives, the Christie and Huang (1995) Model and Chang, Cheng, and Khorana (2000) Model, two herd behavior measurement approaches, were used. Herd behavior, according to Christie and Huang (1995), prevents individual returns from differing from market returns. Based on this viewpoint, researchers used stock prices to compute the cross-section standard deviations or variances of stock returns. It was determined how closely the individual responses collectively resembled the mean using this deviance. Following this theory, the distribution of all stocks that move with the market will be zero, but it is claimed that this value will rise if more stocks move in a different direction. Rational asset pricing models and herd behavior predictions are most visible on days with abnormally significant average price movements or when the market is under stress. Based on this supposition, it was looked into whether the distributions in the herd behavior research were significantly lower than the average during the aforementioned times. Researchers isolate the level of distribution, St, at the extremes of the market return distribution and examine if it significantly differs from the average distribution levels that do not include the outermost market returns to discriminate between the two hypotheses. The stock return distribution S (CSSD) is measured using the following regression to conduct these tests (Christie ve Huang, 1995: 32-33):

$$S = \sqrt{\frac{\sum_{i=1}^{n}(r_i - \bar{\Gamma})^2}{n-1}}$$

$$\mathrm{CSSD} = \alpha + \beta_1 D_t^U + \beta_2 D_t^L + \varepsilon_t$$

r_i: The observed return of the stock.,

r^-: Cross-section average of returns,

α: Sample average distribution that does not include the areas that are affected by the two dummy variables,

D_t^L: Dummy variable, (This value takes the value of 1 if it is found at the low end of the market; 0 if it is not found),

D_t^U: Dummy variable, (This value takes the value 1 if found at the high end of the market, 0 if it is not found),

ε_t: The random error term.

The Rational Asset Pricing Model states that while substantial and positive $\beta 1$ and $\beta 2$ coefficients should be discovered, significant and negative $\beta 1$ and $\beta 2$ coefficients are required to be discovered for herd behavior. To demonstrate herd behavior, it is crucial to ascertain whether asset returns tend to rise or fall in response to changes in market returns. It should be highlighted that while a low distribution is predicted when herd behavior is present, this does not always imply that there is herd behavior. For instance, even in the absence of herd behavior, the lack of new information in a transaction interval may result in limited dispersion (Ergün, 2013: 45).

The Chang, Cheng, and Khorana (2000) Model is a different study methodology that suggests there might not be a linear link between the cross-sectional standard deviation of the return rates and the market return. It can be claimed that the research discussed in this context has the property of complementing one another. In contrast to Chang, Cheng, and Khorana's (2000) Model, which uses the cross-sectional absolute deviation of returns (CSAD) as a measure of distribution, rational asset pricing models forecast that stock return distributions are both an increasing function of market returns and that the relationship is linear. The linear and incremental link between distribution and market return will no longer hold if market participants have a propensity to follow aggregate market behavior and disregard their priorities during periods of significant average price changes, or herd behavior. Instead, the relationship might shift to a nonlinear upward or downward trend (Chang, Cheng, and Khorana, 2000: 1655). They used the cross-sectional absolute deviation of returns (CSAD), a measure of return distribution created by Chang, Cheng, and Khorana in 2000. The application form is provided below:

$$CSAD_t = \frac{1}{n}\sum_{i=1}^{n} |R_{i,t} - R_{m,t}|$$

R_{it} represents the return of the ton asset in question, Rmt refers to the return of the market portfolio, and CSAD shows the link between these returns.

The CCK model is inspired by the Rational Capital Asset Pricing Model (CAPM), which relates the intrinsic linearity of individual stock returns to market portfolio returns. In this sense, a violation of the linearity condition would favor herd behavior. Accordingly, a conditional version of the Black (1972) Capital Asset Pricing Model (CAPM) can be expressed as follows (Chang, et al., 2000: 1655):

$$CSAD_t = \alpha + \gamma_1 |R_{m,t}| + \gamma_2 R^2_{m,t} + \varepsilon_t$$

The CCK model states that a proportional increase in the cross-sectional absolute deviation (CSAD) during moments of extreme market fluctuations can demonstrate the existence of less or less herding behavior. As a consequence, the nonlinear coefficient γ_2 will be statistically significant and negative if there is a herd; otherwise, a statistically positive γ_2 does not show any evidence of herd behavior (Demirer, Kutan, and Chen, 2010: 286). To reiterate, it is conceivable to contend that if the market exhibits herd behavior, the distribution of returns will rise as market returns fall or fall as they rise (Chang, et al., 2000: 1653).

FINDINGS AND ANALYSIS

The Christie and Huang (1995) Model was initially applied to the 16 main indices in Borsa Istanbul as well as the Corporate Governance Index to discover any potential herd behavior. As mentioned at the end of the Dataset part, indices with a density of less than 25 companies were not included in the analysis for the CSSD Model. The analysis's outcomes are summarized below.

Results of the herd behavior investigation using Christie and Huang's (1995) Model are shown in Table 2. While 5% (higher) and 1% (lower) return distributions of the market return were employed to illustrate the market stress times, the $CSSD = \alpha + \beta_1 D_t^U + \beta_2 D_t^L + \varepsilon_t$ regression equation was taken into consideration to examine if herding behavior could be present in the 17 indices used to represent the market. According to CAPM, whilst significant and negative β_1 and β_2 coefficients should be discovered for herd behavior, statistically significant and positive β_1 and β_2 coefficients should be found (Christie & Huang, 1995). According to the analytical findings shown in Table 2, it is also remarkable that in both the 5% and 1% slices of the XUSIN index, the β_1 coefficient is not negative and statistically significant. It was discovered that other indices were meaningful and positive in both the 1% and 5% slices. This demonstrates that, as the CAPM expected, it makes statistically significant and favorable predictions demonstrating that stock return distributions rise during periods of big price movements. On the other hand, not all of the examined sectors could achieve negative and significant β_1 and β_2 coefficients. This indicates that there is no evidence of herd formation in the higher and lower (5% and 1%) market sectors. In other words, the null hypothesis is accepted for all indices in both the 5% and 1% slices and it is claimed that investors do not behave collectively with shared knowledge, do not create herd behavior, and do not experience predictable market fluctuations. When all the data are taken into consideration, it is also important to note that the obtained results are comparable to those of Christie and Huang's (1995) research and that the β_1 coefficients are closer to one another than the β_2 coefficients. According to this scenario, the distribution of returns during periods of significant market declines is more comparable to the distribution of returns during periods of significant market rises.

Table 2. The outcomes of the regression between the return distributions of the stocks included in the indices and the dummy variables that reflect the index's extreme values of 5% and 1% (CSSD Model)

	Market return at 5% of the yield distribution's extreme top/bottom positions			Market return at 1% of the yield distribution's extreme top/bottom positions		
Index	**α**	**(β_1)**	**(β_2)**	**α**	**(β_1)**	**(β_2)**
XUTUM	0,0016	0,0002 (0.000***)	0,0004 (0.000***)	0,0016	0,0003 (0.000***)	0,0009 (0.000***)
XKURY	0,0029	0,0006 (0.000***)	0,0010 (0.000***)	0,0029	0,0011 (0.000***)	0,0019 (0.000***)
XU100	0,0025	0,0004 (0.000***)	0,0008 (0.000***)	0,0026	0,0008 (0.000***)	0,0015 (0.000***)
XUSURD	0,0026	0,0005 (0.000***)	0,0010 (0.000***)	0,0027	0,0010 (0.000***)	0,0017 (0.000***)
XUSIN	0,0029	-0,0000 (0,641)	0,0007 (0.000***)	0,0030	-0,0000 (0,777)	0,0012 (0.000***)
XGIDA	0,0064	0,0011 (0.000***)	0,0024 (0.000***)	0,0065	0,0017 (0,001)***	0,0035 (0.000***)
XKMYA	0,0055	0,0008 (0,0001)***	0,0019 (0.000***)	0,0056	0,0012 (0,0045)***	0,0024 (0.000***)
XMANA	0,0064	0,0011 (0.000***)	0,0022 (0.000***)	0,0065	0,0012 (0,0458)**	0,0040 (0.000***)
XUHIZ	0,0054	0,0009 (0.000***)	0,0017 (0.000***)	0,0055	0,0011 (0,0041)***	0,0031 (0.000***)
XUTEK	0,0101	0,0008 (0,0971)*	0,0029 (0.000***)	0,0102	0,0009 (0,391)	0,0058 (0.000***)

Significance is indicated by the symbols *, **, and *** at 10%, 5%, and 1% level, respectively.

As stated in the methodology section, Table 3 illustrates the outcomes of the herd behavior analysis by using the Chang, Cheng, and Khorana (2000) Model, which was created in addition to the Christie and Huang (1995) Model and chosen to be employed in the research. The linear CH (1995) Model may have difficulties capturing the combined movement between individual asset returns and total market returns, which might produce inaccurate test findings. To conclude herd behavior, nonlinear tests were considered (Demirer et al., 2010, p. 290). The 17 indices that were employed to represent the market were examined using the $CSAD_t = \alpha + \gamma_1 |R_{m,t}| + \gamma_2 R^2_{m,t} +$ regression equation to determine whether herd behavior could be evident.

At first glance, Table 3 appears to indicate that all γ_2 values investigated are positive and statistically significant at the 1% level for the whole sample period. It should be emphasized, nonetheless, that the CCK (2000) Model requires that the γ_2 number be negative and meaningful to address herd behavior that demonstrates a nonlinear and downward connection between stock return distributions and market returns. In this circumstance, it may be argued that there was no herd behavior for the whole sample. That being said, although γ_2 values with various degrees of significance are found, only the XTRZM index is negative among these values, and the other significant values are all positive, according to the study results for the upmarket period. Out of the 17 indices taken into account during the upmarket period, this appears to suggest that only the XTRZM index investor behaved together and caused the formation of a herd. However, only the XKURY, XUSURD, and XGIDA indices exhibit signs of herd behavior when the analytical findings from the down market period are evaluated. The XUSURD index has a 5% significant negative γ_2 value, the XBANK index has a 1% significant negative γ_2 value, and the XKURY and XGIDA indices have a 10% significant negative γ_2 value, respectively. The existence of this herd behavior in the pertinent indices suggests that market fluctuations are predictable. The null hypothesis was accepted for all of the indexes chosen throughout the whole sample period when the hypotheses developed within the scope of the research were examined. The H_{1A} hypothesis was accepted only for the XTRZM index

Table 3. Regression Outcomes of $CSAD_{m,t}$ on Market Returns

	Whole Sample Period			Up Market Period			Down Market Period		
Index	**α**	**γ1**	**γ2**	**α**	**γ1**	**γ2**	**α**	**γ1**	**γ2**
XTUM	0,0162	0,0026 (0,6533)	3,4276 (0.000)***	0,0148	0,1600 (0.000)***	1,3775 (0,0331)**	0,0145	-0,2389 (0.000)***	-0,2451 (0,5006)
XKURY	0,0137	0,0009 (0,8524)	3,1735 (0.000)***	0,0124	0,1371 (0.000)***	1,8716 (0,0011)***	0,0121	-0,2420 (0.000)***	-0,5943 (0,0635)*
XU100	0,0133	-0,0001 (0,9783)	2,5946 (0.000)***	0,0122	0,1020 (0.000)***	1,8095 (0,0011)***	0,0120	-0,1931 (0.000)***	-0,4302 (0,1312)
XUSURD	0,0126	-0,0006 (0,8971)	2,6957 (0.000)***	0,0113	0,1235 (0.000)***	1,5597 (0,0021)***	0,0112	-0,2155 (0.000)***	-0,6651 (0,0186)**
XUSIN	0,016	0,0023 (0,709)	3,2629 (0.000)***	0,0147	0,1425 (0.000)***	1,6288 (0,0237)**	0,0146	-0,2215 (0.000)***	-0,1802 (0,6405)
XGIDA	0,0175	0,0016 (0,8611)	3,6109 (0.000)***	0,0158	0,1894 (0.000)***	1,4630 (0,1714)	0,0155	-0,3028 (0.000)***	-1,0743 (0,0651)*
XKMYA	0,0151	-0,0064 (0,3942)	2,5140 (0.000)***	0,0141	0,0844 (0,0211)**	2,0908 (0,0231)**	0,0139	-0,1966 (0.000)***	-0,5022 (0,2513)
XMADN	0,017	-0,0071 (0,7087)	3,2233 (0.000)***	0,0159	0,0964 (0,2876)	2,2713 (0,319)	0,0160	-0,1678 (0,0215)**	0,6674 (0,5561)
XMANA	0,0153	0,0107 (0,2324)	3,0741 (0.000)***	0,0145	0,1087 (0,0124)**	1,8436 (0,0916)*	0,0137	-0,2071 (0.000)***	-0,1238 (0,8117)
XKAGT	0,017	0,0231 (0,0245)**	3,7278 (0.000)***	0,0159	0,1494 (0,0021)***	2,3616 (0,0528)*	0,0155	-0,2089 (0.000)***	0,1906 (0,7537)
XTEKS	0,0173	-0,0159 (0,1175)	3,5498 (0.000)***	0,0155	0,2076 (0.000)***	-0,3557 (0,7504)	0,0161	-0,1988 (0.000)***	0,7549 (0,239)
XUHIZ	0,0171	0,0074 (0,3707)	3,4795 (0.000)***	0,0156	0,2104 (0.000)***	0,08775 (0,9255)	0,0152	-0,2568 (0.000)***	-0,4110 (0,4185)
XTRZM	0,0199	0,0262 (0,1151)	4,1925 (0.000)***	0,0175	0,3991 (0.000)***	-3,7321 (0,0619)*	0,0176	-0,2728 (0.000)***	0,0197 (0,9838)
XULAS	0,0158	0,0187 (0,1743)	2,9206 (0.000)***	0,01467	0,1748 (0,0089)***	0,0967 (0,954)	0,0145	-0,1500 (0,0036)***	0,4504 (0,573)
XBANK	0,0122	0,0174 (0,0648)*	4,5583 (0.000)***	0,0101	0,2487 (0.000)***	1,9236 (0,0783)*	0,0096	-0,3768 (0.000)***	-1,4715 (0,0068)***
XSPOR	0,0204	-0,0099 (0,6442)	4,1403 (0.000)***	0,0179	0,2685 (0,0064)***	-0,0539 (0,9826)	0,0192	-0,2371 (0,0057)***	0,4719 (0,7228)
XUTEK	0,017	-0,0260 (0,0308)**	2,4986 (0.000)***	0,0160	0,0970 (0,0776)*	0,8039 (0,5605)	0,0152	-0,2684 (0.000)***	-1,0581 (0,1504)

Significance is indicated by the symbols *, **, and *** at 10%, 5%, and 1% level, respectively.

and denied for the other 16 indices, according to the analytical findings obtained during the up-market period. The H_{1A} hypothesis was finally adopted owing to the herd formation in the XKURY, XUSIN, XGIDA, and XBANK indices, and the H_{0A} hypothesis for the other indices, as a consequence of the observations and findings seen in the down market period. Additionally, it can be demonstrated that the herd effect is more pronounced in market losses when the regression findings from tests using sparse data on markets that are up and down separately are examined. This suggests that times of market losses are when herd behavior is most likely to be seen. The idea of loss aversion is put out in certain behavioral finance research, and our conclusion

is compatible with that. This theory postulates that investors' utility functions are constructed in a way that makes it more likely that they will avoid losses than they will experience gains. To put it another way, for investors, the pleasure of winning is equal to the agony of losing (Kahneman and Tversky, 1979; Tversky and Kahneman, 1991). Due to investor psychology's tendency to produce asymmetrical responses to market gains and losses, the herd find, which happens when investors experience market losses, may thus be caused by these times of market losses (Demirer et al., 2010).

Also, it is estimated that the outcomes of the Christie and Huang (1995) Model, a unique aspect of the research that is carried out in the framework of potential herd behavior in companies that are listed in the XKURY and whose corporate governance rating points are classified as high or low within the established criteria. Similarly, for this model, since the number of companies whose corporate governance score has decreased is less than 25, analysis for the CSSD Model has been carried out only on companies whose corporate governance score has increased compared to the previous period. In this context, the analysis findings were not mentioned in a table, since no statistically significant result could be determined on the herd behavior, and the possibility of comparison was lost.

The outputs of the Chang, Cheng, and Khorana (2000) Model, which was used to classify firms listed on XKURY as having high or low corporate governance rating points within the predetermined criteria, are shown in Table 5. To ascertain if herd behavior could exist in the grouped companies, the $CSAD_t = \alpha + \gamma_1 |R_{m,t}| + \gamma_2 R^2_{m,t} + \varepsilon_t$ regression equation was examined.

Table 4 shows that only the companies with strong corporate governance rating scores have a significant negative γ_1 coefficient during the up-market period. However, the CCK (2000) Model stipulates that to address herd behavior in the markets, a negative and significant γ_2 value must occur. In this case, it is argued that the investor of the firm that possesses both high and low corporate governance ratings does not act by broad information in any of the three scenarios (whole sample, upmarket, and downmarket periods). By rejecting the H1B hypothesis developed within the constraints of the research, the requirement of acknowledging H0B has been revealed in light of these findings.

CONCLUDING REMARKS

By seeking to explain "how" and "why" markets can be inefficient, reflecting the erratic nature of the general human psyche, behavioral finance varies from classic finance theories. The field of behavioral finance studies the influence of psychological and social factors on financial markets. The underlying principle of this review is that individuals are illogical and that cognitive dissonances and psychological misconceptions influence how they make decisions. Herd behavior, which is one of many psychological fallacies and is crucial to understanding how investor behavior affects financial markets, is defined as replicating other investors' judgments rather than conducting one's comprehensive examination. Herd, a challenging term to define accurately, may be summed up as connected individual behavior patterns. At this point, it may be concluded that the idea of the herd is strongly connected to concepts like false expectations, erratic shifts without a significant amount of new information, bubbles, exuberance, and lunacy. The major emphasis of this research, corporate governance, which may affect herd behavior, comprised both the data component and the conceptual focus of the study. Corporate governance, which has lately emerged as a primary concern for the performance of businesses in the market, is defined as a framework that integrates all of the company's stakeholders. The procedures and methods used to command and control a corporation are another definition of corporate governance. As a result of the

Table 4. Regression Outcomes of $CSAD_{m,t}$ on Market Returns (for XKURY)

	Whole Sample Period			Up Market Period			Down Market Period		
Index	**α**	**γ1**	**γ2**	**α**	**γ1**	**γ2**	**α**	**γ1**	**γ2**
High Score Firms	0,0157	-0,0074 0,7017	0,4499 0,4879	0,0142	0,1678 (0,0434)**	-2,4316 0,1723	0,0156	-0,0937 0,4121	-1,8791 0,4743
Low Score Firms	0,0194	-0,0526 0,1346	-0,5252 0,6523	0,0179	0,0878 0,5446	-2,1789 0,4825	0,0191	-0,2135 0,3143	-5,0942 0,2987

Significance is indicated by the symbols *, **, and *** at 10%, 5%, and 1% level, respectively.

necessity to embrace the idea of corporate governance and compare the levels of corporate governance activity among firms, a corporate governance compliance rating exercise has been developed and is now a requirement for companies to be included in the Corporate Governance Index. The four corporate governance principles (equality, accountability, responsibility, and transparency) are used to determine the corporate governance compliance rating, which is commonly alluded to as a rating.

The research's primary goal in this manner is to shed light on the potential impact of corporate governance ratings on herd behavior from a new angle. Two sub-objectives within the purview of this aim were established within the context of the study. The first goal is to demonstrate that using models developed by Christie-Huang (1995) and Chang, Cheng, and Khorana (2000) throughout 04.01.2010–29.03.2022, it is feasible to detect the presence of herd behavior in the Corporate Governance Index and 16 prominent indices in the Borsa Istanbul. Using the same techniques in the timescale of 04.01.2021-29.03.2022, the second sub-objective of the research is to identify the potential existence of herd behavior in the corporations whose corporate governance score is classified as high or low within the herd behavior perspective and over the determined criteria. According to the outputs of the Chang, Cheng, and Khorana (2000) Model, even though there was no evidence for the existence of herd behavior throughout the whole sample period. In this regard, the presence of this herd in the pertinent indexes leads to the conclusion that market participants might take advantage of predictable market movements. Furthermore, there is no connection between the corporate management score and herd behavior when we take a gander at the possibility of herd behavior in companies that are listed on the Corporate Governance Index and categorized as having a high or low corporate governance score within the parameters of the established criteria. The research's main results indicated outcomes in line with numerous other studies in the literature (Dornbusch and Park, 1995; Xu et al., 2004; Ha, 2007; Caporale, 2008; Nakagawa and Uchida, 2011; Kayalıdere, 2012; İç and Kahyaoğlu, 2013; Akçaalan, 2017; Kuzu and Çelik, 2020). However, the sensitive point here should not be forgotten that the comparison, which is expressed by the presence of similar studies in the literature, is the prominent research on the existence of herd behavior. There is no similar study in the literature about herd behavior and corporate management capacity, which is the main motivation and purpose of this research.

Additionally, it can be demonstrated that the herd effect is more pronounced in market losses when the regression findings for rising and falling markets are examined independently within the context of small data. This shows that during a time of market losses, there is a larger likelihood of detecting herd behavior. This finding was in line with the Prospect Theory proposed by Kahneman and Tversky in 1979, and it highlighted the idea of loss aversion. This research not only fills in the relevant literature gap but also offers a fresh collection of data that market participants may use. Moreover, it is anticipated that case studies will eventually contribute to the pertinent research, the corporate governance rating will be assessed from a different perspective besides herd behavior, and a comparison of herd behavior across globally selected indices would be possible. To be clear, in future studies, empirical applications focusing on a specific firm and studies that can take into account different country indices will provide added value to the literature on the interaction of corporate governance and herd behavior.

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Inquiring Children's Security within the Framework of Human Security: A Theoretical Assessment

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ABSTRACT

While there is consensus on the individual as the primary referent object within the human security debate the question of which individuals remains inadequately addressed. In this paper children are the primary referents and beneficiaries of security, arguing children's human security possesses distinct characteristics that differentiate the nonviolent, preventable threats they face from those encountered by adults. Addressing these threats requires an integrated approach that combines theoretical exploration with practical policy implementation. The current academic discourse on human security, while extensive, must prioritize children's specific needs by acknowledging them as key referents of security and essential subjects in both theory and practice. This involves recognizing children as active social and political agents, and addressing the unique dimensions of their vulnerability through comprehensive, targeted strategies. Achieving meaningful progress in safeguarding children's security demands concerted efforts from all sectors, including researchers, policymakers, practitioners, and political leaders. Effective policy and practice require a collaborative approach that emphasizes the prevention and early identification of risks. Enhanced academic attention and robust discussions on children's security are vital in shaping policies that reflect the urgency of these issues and drive effective interventions on a global scale.

Keywords: Children's Security, Children's Rights, Child Well-Being, Human Security, Critical Security.

JEL Classification Codes: J13, H56, I31, K33, K38

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INTRODUCTION

The human security approach represents a significant shift from traditional security approaches that predominantly focus on states' security to individuals' security. While there is widespread agreement in the human security discourse regarding the individual as the primary referent object of security, particularly which individuals are being addressed remains insufficiently clarified. This study seeks to address this gap by claiming that children are the principal referents and beneficiaries of human security: it asserts that the security of children possesses unique characteristics that differentiate them from those experienced by adults, particularly in terms of the nonviolent, preventable threats they face.

The examination begins by exploring the conceptual relationship between *human security* and *children's security*, offering a detailed analysis of how the two intersect. This analysis is followed by an evaluation of the theoretical, legal, and practical developments pertinent to this area. As the global landscape evolves, children are increasingly exposed to a wide array of human security threats, including but not limited to violence during armed conflicts. The escalation of such threats, alongside numerous nonviolent and preventable risks, significantly impacts the physical, emotional, and social well-being of millions of children worldwide. The urgency of addressing these issues is underscored by the need to recognize and respond to the distinct and multifaceted nature of threats facing children today. Therefore, a comprehensive examination of children's security within the human security agenda is imperative, as both *violent and nonviolent threats* pose profound existential risks to children in our increasingly interconnected world: the *2024 Global Outlook Report of UNICEF* emphasises an urgent call for global cooperation to protect rights and well-being of world's children who represent 30% of the world's population. The report highlights the growing global geopolitical and geoeconomic fragmentation under eight key trends affecting and threatening children's lives all around the world (UNICEF, 2024).

For a long time, children were largely invisible in the field of International Relations (IR). The discipline showed little interest in incorporating studies of childhood or recognizing children as social/political actors or agents. This oversight left a significant gap in understanding

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the role of children within global political contexts, with children often excluded from discussions of agency and power in IR. On the other hand, the unique vulnerabilities of children in various international settings were overlooked; relatively young human security approach has also had no particular interest in studying children's security own its own merit. This study seeks to incorporate children's security into the human security approach asserting that the security of children should be regarded as an essential component of human security research. Thus, it aims to provide a nuanced understanding of particular challenges that children face and advocate for more effective measures to safeguard children's security in a contemporary globalized world.

CONCEPTUAL FRAMEWORK

This section aims to provide a clear understanding of key concepts related to human security and children's security. It addresses the theoretical frameworks, definitions, and scope of these concepts to ensure a comprehensive foundation for subsequent analysis. By clarifying these concepts, we can better evaluate the intersection of theoretical, legal, and practical developments concerning children's security and understand the diverse threats they face in both violent and nonviolent contexts.

Since the mid-1990s, human security has become a widely utilised concept. It is founded on the principle that human lives should be the security policy's prime objective, with the individual serving as the security referent. Thus, human security approach is normative; grounded in solidarism and cosmopolitanism; and predominantly policy-oriented (Newman, 2010). Furthermore, human security approach is closely linked to human development and human rights, encapsulated by the notions of *freedom from fear* and *freedom from want*. Most academic efforts have focused on defining the human security concept and enumerating the particular threats that individuals are confronted with.

Human security can be categorised in four distinct ways. The first one is a narrow conceptualisation that focuses on violent threats such as political violence by repressive governments, armed conflicts, or failed states. This perspective is primarily advocated by several IR scholars criticising this broad understanding as being overly vague as it hinders policy implementation as well as conceptual inquiry (MacFarlane & Khong, 2006; Krause, 1998).

The second one is a broad conceptualisation of human security, first presented in the *1994 UNDP Human Development Report*, and later supported through several IR studies (Bajpai, 2000; Thakur & Newman, 2004; Tadjbakhsh & Chenoy, 2007). It encompasses all threats and risks that can endanger freedom, dignity and human well-being, for instance, environmental disasters, diseases and poverty. It broadens the conception of human security to incorporate more than protection from violent threats such as socio-economic, political, and psychological, aspects (Alkire, 2003).

The third approach to human security involves expanding it by highlighting the role of actors beyond the state: these actors could be sources of threats or responsible actors for the protection and empowerment of individuals (Commission on Human Security, 2003). The fourth approach regards human security as an umbrella concept for addressing a range of non-traditional security issues such as HIV/AIDS, terrorism, drugs, small arms, anti-personnel landmines, and human trafficking (Newman, 2010). It contributes minimally to theoretical discourse, but seeks to integrate human security into states' foreign policies (Dodds & Pippard, 2005; Chen, Leaning, & Narasimhan, 2003).

Despite the increasing academic engagement in human security, it remains one of the contested concepts within IR. Although there is no consensus on its definition, threats, and strategies, the debate on human security in IR continues to be dynamic. For several academics, it appears fruitless and never-ending, while others believe that it has the potential of creating a critical and policy-oriented debate. Therefore, Ağır claims "the concept of human security blurs the distinction between national and global security, while also challenging the traditional norms and realities of the discipline of International Relations" (Ağır, 2022). For instance, there have been attempts to incorporate human security into foreign policies and to institutionalise it within the UN, which created considerable controversy. Consequently, human security was distinguished from the *Responsibility to Protect (R2P)* since the developing countries have been hesitant about its consequences for sovereignty (Fukuda-Parr & Messineo, 2012). The *2005 World Summit Outcome* addresses R2P in articles 138-140, while separately defining the overarching goals of human security in article 143, stating that individuals have a right to live in freedom and dignity, free from poverty and despair (2005). The UN also acknowledged that all humans are qualified for *freedom from fear* and *freedom from want*, and that they should enjoy equal opportunities to live

up to their basic rights and develop their full potential. (2005). They committed to discussing human security further. Consequently, more and more IR scholars and practitioners pursue answers to the questions of what human security is and what function it serves.

Within this context, another group of theorists emphasises the need for a debate aimed at broadening the human security perspective. This newly emerging view seeks to understand human security theoretically and tries to integrate it into security studies (Newman, 2010). As for Wibben, these theorists particularly focus on *opening the human security agenda* to discuss various meanings of security. This broader conceptualisation includes alternative conceptions of security, noticeably based on a normative foundation (Wibben, 2008), such as Galtung's structural violence, feminist security approaches, and the critical security studies (Welsh School).

Hence, Newman advocates for a renewed relationship between critical security studies and human security: He claims this could result in a new approach - *Critical Human Security Studies*. He outlines several reasons for criticism by critical security theorists since they argue that the human security approach is uncritical and simplistic. First, because human security is policy-oriented, it reinforces state-centred norms and institutions that are themselves responsible for generating human insecurity. Second, it furthers the hegemonic discourse by linking human security with humanitarian intervention through the justifications of domestic regulations (anti-terrorism laws, counter-terrorism measures, etc.). Third, many human security perspectives are classified as problem-solving theories as they do not question existing power structures, gender norms, or distribution mechanisms related to economic and political organization. Moreover, they do not contribute to an objective conceptualisation of security (Newman, 2010). Despite these critiques, Newman asserts that scholars working on human security should take their part in the development of *Critical Human Security Studies* by engaging in conceptual discussions on the nature and array of security threats, the referent objects, and viable reactions to insecurities. This involves investigating the sources and factors creating insecurities, and making in-depth discussions of the security institutions (Newman, 2010).

More recent "discussions about human security largely focus on which threats it should address and what the core focus of human security should be" (Ağır, 2022). In fact, Owen has introduced a *threshold definition* of human security as follows: "the protection of the vital core of all human lives from critical and pervasive environmental, economic, food, health, personal, and political threats" (Owen, 2004). In his *hybrid definition*, Owen categorises threats based on their scope, immediacy, and severity. He categorises them into six conceptual groups: political threats, economic threats, environmental threats, food threats, health threats, and personal threats. He leaves out community security from his definition, arguing that the preservation of cultural integrity does not align with the pervasive and critical threats faced by individuals (Owen, 2004). Consequently, Owen supports the idea that human security should address *nonviolent preventable human security threats* by reevaluating security theories as well as policies today, to mobilise global political leaders, intellectuals and public opinion leaders to engage in strategies and redirect resources to resolve human security issues of all (Owen, 2004).

EXPLORING CHILDREN'S SECURITY: THEORETICAL AND PRACTICAL INSIGHTS

This section delves into both the theoretical frameworks and practical applications related to children's security. It aims to examine the intersection of human security with children's security as different conceptual approaches to children's security, including definitions, referent objects, and the categorization of threats, are discussed. Additionally, the role of national governments, intergovernmental organizations (IGOs), and non-governmental organizations (NGOs) in mitigating threats to children's security is analysed, alongside the evaluation of policies and programs aimed at protecting children's rights and ensuring their well-being. Specific threats to children's security, such as violence, exploitation, and deprivation, are identified and briefly discussed, highlighting the unique vulnerabilities of children in various contexts, including conflict zones, impoverished areas, and marginalized communities.

In a globalized world, many argue that the traditional state-centric security theory is not fulfilling the fundamental commitment of securing individuals (Owen, 2004). While there is consensus on the individual as the primary referent object within the human security debate the question of *"which individuals?"* remains inadequately addressed. Whereas this fundamental conception encompasses *all human lives*, the scope, severity, and immediacy of threats and risks are influenced by the specific identity of the individual – whether they are disabled, elderly, a woman, or a child. In both mainstream IR discourse and existing human security discussions, children are often not recognized as significant actors or referent objects. In such an effort,

Watson claims that mainstream IR discourse should recognize the fundamental role that children play in the international system (Watson, 2006). Despite the well-established presence of *childhood studies* in other disciplines, such as sociology, economics, history, social policy, social psychology, anthropology, geography, and philosophy, IR remains hesitant to acknowledge children as a critical area of knowledge.

The *1989 United Nations Convention on the Rights of the Child (UNCRC)* defines a child as any humanbeing under 18. The *UNCRC,* in alignment with the *Universal Declaration of Human Rights (UDHR),* asserts children require appropriate assistance as well as special care. Especially, *Preamble of the UNCRC (1989)* emphasizes that to ensure the full and harmonious development of a child's personality, the child should grow up in a family setting characterized by love, happiness, respect, and understanding. Furthermore, it states that children must be adequately taught to live independently in their communities; they must also be raised in line with the ideals stated in the *Charter of the UN*, including dignity, freedom, equality, tolerance, and solidarity (UNCRC, 1989). Additionally, due to their physical and mental immaturity, children require special care and protection, including appropriate legal protection, both before and after birth (UNCRC, 1959). Despite the high standards for child protection established by the *UNCRC,* Lewis points out that "children's rights are meaningless unless they are capable of exercising them. The notion of the rights of the child may appear robust in the Convention, but in practice, children are not fully recognized as legal subjects capable of exercising equal rights" (Lewis, 1998).

Unlike other oppressed and vulnerable social groups, such as women, LGBTQ+ individuals, people with disabilities, or ethnic minorities, the dependence and vulnerability of children necessitate a shift in focus from the rights of the child to the obligations of adults to protect them. Consequently, parents, legal guardians, and the state are responsible for the upbringing and comprehensive development of children – encompassing social, physical, mental, and moral aspects. Children typically lack the capacity to form and express their own views on critical matters such as conception, upbringing, and the legislative, social, and educational measures affecting their protection and development. Therefore, it is imperative to reassess the roles of those accountable for a child's development, including parents, legal guardians, and the state. The roles of other actors influencing children's development directly or indirectly can be identified as political systems, international institutions, judicial systems, civil society institutions, and media. This reassessment should be based on their effectiveness, activities, and commitment to providing the necessary protection and care for children.

As referent objects of security, children represent a significant portion of the population whose personal security relies on adults' capacity to protect them from various forms of violence (terrorism, crime, war), and, from deprivation of fundamental rights and freedoms. Additionally, children may be vulnerable to structural violence stemming from existing cultural, political, socio-economic, and legal systems nationally or internationally. Such violence may involve coercion or restrictions affecting the essential aspects of their existence. Elshtain observes that the infant, akin to all new beginnings, is inherently vulnerable; thus, we must support and nurture this early stage, despite our inability to predict or control its eventual outcome (Elshtain, 1991). Drawing on Arendt's work entitled *The Human Condition*, Elshtain points out that fully experiencing the essential capacities of faith and hope, which are rooted in birth, enables us to recognize and appreciate individualities and differences, rather than perceiving humans merely as a homogeneous mass subject to control or manipulation (Elshtain, 1991). Thus, children represent both miracles that renew and transform the world and are also potential agents of future change. In recognizing children, we acknowledge our own inherent vulnerability and the essential nature of our dependency on others (Elshtain, 1991).

Recent academic efforts have increasingly focused on issues related to children, including child soldiers; children in conflict and post-conflict situations, child labour, child trafficking, child refugees, child consumers, and child mortality (Roberts, 2008). Particularly focusing on child trafficking, it "could be identified among the direct threats to human security under the category of dehumanization, which does not only include physical abuse, but also implies degradation of human dignity" (Öztürk, 2019). Additionally, the growing emphasis on children's rights has led to their recognition as *rights-bearers* under international law (Lewis, 1998). Nevertheless, further efforts are needed to recognize children as *social and political actors* within international relations, enabling them to be considered *subjects of security*. Building on the foundational concept of the individual as the referent object of security, the human security approach should also include children among the *subjects of security*. Therefore, this study identifies *children* as the *principal referents of security,* arguing that the human security of children involves distinct

characteristics that differentiate both violent and nonviolent preventable threats faced by children from those experienced by adults.

Another critical issue related to children's security is child well-being, which encompasses the overall quality of children's lives. Being multidimensional, it includes physical, material, social, and psychological dimensions. Child well-being pertains to political rights, economic status, development opportunities, and peer relationships – all of which are influenced by the social context in which they exist. This encompasses two primary perspectives: the developmentalist perspective and the child rights perspective. The developmentalist approach emphasises social skills and human capital, focusing on *well-becoming* and preparing children for future success. Conversely, the child rights approach views children as individuals who experience *well-being* in the present. This perspective focuses on children's input in defining and measuring their well-being (OECD, 2009).

Children in global politics face a range of vulnerabilities due to their inherent dependency, developmental stage, and lack of political representation. These vulnerabilities may range from exposure to violence in conflict zones and human trafficking to lack of access to education and healthcare, or even political marginalization. In sum, children's unique vulnerabilities in global politics stem from their exclusion from decision-making processes, their dependence on adults, and the harsh impact of global challenges like conflict, poverty, and exploitation. Recognising these vulnerabilities within international policy frameworks remains crucial for addressing their human security and fundamental rights.

Owen (2004) claims that human security threats are predominantly addressed by governments, IGOs, and NGOs, depending on their political commitment, foreign policy objectives, and their capabilities to manage these threats. He suggests that if these threats surpassing the threshold are either perpetrated by governments or if governments cannot provide adequate protection against them, then the international community should intervene (Owen, 2004). Although Owen's conceptual evaluation hints an R2P approach to human security, it would complicate further the implementation of R2P strategies in a multifaceted intervention setting. According to Owen (2004), insecurities and issues that may escalate to these security threats for children encompass a myriad of survival risks; diseases; malnutrition; disabilities; sexual abuse; physical violence; child labour; child poverty; child trafficking; juvenile crime; adolescent marriage, and environmental disasters. Additionally, constituting significant numbers of immigrants, refugees, and those in war, conflict, and emergency settings, children are also at significant risk.

Owen contends that among the potentially limitless array of threats, only some will exceed a critical threshold and be recognized as human security issues. In contrast, other threats will be addressed by established mechanisms (Owen, 2004). This determination depends on the severity of threats and the extent to which they systematically affect children within the specific social and cultural contexts of their national settings. Especially intrastate and interstate wars expose children to serious forms of violence such as forced displacement, war rape, sexual exploitation, abduction, amputation, mutilation, and even genocide. These issues have been progressively explored over the past decades. Additionally, numerous IGOs and NGOs have been extensively working on various forms of violence against children such as neglect, physical and mental abuse, sexual exploitation at homes, orphanages, schools, on the streets, and in the workplace. Targeting the physical integrity and dignity of children, regional IGOs like the European Union (EU) puts "particular emphasis on the bottom-up approach: on communication, consultation, dialogue and partnership with the local population in order to improve early warning, intelligence gathering, and mobilisation of local support, implementation and sustainability" (Ağır, 2015). Hence, effective solutions to different forms of violence against children should be dealt with the participation of civil society and the support of local communities in which children live. Alongside those NGOs supporting children's security, there are other "violent non-state actors that include terrorist organizations, militias, warlords, and criminal organizations. VNSA refers to any organization that uses illegal violence to reach its goals, thereby contesting the monopoly on violence of the state" (Ağır & Arman, 2014). Through their illegal violent activities, the VSNAs affect children's security directly or indirectly in the communities of their particular regions.

Another critical, yet often overlooked, human security issue is the treatment of children within the criminal justice system. Children within the criminal justice system may face numerous violations of their rights, which can aggregate to a critical extent at both national and international levels. These violations can impede the child's development and deprive them of their fundamental rights and freedoms. These violations can impede a child's development, and infringe upon their fundamental rights and freedoms. *Children in conflict*

with the law is defined as any individual below the age of 18 who interacts with the justice system due to being regarded as suspects or accused of committing an offence (UNICEF, 2006). In addition, child witnesses and child victims can be adversely disturbed by incompetent justice systems failing to effectively address the abuse, violence, and exploitation they face during and after judicial proceedings.

Children within the criminal justice face significant threats because "states are more accepting of the notion that children can acquire *'negative agency'* as opposed to *'positive agency'*" (Watson, 2006). *Negative agency* implies that children are held accountable for crimes they commit, whereas *positive agency* suggests they are generally considered too young to make meaningful societal contributions or decisions for themselves. Issues such as poverty, urbanization, unemployment, social and economic discrepancies, inadequate public services, substance abuse, family breakdown, and parental abuse can lead to feelings of exclusion and frustration among children, which may result in criminal behaviour. Those children within the justice system as witnesses, victims, suspects, or offenders are particularly susceptible to nonviolent, preventable human security threats. These threats can include immediate effects alongside long-term negative effects on the children themselves, such as impeding their development and eroding their trust in adults and societal structures. Additionally, such threats can have broader implications for both national and global societies.

Illustrating this, *UNICEF* reports that over one million children globally are held in detention. In numerous prisons, these children frequently face denial of essential rights, including access to education, medical care, and opportunities for personal development (UNICEF, 2006). As stated by the *UN Interagency Panel on Juvenile Justice (IPJJ)*, detention and sentencing processes can be frequently arbitrary or at times, unlawful. Children in detention may be below the age at which they can be held criminally responsible and are often placed with adult prisoners, exposing them to potential abuse. Additionally, the conditions in which these children are confined are often characterised by severe neglect and inhumanity (IPJJ, 2008). The *2006 UN World Report on Violence against Children* underscores troubling observations about justice systems globally. Despite being banned by the *International Covenant on Civil and Political Rights* (Part 3, Article 6), as well as the *UNCRC* (Article37), numerous sovereign states continue to impose the death penalty for crimes committed by individuals under the age of 18. Currently, 31 countries allow corporal punishment as part of sentencing for juvenile offenders. Additionally, corporal and other forms of violent punishment are legally sanctioned as disciplinary measures within penal institutions in 77 countries. Children in these settings may endure severe physical abuse. Particularly, girls in detention facilities face heightened risks of physical and sexual abuse (UNGA, 2006).

Currently, children constitute over one-third of the global population. Specifically, among the 8.2 billion people on Earth today, over 2.4 billion individuals are under the age of 18 (UNICEF Data, 2023). Thus, they constitute one fourth of the world population who deserve utmost attention to their fundamental rights, well-being, development, and security. Research conducted by The United Nations International Children's Emergency Fund (UNICEF) among the 24 wealthiest member-states of the Organization for Economic Cooperation and Development (OECD) to assess which nations allow children to lag behind in three critical measures of well-being: material conditions, health conditions, educational facilities and opportunities (UNICEF, 2010). This study highlighted significant disparities among these countries (including European OECD members except Estonia, Latvia, Slovenia, and Turkey plus the United States and Canada) and emphasized that the issue of children *falling behind* is not only a pressing concern for countless individual children currently but also poses risks for the socio-economic future of their countries (UNICEF, 2010). A more recent UNICEF report of 2023 reviewing the status of child poverty in 43 high-income and upper middle-income countries of the EU and the OECD underlined the fact that "more than 69 million children live in poverty in some of the world's richest countries" (UNICEF, 2023).

Extensive research conducted over several years across various countries by UNICEF has identified numerous costs of inequality and poverty associated with children falling significantly behind. Poverty experienced by children include monetary poverty (based on relative household income), non-monetary poverty (deprivations such as nutrition, water, sanitation, clothing, housing, education, health, information, and play), and inequalities in child poverty (such as high levels of poverty experienced by children in specific minority groups, including children affected by migration, children with disabilities and children who come from racial or ethnic minorities) (UNICEF, 2023). On the other hand, these costs of inequality include low birthweight, parental stress, chronic stress leading to potential long-term health issues and diminished cognitive abilities,

inadequate nutrition, food insecurity, poor health outcomes, increased hospital and emergency room visits, low levels of educational achievement, diminished returns on educational investments, lower linguistic abilities, lower skills, higher rates of unemployment and dependency on welfare support, behavioural problems, juvenile crime, early-age pregnancy, and substance usage (UNICEF, 2010).

Poverty is a critical component of human security, as it is closely interlinked with various other threats to human security. This is equally true in the context of children's security. Poverty not only deprives children of basic needs like food, shelter, and healthcare but also increases their vulnerability to exploitation, violence, and neglect. It exacerbates risks such as child labour, trafficking, and limited access to education, all of which pose significant threats to their overall well-being and development. As such, addressing poverty is essential for ensuring the security and protection of children. However, poverty is not merely about the physical and material needs and wellbeing of children. It is also about child's subjective well-being which include experiences of positive emotions (such as optimism), negative emotions (such as sadness), satisfaction related to specific domains (such as work or relationships) and overall judgements of life satisfaction (UNICEF, 2021). Thus, for poor children, poverty is about growing up in a home without enough heat or nutritious food; poverty means no new clothes, no mobile phones, no access to internet; poverty means no money for a birthday cake or for watching an animation movie at cinema. All of these deprivations and lack of seemingly material conditions make children's contentment in their lives, and happy memories of their childhood which corresponds to human dignity and fulfilment beyond survival and livelihood. In fact, children are disproportionately affected by poverty in the world today: "they represent half of those struggling to survive on less than $2.15 a day. An estimated 333 million children live in extreme poverty" (UNICEF, Child Poverty). Consequently, children are more likely to experience poverty than adults and are particularly susceptible to its impacts. Their developmental needs, physical health, and educational opportunities are more vulnerable to the detrimental effects of poverty, which can have long-term consequences on their well-being and future prospects.

Furthermore, the UN General Assembly underlined the fact that a growing number of children are being affected worldwide by wars, domestic abuse, sexual exploitation, and human trafficking (UNGA, 2005). Thus, the UN committed itself to upholding and securing the rights of every child; and urged sovereign states to ratify the *UNCRC* as soon as possible (UNGA, 2005). According to the *UNICEF's Annual Report of 2023*, "children's lives continued to be significantly affected by great challenges. … conflicts in Ukraine, Gaza, the Sahel and Sudan, earthquakes in the Syrian Arab Republic and Türkiye, and gang violence in Haiti" are just few examples of the threats children and their families have faced with. The list of challenges and threats also included persistent food insecurity, energy crisis, challenges to democracy and child rights, factionalism, stress on the multilateral system and dangers caused by the fragmentation of the internet. On the other hand, the *2024 Global Outlook Report of UNICEF* underscores the increasing global geopolitical and geoeconomic fragmentation, emphasising eight key trends that pose significant risks to children's lives worldwide. These trends range from conflict and economic instability to environmental challenges and the impacts of emerging technologies, all of which threaten the well-being and development of children on a global scale. However, the report also highlights potential avenues for reform, cooperation, and innovation that could mitigate these threats and improve outcomes for children (UNICEF, 2024). Geopolitical shifts, economic fragmentation, and a fragmented multilateral system present significant challenges to children's survival, well-being, and development. However, opportunities for accountability, cooperation, and economic solidarity offer promise. Structural inequities in developing economies hinder investments in children's futures, yet reforms to financial systems and the rise of new technologies hold hope for progress. As global democracy faces threats from disinformation and political violence, positive youth-led movements provide a potential counterforce. Meanwhile, the green energy transition, if managed responsibly, can benefit children, while climate-related health threats like El Niño and water scarcity can be mitigated through collaboration and innovation. Finally, while emerging technologies pose risks, responsible policy-making and digital cooperation can safeguard children's well-being (UNICEF, 2024).

In conclusion, this study claims that children's security within the broader framework of *human security* should be identified as a sub-study area that emphasises the specific and unique threats children face in terms of their rights, well-being, development, and security. It should focus on the physical, emotional, social, and psychological vulnerabilities of children, recognising them as distinct from those of adults. The idea of children's security highlights that children are not merely smaller adults but individuals with unique developmental needs and

rights that must be addressed in specific ways. Therefore, children should be regarded as human capital for the future, as their healthy and positive development will yield positive contributions to their communities. In fact, children's needs and agency are fundamental to the future well-being of individuals, communities, and nations as a whole.

CONCLUSION

Within the framework of the human security agenda, children's security requires an intensive and detailed examination due to the presence of both violent and nonviolent threats that pose existential risks to children. Given their profound need for nurturing, protection, education, and care to ensure their comprehensive physical, mental, moral, and social development, addressing human security threats directed at children is of paramount importance. Ensuring the well-being and safety of children is essential for their growth into healthy, productive, and self-sufficient adults. Consequently, it is imperative to prioritise strategies and policies that effectively mitigate these threats.

To advance theoretical development and policy impact, IR theorists must prioritize human security and child security issues through rigorous conceptual analysis and theoretical discourse. This entails recognising children as both social and political actors, identifying them as primary referents and beneficiaries of security, and establishing them as a critical area of inquiry within IR. On the policy front, national governments, IGOs, and NGOs need to collaborate and coordinate efforts to develop a more comprehensive child protection strategy. This strategy should emphasise the prevention and early identification of children at risk. Key risk factors include poverty, substandard housing, inadequate parental supervision, parental conflict and separation, unequal access to education, child labour, adolescent marriage, the negative impacts of rapid urbanization, and the proliferation of drug and alcohol abuse. Consequently, national governments should be encouraged to reform their child protection and care systems to address these issues effectively.

Significant efforts are required from researchers, policymakers, practitioners, and politicians to develop effective and coherent public policies and practices for addressing both direct and indirect, as well as violent and non-violent, threats to children's security. Reflecting her broader views on child-rearing and cultural development found throughout her career and works Margaret Mead, the renowned American cultural anthropologist, aptly noted, "the solution to adult problems tomorrow depends in large measure upon how our children grow up today" (Mead, 1930). It highlights the critical importance of child development in shaping the future of society emphasising that nurturing the well-being, education, and environment of children today directly impacts the adult challenges we face in the future. Therefore, it is essential for state actors to demonstrate political will in fulfilling their primary objective: the protection of people, with particular emphasis on prioritising what is best for children since it is also integral to societal well-being. To mobilise national leaders and resources in addressing the security issues affecting children and, by extension, society at large, IR specialists should investigate various dimensions of children's human security in theory and practice. Given that issues such as *falling behind* are critical not only for individual children but also for all nations within our interconnected globalised world, fostering academic interest and promoting detailed discussions on children's security can significantly engage public opinion and influence policymakers and practitioners in IR.

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The Spatial Linkages Between International Migration and Security: The Empirical Findings From Türkiye Hosting Most Refugee In The World

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ABSTRACT

The increasing international migration in the world, especially due to the conflict, have potential negative impacts in immigrant countries. An increase in crime rates caused by unemployed immigrants who cannot meet their food and housing needs is one of them. Accordingly, the study investigates the effects of international immigrants, whose numbers reached about 3,9 million in Türkiye, on violent and financial crime rates. The Spatial Error Panel Model with Fixed Effects covering Türkiye's 26 NUTS-II regions and 2016-2019 period indicate that there are positive and statistically significant relationships between immigrants and these crime rates. However, the negative impacts of international migration on security are mainly observed in financial crimes rather than violent crimes. Furthermore, the most important determinants of these crimes are high food and housing costs. And also, there is a negative relationship between uneducated employment and financial crimes rather than violent crimes. On the other hand, the findings indicate that regions have spatial dependency positively in terms of violent crimes. It means that as average violent crimes increase in the neighbors of a region, the violent crimes of that region also increase.

Keywords: Financial Crimes, International Migration, Spatial Panel, Data Analysis, Violent Crimes.

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INTRODUCTION

According to Hobbes, the most basic need is security, which the absence of fear of attack and the absence of a threat to the existing values as defined by Wolfers, within the framework of international relations (Hobbes, 2007; Wolfers, 1952). After the Second World War, it was seen that for a long time, military security was taken as the basis and the state was accepted as the main reference object, with the effect of the realist paradigm (Morgenthau, 1997; Waever, 2008). In other words, the traditional security, depending militaristic aspects of national states, was accepted during the Cold War Period while the security concept gained a wider perspective, with the evolution of the international system to a multipolar structure especially since 2000's. In fact, it is highly associated with the expanding interdependency which facilitates the reflection of negative effects as well as positive effects experienced in any state after the Cold War (Keohane and Nye, 2011). Since, expanding dependency has led to a situation that can affect many actors with social, economic, political and intellectual phenomena apart from state-centered or regional-level evaluations (Cha, 2000; Mittelman, 2002). Thus, re-answering questions such as security for whom/what and security against which threat has become necessary. In other words, as threats become multidimensional structure, the security concept has expanded to include social, individual, economic and environmental factors (Buzan, 1983; Brauch, 2009).

In this sense, international migration, reached dramatic levels in last two decades, become a threat to national security within the framework of social and economic security as well as internal security (Brettel and Hollified, 2000). Since, according to International Organization for Migration (IOM) statistics, the stock of international migrants has exceeded 280 million by 2022, and it has reached 3.6% of the world's population. Among these immigrants, the number of people who forced migration from their own countries and/or in need of international protection due to reasons such as conflict, violence,

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persecution, fear, or violation of human rights has reached 104 million increasing by 5.5 times in last two decades.

Considering the geographical distribution of immigrants, it is understood that migration mobility, turning into an international security problem, could become a serious security problem for Türkiye hosting most refugees in the world. Indeed, according to United Nation (UN) (2020) and United Nations High Commissioner for Refugees (UNHCR) (2022) statistics, Türkiye, which has 6,1 million immigrants coming for different reasons, is the country hosting 3,9 million refugees. It is a potential problem for Türkiye in terms of internal, social, and economic security due to the negative impacts of international migration. Since, various factors in the adaptation and integration processes to the host country could push immigrants to crime and/or cause increases in general crime rates (Bell, 2019). In fact, according to the opportunity structure theories, which suggest that immigrants are disadvantaged, compared to the citizens of that country in gaining economic power, due to this disadvantageous situation, it is thought that these immigrants, who cannot obtain the desired economic power through legitimate means, could resort to illegitimate means (Merton, 1938). On the other hand, if immigrants gain wide employment opportunities, the crime tendencies of the citizens, who lost their employment opportunities, may increase in order to regain their lost economic power (Wilson, 1996). From this point of view, it should not be ignored that as the number of international immigrants living in a society increases, increases in crime rates depending on social, psychological, and economic conditions, may be observed and this situation may pose a threat to national security. Indeed, according to Turkish Statistical Institute (TSI), in Türkiye, total crime rates increased about 50% in the 2016-2019 period. Furthermore, increases in financial crime rates reached about 58% while violent crime rates were 28%.

Therefore, the study investigates the relationship between international immigrants and violent and financial crimes in Türkiye, hosting the most refugees in the world, by spatial econometric methods for develop policy proposals minimizing negative impacts of international migration. In this regard, firstly, the economic and social determinants of crime were discussed conceptually and theoretically; afterwards, the empirical literature is summarized. Finally, based on the findings of spatial econometric analyzes that are constructed in parallel with theoretical and empirical literature views, suggestions for immigration policies implemented in Türkiye, have been developed.

THE DETERMINANTS OF CRIME

International Migration and Crime

International migration, defined by IOM as *"the movement of persons away from their place of usual residence and across an international border to a country of which they are not nationals"* refers to human movements covering all types of migration (Sironi and Emmanuel, 2019).[1] Migration, which has existed for various political, economic, ecological and social reasons throughout history, has become more visible, especially towards the end of the 20th century, with the effect of globalization. In other words, international migration, which has gained a global dimension and accelerated, has turned into a multidimensional process that also affects cultural, demographic, political and economic fields (Faist, 2003). For this reason, international migration, like as the changing perception of security, also began to take its place on the security agenda of states towards the end of the Cold War.

For instance, Huntington (1993) pointed out that immigration would pose a threat to national security; Weiner (1993) argued that the increase in international migration would pose a threat to international stability and security. Besides Buzan et al. (1998) evaluated migration in the context of social security; Huysmans (2000), also, associated the inclusion of immigration on the security agenda by states as a phenomenon that disrupts public order and poses a threat to internal stability. Böhmelt and Mehrl (2022) on the other hand, tried to present a perspective on the migration-security relationship with quantitative data through their interdisciplinary studies.

From a sociological point of view, migration, which is considered as a source of social disorder and crime, poses a potential threat to national security. Thusly, there is a widespread belief in OECD countries that the immigrant population commits more crimes than the local population, thus increasing the crime rates (Bauer et al., 2000). In this context, there are statistics from different regions examining the relationship between immigrants and crime in the literature (Vasiljevic et al., 2019; Hagan et al., 2008; Bell et al., 2013).

[1] In this context, international migration includes all types of migration as circular migration, climate migration, displacement, economic migration, facilitated migration, family migration, forced migration, human mobility, irregular migration, labor migration, migrant, migration, safe, orderly, and regular migration, resettlement, return migration.

The first reason for the relationship between immigration and crime stems from the argument that criminal tendencies are more common in young adults, adolescents and men (Hirschi and Gottfredson, 1983; Waters, 1999). Since these demographic characteristics are at the forefront in international migration, it is expected that there will be an increase in crime rates. The second is related to the fact that the population instability that will be experienced with migration leads to social disorder. Indeed, migration, which triggers population and housing instability, has the potential to bring about the erosion of social control. This disruption of control is a critical factor in increasing crime rates (Shaw and McKay, 1942; Lee and Martinez, 2002). Third, according to the opportunity structure theory, the argument is directly related to economic poverty. Accordingly, the lack of unqualified and modern working skills of immigrants will lead to limited employment opportunities; it is thought that unemployed or low-paid immigrants will seek economic opportunities that they cannot obtain through legal means, in criminal-prone alternative ways (Reid et al., 2005).

On the other hand, international migration is more than just demographic mobility. Because it is a process that affects the society by bringing along cultural encounter and diffusion, social differentiation, and harmony-incompatibility processes. For this reason, it is possible that functionalist approaches, based on the relationship between socio-economic structure of society and crime, could be associated with migration. In this context, theories based on the opportunity structure firstly focus on the potential of immigrants' tendency to crime. The fact that immigrants coming to a new country initially experience poverty (Clark, 1998) and are exposed to discrimination in the labor market (Waldinger, 1993) cause the immigrant population to experience some economic barriers. Factors such as language, culture and educational differences could increase economic barriers by prolonging the integration process. These barriers cause immigrants to be disadvantaged in reaching their economic goals compared to the citizens of the country. This situation increases the potential of immigrants to resort to crime for successes that they cannot achieve through legitimate means (Merton, 1938).

The second argument focuses on the indirect effect of immigrants on the increases in crime rate caused by the citizens. Immigrants can displace the citizens of the country if they can obtain various opportunities in employment (Beck, 1996). Because the preference of immigrants for reasons that provide cost advantages for employers such as low wages or unregistered employment, especially in some sectors where skilled labor is not needed, will cause the citizens to be excluded from these sectors. Citizens of countries that are disadvantaged in the opportunity structure and whose employment opportunities are lost will increase their crime tendencies in order to regain their lost economic power (Wilson, 1996). This shows that as the international migrant population increases in a region, there may be increases in all types of crimes, especially economic crimes, directly or indirectly.

Indeed, several empirical studies (Buonanno and Montolio, 2008; Alonso et al, 2008; Cracolici and Uberti, 2008; Kakamu et al., 2008; Alonso et al., 2012; Piopiunik and Ruhose, 2017; Feng et al., 2019) have reached the conclusion that the increases in immigration rates increase crime rates.

Other Determinants of Crime

It is seen that the reasons for the increases in crime rates are the subject of many studies, since it is a social problem that is becoming increasingly evident in all developed or developing countries. When the empirical studies on the socio-economic determinants of crime are examined, it is seen that income, inflation which is actually associated with purchasing power of individuals, education, unemployment and spatial closeness are among the prominent determinants of crime apart from migration.

Becker (1968), one of the leading studies investigating the causes of crime from an economic perspective, emphasizes the importance of economic gains in committing crimes. Accordingly, the criminal makes a cost-benefit analysis between legitimate and illegitimate behaviors before committing a crime and decides to commit a crime if the benefit from the crime is greater than legitimate activities. Emphasizing the importance of income level in committing a crime, Ehrlich (1973), decides whether the person who will commit the crime depending on the income level of the person in front of him. It is supported by findings of several empirical studies (Narayan and Smith, 2004; Pazarlıoğlu and Turgutlu, 2007; Baharoom and Habibullah, 2008; Aksu and Akkuş, 2010; Dursun et al., 2011; Ulucak and Bilgili, 2020).

On the other hand, inflation could be accepted as other important determinants of crime (Tang and Lean, 2007; Seals and Nunley, 2007; Gillani et al., 2009; Torruam and Abur, 2014; Rosenfeld and Levin, 2016; Rosenfeld et al., 2019)

and it is actually related with income level. Since, in high inflationary periods, it may cause the cost of living to rise and individuals to have difficulty in purchasing goods and services. In other words, when inflation is high, individuals' purchasing power will weaken, economic life will become more difficult, and if this situation creates pressure on individuals, it can be expected that some individuals' tendency to crime will increase (Adekoya and Razak, 2016).

Furthermore, education level of individuals is one of the other important determinants of crime (Lochner and Moretti, 2004; Aksu and Akkuş, 2010; Machin et al., 2011; Hjalmarsson and Lochner, 2012; Rivera, 2016; Furqan and Mahmood, 2020; Ulucak and Bilgili, 2020). Educated individuals can also avoid the costs of committing a crime because they could find more qualified jobs. Since these individuals know the criminal burdens of committing a crime, they cannot take these risks and their probability of committing a crime decreases (Machin et al., 2011). In the studies on uneducated individuals, as in the studies of Jonathan et al., (2021), it is seen that in societies with low education level and low literacy, individuals will increase their tendency to commit crimes by joining criminal gangs, and such people do not hesitate to take risks and they also tend to commit crimes. It is stated that this will increase crime rates.

Another important determinant of to commit crime is unemployment (Carmichael and Ward, 2001; Narayan and Smith, 2004; Edmark, 2005; Baharoom and Habibullah, 2008; Fougere et al., 2009; Andresen, 2012; Wu and Wu, 2012; Recher, 2020; Mazoredze, 2020; Ayang et al., 2022; Asante and Bartha, 2022). When unemployment is high, it can be expected that the tendency of individuals to commit crimes will increase. In the event of an increase in unemployment, it is expected that the incomes of individuals will decrease, the returns from illegal work will increase, so crime rates will increase (Raphael and Winter, 2001). When unemployment is high, the relative marginal benefit of income in the legal labor market of individuals decreases, and therefore, it is expected that illegal activities in the country will increase, and crime rates can be expected to increase in parallel (Altındag, 2012).

Finally, as Kierepka (2022) states, when crimes accumulate in a certain region, these crimes increase the crime rate of neighboring regions. In addition, as stated in the literature in this area, an increase in crime rates in a region increases crime rates in other regions (Andresen, 2006; Lauridsen et al., 2013; Maghularia and Uebelmesser, 2019; Leiva et al., 2020; Adeyemi et al., 2021). For this reason, the problem of crime can turn from a regional problem into a national problem. From this point of view, especially in an economy which the cost of living for basic needs such as housing and food are high, the tendency of uneducated individuals, who could not find a job, to commit crimes will be significantly higher; it could be thought that increasing crime rates may spread between regions and turn into a national problem.

Table 1: Features of Variables

Variables	***Abbreviation***	***Explanation***	***Expected Sign***	***Source***
Dependent Variables	crmvil100	violent crimes per one hundred thousand people in a region		TURKSTAT
	crmfin100	financial crimes per one hundred thousand people in a region		TURKSTAT
Independent Variables	mig100	migrants per one hundred thousand people in a region	+	TURKSTAT
	Inffood	12-month food inflation rate (2003 constant prices)	+	CBRT
	Infhouse	12-month housing inflation rate (2003 constant prices)	+	CBRT
	uneduemp100	uneducated employment per one hundred thousand people in a region	-	TURKSTAT
TURKSTAT : Turkish Statistical Institute CBRT : Central Bank of the Republic of Türkiye				

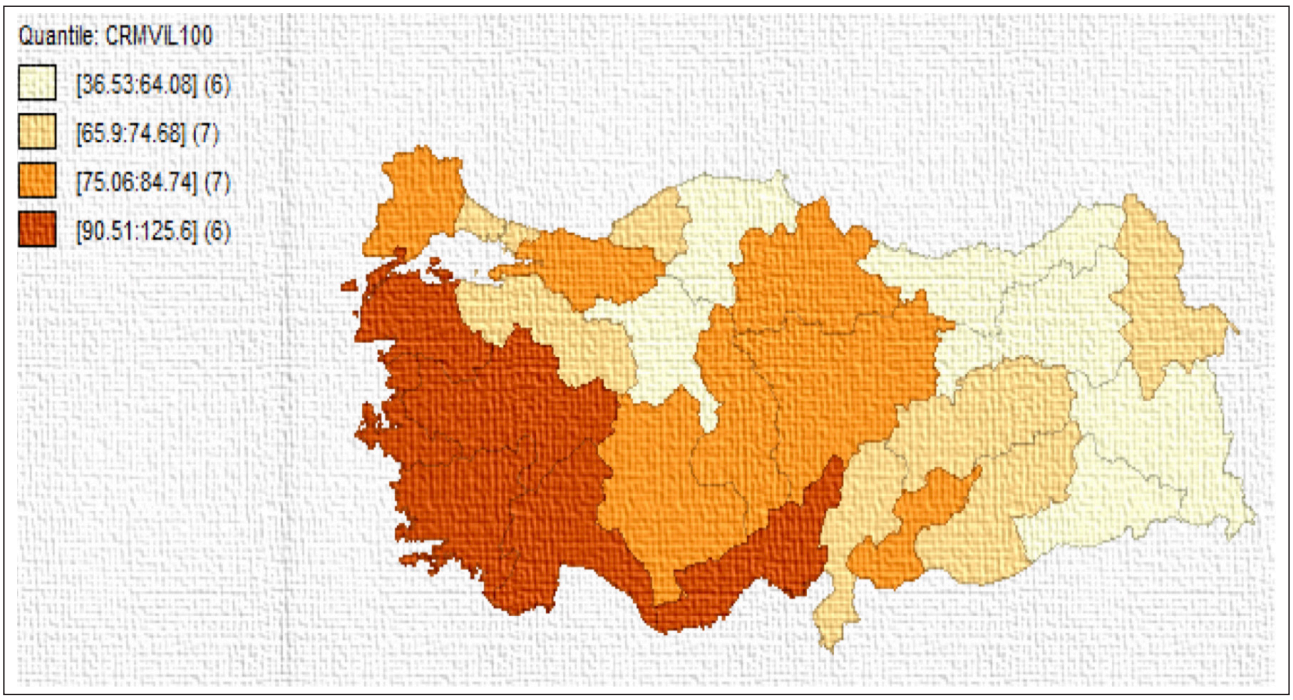

Figure 1: Spatial Patterns of Violent Crimes per One Hundred Thousand Persons (2016-2019 Average)
Source: It is compiled by the Authors (statistics increase as the colors get darker).

EMPIRICAL ANALYSIS

Data and Variables

Increasing of crime rates, in both immigrant countries and regions, is one of the potential negative impacts of international migration. Indeed, opportunity costs of especially uneducated or unskilled poor migrants, who could not find a job and could not meet their food and housing needs easily, are lower than educated and skilled citizens in any society. In other words, propensity of migrants to commit a crime is higher than citizens.

TURKSTAT database provides statistics on a wide range of crimes. In this study, fraud, forgery, embezzlement, smuggling, extortion, theft, and crime against property are grouped as financial crimes while murder, sexual crimes, deprivation of liberty, extortion, manufacture and trade of drugs or stimulants, crimes related to firearms and knives, and threats are grouped as violent crimes. Moreover, bribery crime was not included in the analysis due to lack of data. Therefore, in alternative econometric models investigating the social cost of migration by crime rates, violent crimes per one hundred thousand people (crmvil100) and financial crimes per one hundred thousand people (crmfin100) are accepted as dependent variables, which are quantified as the sum of the crimes specified.[2] Migrants per one hundred thousand people (mig100), uneducated employment per one hundred thousand people (uneduemp100), food inflation (inffood) and housing inflation (infhouse) are accepted as independent variables. Table 1 includes detail information about them.

Accordingly, considering that especially forced immigrants are poor and relatively uneducated as well as their cultural mismatch problem, as the share of immigrants increase in any region, increases in both violent and financial crimes could be expected. In other words, mig100 variable could be taken a negative sign. On the other hand, the crime tendencies of unemployed persons, who could not meet their food and housing needs, increase especially in hyper-inflation periods. Therefore, it is expected that both inffood and infhouse variables will take positive signs rather than uneduemp100 variable.

Econometric Model and Analysis

Two alternative models covering Türkiye's 26 NUTS-II regions and 2016-2019 periods were designed for investigating the effects of international migration on

[2] Violent crimes include murder, sexual crimes, deprivation of liberty, extortion, manufacture and trade of drugs or stimulants, crimes related to firearms and knives, and threats. Financial crimes include fraud, forgery, extortion, theft, crimes against property, embezzlement and smuggling. Bribery crime was not included in the analysis due to lack of data.

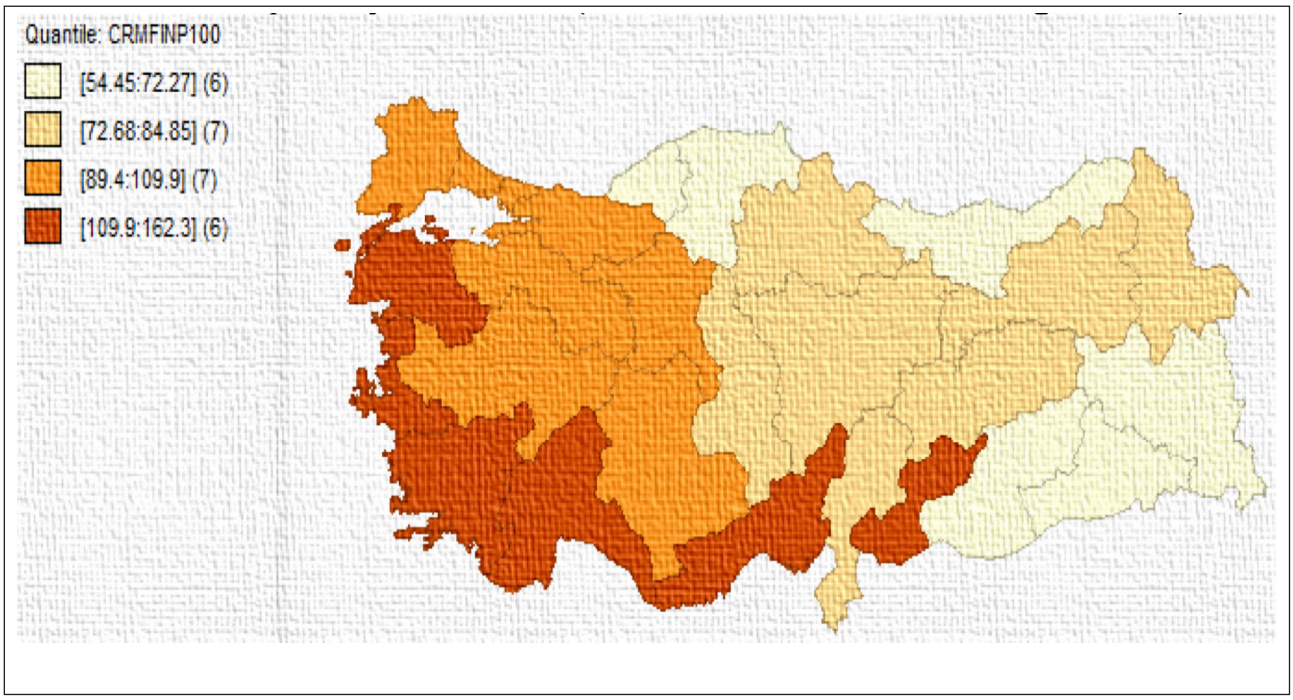

Figure 2: Spatial Patterns of Financial Crimes per One Hundred Thousand Persons (2016-2019 Average)
Source: It is compiled by the Authors (statistics increase as the colors get darker).

both violent and financial crimes. Accordingly, Model 1 investigates the effects of international migration on violent crime rates while Model 2 investigates the effects of international migration on financial crime rates.

$$crmvil100_{it} = f\,(mig100it + inffoodit + uneduemp100it + ter100it) \quad (Model\ 1)$$

$$crmfin100it = f\,(mig100_{it} + inffoodit + uneduemp100it + ter100it) \quad (Model\ 2)$$

Firstly, potential spatial dependency relationship between variables was tested by LMLAG and LMERR Tests because of the spatial patterns of both violence and financial crime rates which could be seen in Figure 1 and Figure 2. Accordingly, violence and financial crimes are clustered in the western regions that host the most immigrants. Therefore, spatial dependency needs to be tested due to these clustered patterns. Because, Ordinary Least Square (OLS) estimators are damaged when spatial dependency is ignored. For instance, OLS estimators are lose their efficiency characteristic when spatial dependency is observed in error terms while they are lose their unbiased and consistency characteristic when spatial dependency is observed in dependent variable (Anselin, 1988). Therefore, Spatial Error Model or Spatial Lag Model depending on Maksimum Likelihood (ML) Estimators should be estimated rather than OLS in such conditions (Anselin and Ray, 1991).

According to results of LMLAG and LMERR Tests in Table 2, there is a spatial dependency observed in error term in Model 1 while there is not any spatial dependency both in error terms and dependent variable in Model 2. Therefore, Model 1 must be estimated by Spatial Error Model rather than Model 2.

Secondly, according to LR and Hausman Tests, random effects are valid for Model 1 and Model 2. Especially in cases where the period is less than the cross section (T<N), as in this study, when the units forming the panel are not randomly determined within the large population, fixed effects panel model is appropriate (Gujarati and Porter, 2012). Despite the Hausman test results obtained, it was concluded that the model that best explains the relationship between the variables is the fixed effects panel model, due to the suggestions of Johnston and Dinardo (1997) and the fact that the regions forming the

	Model 1		***Model 2***	
	Value	***Prob.***	***Value***	***Prob.***
LM_{LAG}	2.01	0.5695	2.10	0.5512
LM_{ERR}	**7.18**	**0.0663**	2.06	0.5603

$$crmvil100_{it} = c + \alpha_1(mig100_{it}) + \alpha_2(inffood_{it}) + \alpha_3(uneduemp100_{it}) + \text{ʊ}_i \quad \text{(Equation 1)}$$

$$\text{ʊ}_{it} = \lambda W\text{ʊ} + \varepsilon$$

$$crmfin100_{it} = c + \beta_1(mig100_{it}) + \beta_2(inffood_{it}) + \beta_3(uneduemp100_{it}) + u_{it} \quad \text{(Equation 2)}$$

$$i : 1, 2, \ldots, 26 \text{ (26 NUTS-II Regions)}$$

$$t: 2016, 2017, \ldots 2019 \text{ (4 years)}$$

cross-section have similar characteristics and that they are not randomly determined cross-sections. As a result, since each spatial region is representative of that region and is not randomly sampled, the fixed effects model is more appropriate than the random effects model in panel models representing regions of the country (Elhorst, 2012). Accordingly, Model 1 is estimated by Fixed Effects Spatial Error Model (SEM) while Model 2 is estimated by Fixed Effects Panel Model.[3] Their functional forms are showed in, respectively, Equation 1 and Equation 2.

W is a 26x26 spatial weight matrix while λ is a spatial autoregressive coefficient, showing the effects of spatial dependency, in Equation 1. The weight matrix (W) was prepared according to queen border neighborhood criteria. It has the least restrictions among the weight matrix criteria, which means that all border neighbors of a region are given the value 1 while others are given the value 0, regardless of location. It is most suitable criterion for Türkiye's NUTS-II regions, which are not based on geographical dynamics.

Findings

Table 3 shows the findings of Model 1 depending alternative panel estimators that are pooled, fixed effects, random effects with spatial dependency while Table 4 shows the findings of Model 2 depending these alternative panel estimators without spatial dependency[4]. Table 3 also show the findings of Spatial Durbin Panel Model (SDM) as the largest spatial model. It is seen that there are no significant differences between the fixed effects and random effects results.

The empirical findings indicate that there is positive relationship between immigrants and both violent crimes and financial crimes. Model 1 and Model 2 show that violent crimes per one hundred thousand people increase as 0,05% while financial crimes per one hundred thousand people increase as 0,1% when immigrants per one hundred thousand people increase as %10. Accordingly, the negative impacts of international migration on security are observed mainly financial crimes rather than violent crimes.

According to Model 1 estimating Spatial Error Panel Model with Fixed Effects (SEM-FE), there is a positive spatial dependency in violent crime rates rather than financial crime rates. Accordingly, violence crime rates increase as 5,6% in that region when the average violent crime rates increase as 10% in neighbors of a region. Secondly, food and housing inflation are the most important determinants of violent crimes. Indeed, when food and housing inflation increase as 10%, violent crime rates increase as, respectively, 11,1% and 8,2%. Finally, there is no statistically significant relationship between uneducated employed persons and violent crimes.

According to Model 2 estimating Panel Model with Random Effects, food and housing inflation are the most important determinants of financial crimes like as violent crimes. Accordingly, when food inflation and housing inflation increase as 10%, financial crime rates increase as, respectively, 19,2% and 20,8%. On the other hand, there is a negative and statistically significant relationship between uneducated employed persons and financial crime rates; but it is negligible. Accordingly, when uneducated employed persons increase as 10% in a region, financial crime rates decrease as 0,08%.

CONCLUSION

International migration, which has increased worldwide since the 1990's with increasing local-regional conflict environments and inequalities of opportunity triggered by globalization, has been on the security agenda of states especially since the 2000's. In this context, mass-forced migrations, which occur at unexpected times and intensity, appear as a type of migration that states deal with in the context of security due to the migration management problems they create.

[3] As seen in Table 3 and Table 4, the random effects results are not different from the fixed effects results.

[4] The findings about the effects of housing inflation, as an alternative to food inflation, on crime rates could be seen in Table 4 in Appendix.

Table 3: Spatial Regression Analysis Findings

2016-2019 26 Regions	***Model 1*** **Dep. Variable: *crmvil100*** ***Spatial Panel Models***						
	POLS	FE	RE	**SEM-FE**	SEM-RE	SDM-FE	SDM-RE
Λ				**0.56*** (.032)**	0.56*** (.0835)	0.54*** (.0646)	0.54*** (.0655)
mig100	-0.001 (.0067)	0.009** (.0043)	0.009** (.0041)	**0.005* (.0028)**	0.005* (.0031)	0.005* (.0030)	0.004 (.0031)
lnffood	1.31*** (.3141)	1.15*** (.1113)	1.14*** (.1096)	**1.11*** (.2422)**	1.1*** (.2524)	0.049 (.6021)	0.182 (.5792)
unedue-mp100	-0.008*** (.0014)	-0.002 (.0024)	-0.003** (.002)	**-0.001 (.0026)**	-0.002 (.0021)	-0.002 (.0030)	-0.001 (.0019)
W* mig100						0.006 (.0124)	0.007 (.0106)
W* lnffood						0.411 (.7349)	0.247 (.6629)
W* unedue-mp100						0.000 (.0043)	-0.002 (.0026)
Log-likeli-hood				**-294.70**	-361.71	-291.01	-354.46
R^2	0.28	0.70	0.69	**0.69**	0.69	0.72	0.72
JB Normality Test	5.865 [.0533]	0.843 [.6561]	0.6308 [.7295]	**2.145 [.3421]**	2.073 [.3547]	2.274 [.3208]	2.001 [.3676]
Hausman Test		3.34 [.3421]		**4.78 [.3110]**		13.26 [.0661]	
NxT	104	104	104	**104**	104	104	104

Note: *, **, *** stands for, respectively, %10, %5 and %1 significance level, statistics in parentheses ( ) stands for var-cov matrices with resistance to heteroscedasticity and autocorrelation; statistics in square parentheses [ ] stands for p-values.
POLS : Pooled Ordinary Least Square
FE : Fixed Effects
RE : Random Effects
SEM-FE : Spatial Error Model with Fixed Effects
SEM-RE : Spatial Error Model with Random Effects

Due to the lack of access to basic human rights such as the right to life, food and housing, many individuals are forced to migrate. While individuals who migrate forcibly have relatively insufficient access to food, housing, and employment opportunities in the countries they go to, they also experience integration problems in many contexts. As a matter of fact, this inequality of opportunity that all immigrants, especially those who migrate, are exposed to, results in a relatively higher tendency of immigrants to be involved in violence and financial crimes. This situation causes increasing immigration rates to turn into a security problem in countries where an effective management and governance process cannot be allocated.

Türkiye has become the country hosting the largest number of refugees in the world suddenly due to the conflicts in Syria. This situation has caused Türkiye to become sensitive to the negative effects of international migration, especially as the security issue. In this context, it is aimed to analyze the effects of international migration on security through crime rates and to develop recommendations on migration policies that countries that will face such mass-migration mobility should follow. Accordingly, the findings of econometric models designed by considering the spatial dependency relationship indicate that there is a statistically significant and positive relationship between international migration and both violent crimes and financial crimes. On the other hand, it is understood that the most important reasons for the increases in crime rates are the cost of living for basic needs such as food and housing, and that especially violent crimes spread spatially among regions.

The findings show a potential to pose a threat to national security on social and economic axes in cases where migration is not well managed. For this reason, countries

Table 4: Regression Analysis Findings

Model 2 **Dep. Variable:** ***crmfinprop100*** ***Panel Models***			
2016-2019 *26 Regions*	POLS	FE	**RE**
mig100	-0.002 (.0082)	0.01* (.0071)	**0.01*** (.0070)**
lnffood	2.05*** (.4254)	1.92*** (.1824)	**1.81*** (.1921)**
uneduemp100	-0.01*** (.0025)	0.002 (.0039)	**-0.008*** (.0031)**
R^2	0.49	0.69	**0.66**
JB Normality Test	9.95 [.0069]	4.051 [.1319]	**0.4722 [.7897]**
Hausman Test		**0.00 [1.0000]**	
NxT	104	104	**104**

Note: *, **, *** stands for, respectively, %10, %5 and %1 significance level, statistics in parentheses ( ) stands for var-cov matrices with resistance to heteroscedasticity and autocorrelation; statistics in square parentheses [ ] stands for p-values.
POLS : Pooled Ordinary Least Square
FE : Fixed Effects
RE : Random Effects

should develop proactive security policies regarding the possible negative effects of mass-migration mobility on security. In this context, in the short-run, incentives and subsidies policies for the accommodation and nutrition opportunities of the immigrants while the employment policies to increase the employment opportunities of immigrants in the medium-run is necessary for minimizing of potential security problems. However, the pressures on the budget as well as the opportunity costs that will arise in the labor, goods, and housing market due to these expansionary fiscal policies should not be ignored. Indeed, the increased labor supply and the increased aggregate demand for food and housing by immigrants could cause inflation increase and real wage level decreases; this situation may turn into an economic security problem. For this reason, migration policies based on incentives and subsidies should be applied temporary.

In the long run, it is important that the solution processes of the problem are carried out with multiple actors, especially since the effects of mass migration are not limited to the immediate environment. In this context, eliminating the driving factors of migration in countries that are the source of migration and ensuring the return of forced migrants to their countries should be understood as a common problem of the international community and cooperation between countries should be ensured.

On the other hand, policies for social integration should also be introduced in order to prevent inability to socialize caused by cultural differences. One of the important points of the social integration of immigrants is the language problem. By opening courses that will provide language education to immigrants, the language problem of immigrants can be solved, and social integration can be achieved.

Finally, considering the spatial spillover effects observed especially in violent crimes and the relationship between international migration and crime, it is understood that it is necessary to prevent immigrants from clustering in only one province or region. For this reason, limiting the proportion of the immigrant population in a province or region to the population of that region and limiting the residence permits for immigrants in a province or region could be considered as alternative policy proposals in the short-run and medium-run.

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Appendix

Table 4. Regression Analysis Findings

2016-2019 ***26 Regions***	***Model 1*** **Dep. Variable:** ***crmvil100*** ***Spatial Panel Models***					***Model 2*** **Dep. Variable:** ***crmfinprop100*** ***Panel Models***		
	POLS	FE	RE	**SEM-FE**	SEM-RE	POLS	**FE**	RE
λ				**0.7*** [0.0988]**	0.7*** [0.1067]			
mig100	0.01*** [0.0043]	0.01*** [0.0031]	0.01*** [0.0043]	**0.008** [0.0031]**	0.007*** [0.0029]	0.02*** [0.0067]	**0.02*** [0.0047]**	0.02*** [0.0065]
infhouse	1.15*** [0.1338]	1.14*** [0.1517]	1.15*** [0.1308]	**0.8** [0.3511]**	0.8** [0.3780]	1.99*** [0.2075]	**2.08*** [0.2486]**	2.004*** [0.1997]
uneduemp100	-0.005** [0.0021]	-0.003 [6.3990]	-0.005** [5.2931]	**-0.001 [0.0024]**	-0.002 [0.0021]	-0.007** [0.0032]	**0.0005 [0.0037]**	-0.006* [0.0035]
Log-likelihood			-379.23	**-299.31**	-365.12			-422.05
R^2	0.62	0.62		**0.62**	0.62	0.66	**0.67**	
JB Normality Test	0.3898 [0.8229]	2.585 [0.2746]	0.422 [0.8098]	**2.932 [0.2309]**	2.853 [0.2402]	0.3464 [0.8410]	**4.039 [0.1327]**	0.7332 [0.6931]
Hausman Test		0.00 [.]		**0.00 [.]**			**0.00 [.]**	
NxT	104	104	104	**104**	104	104	**104**	104

Note: *, **, *** stands for, respectively, %10, %5 and %1 significance level, statistics in parentheses ( ) stands for var-cov matrices with resistance to heteroscedasticity and autocorrelation; statistics in square parentheses [ ] stands for p-values.

POLS : Pooled Ordinary Least Square

FE : Fixed Effects

RE : Random Effects

SEM-FE : Spatial Error Model with Fixed Effects

SEM-RE : Spatial Error Model with Random Effects

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Bitcoin Price Bubbles and The Factors Driving Bitcoin Price Formation

Murat AKKAYA[1]

ABSTRACT

Bitcoin, one of the most discussed events of recent times, is the first cryptocurrency to be released. Bitcoin has the biggest market capitalization in the cryptocurrencies, and it is a decentralized payment tool that cannot be controlled by any government institution. Cryptocurrencies operate on top of a decentralized network, recording and verifying transactions using Blockchain. Many bubble price formations occurred in financial markets throughout history. Cryptocurrency markets are prone to manipulation because they are not connected to any center. This study aims to to investigate the bubble formations in Bitcoin (BTC) US Dollar price for the period of 11 December 2017 - 31 July 2023, and determine the main financial variables affecting Bitcoin prices. ARDL Bounds test proves the cointegration between Bitcoin price and dependent variables. Error Correction Model determines a positive connection between BTC and the Nasdaq100 index. A daily change in the Nasdaq100 index leads to a 0.58% increase in BTC price. The model captures also a negative relationship between the Volatility Index, USD Index and BTC price. No long-term relationship emerges in the results. In the long run, unique and different variables shape BTC price formation.

Keywords: Cryptocurrency, Bitcoin, Price Bubble, Financial Modeling, ARDL Model.

JEL Classification Codes: E40, G12, C32, G17

Referencing Style: APA 7

INTRODUCTION

In parallel with financial globalization, banks and financial market firms are looking for new methods and/or ways to perform payment transactions more effectively and with lower costs in the national and international systems. Recently, they have had an intense interest in cryptocurrencies after Blockchain technology, a new and alternative payment system. This technology can be used in many areas such as, utility exchange, energy trading, automatic invoicing for electric vehicle charging stations etc. Blockchain technology offers cross-border payment systems instead of interbank systems. Thus, cryptocurrencies such as Ripple and Stellar put some new models into service. These cryptocurrencies are solutions for performing transactions across all currencies (Treleaven et al. 2017).

The first emergence of cryptocurrency was the publication of Nakamoto's article "*Bitcoin: A peer-to-peer electronic cash system*" (2008), and the first Bitcoin was released on January 3, 2009. There is no clear information about whether Nakamoto is the only one behind this new currency or whether he used his real name. Since the resources of the system are open-coded, the software developers constantly strengthen the system and additions are made to improve the usage area of the system. The most prominent point of the system is that money transfers may be made without the need for any intermediary institution or payment instrument (Greenberg, 2011). Cryptocurrencies are the mechanisms that provide an end-to-end (peer-to-peer) payment system without the need for a financial intermediary. The price of cryptocurrencies is determined through a security algorithm. Cryptocurrencies has many advantages such as low transfer costs, high efficiency, and alternative financial solutions for the markets. They also lead to many problems, such as energy costs, environmental pollution, volatility, and security issues. The absence of a traditional basis in the price valuation of cryptocurrencies allows the formation of volatility in the cryptocurrency market, which is highly sensitive to psychological variables such as vogue, speculative and/or manipulative activities, economic morale, fear of missing the opportunity (Shahzad et al., 2022).

The Internet age, along with financial innovation and other developments, has given rise to an entirely electronic alternative currency based on a transaction-friendly algorithm for instant transfers and a peer-to-peer

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mechanism that allows for creating transparency and storing transaction history. Due to its advantages and innovations, Bitcoin, the flagship cryptocurrency that started trading in 2009, is the most popular and most traded decentralized free cryptocurrency today. Bitcoin has been widely accepted as a currency compatible with current technology, providing fast, reliable and low-cost transfer. Bitcoin (BTC) was first introduced in 2009 as a cryptocurrency and is the cryptocurrency market leader in terms of market capitalization.. The adoption of Bitcoin as a means of payment has increased the interest in itself. Specifically, Bitcoin was issued to trade goods within a network of buyers and sellers that recognize it as a means of payment. Also, Bitcoin, which offers money and investment opportunities as a different option, operates outside of central financial institutions. BTC is a solution to optimize transactions by reducing costs and partially eliminating the need for financial intermediaries. Bitcoin transactions proceed in the Blockchain system, a database that provides encrypted transaction tracking. This system is similar to an accounting ledger and records each transaction. This system verifies payments between parties using methods such as asymmetric encryption, point-to-point network connection and proof of work.

Bitcoin was launched as 0.004 US Dollars in May 2010. Bitcoin has led to the emergence of different cryptocurrencies such as Ethereum, Cardano, Dogecoin and Ripple. Bitcoin price has risen sharply during the COVID-19 era. According to "www.coinmarketcap.com", one of the essential platforms in the crypto money market, as of August 29, 2023, 9.354 different cryptocurrencies are on trade, and the global crypto market value is 1.05 Trillion USD. Figure 1 shows the Bitcoin prices in US Dollars from the period of 11 December 2017 – 31 July 2023.

Bitcoin is not universally accepted as a medium of Exchange, although many companies nowadays accept it as a payment method (de la Horra et al., 2019). Yermack (2013) also point outs that Bitcoin is an investment tool or a speculative asset rather than a currency. Bitcoin price is highly correlated with its trading features, and macroeconomic events have no effect on BTC price. Therefore, Bitcoin has no chance of being included in risk management process, and Bitcoin holders has diffuculties to obtain hedge positions. Risk and volatility are the two main disadvantages encountered using Bitcoin. Although Bitcoin is limited in quantity, its constant increase in demand is the biggest reason for the fragility seen in prices. The high volatility in Bitcoin prices is its main drawback, which has led to criticism as to whether it is a currency or not. The main reason for this disadvantage is that this market is far from regulation and has low liquidity problems.

The fact that Bitcoin has no central control and is far from regulations has led to it being open to speculative movements, and the predictability of the course of price movements has been a subject of constant research. Bitcoin price and price bubbles in BTC price studies come to the fore in recent years. Ample studies on the Bitcoin and price formation appear in the academic literature. Demand and supply are essential factors in BTC price formation. The arrival of new information positively affects the price of Bitcoin, and increases the trust of BTC investors. Cryptocurrencies do not generate cash flow. Bitcoin investors adjust prices according to behavioral biases (Smales, 2022). Cryptocurrencies generally do not serve as legal tender or as an ordinary and official medium of exchange. Therefore, cryptocurrencies offer an ideal environment to test speculative behavior (Geuder et al.,

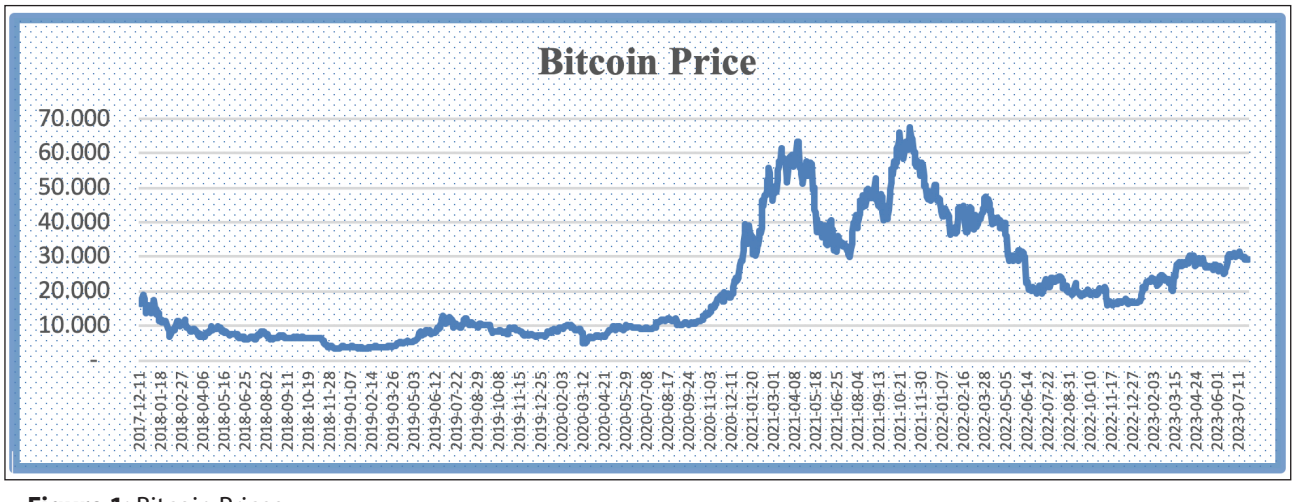

Figure 1: Bitcoin Prices

2019). The main feature distinguishing crypto money markets from others is that the participants are primarily investors with no or minimal investment history, and this situation makes the market psychology phenomenon much more critical than other asset markets. Also, these investors are much more inclined to act irrationally than other market investors.

Despite the diversity of cryptocurrencies, Bitcoin has arguably been the most used currency in the world. It is a well-known fact that the abundance of liquidity brought about by the monetary expansion and negative real interest policies of the developed countries after the 2008 financial crisis and the coronovirus case pushed asset and cryptocurrency prices up. In fact, many economists frequently warn investors about asset bubbles. This study considers these warnings, and aims to examine the bubble formations of the Bitcoin price for 11 December 2017 - 31 July 2023. In addition, the second aim is to determine the main financial variables affecting Bitcoin prices.

LITERATURE REVIEW

Digital currencies propose a move away from the established design of financial system infrastructures; technological solutions and information systems such as cryptographic algorithms provide decentralized organization, transparency and operational security. These currencies oppose traditional monetary systems that are centrally coordinated and less transparent (Bartos, 2015). Cryptocurrencies like Bitcoin appear to be viable competitors for central bank fiat currencies, posing a challenge to central banks. Central banks have begun to develop payment and clearing processes using blockchain technology and to issue their own digital currencies. A Central Bank Digital Currency (CBDC) is an digital form of central bank money that can be exchanged in a decentralized manner. Transactions with this currency occur peer-to-peer, that is, directly between the payer and the payee, without the need for an intermediary (Bech & Garratt, 2017). CBDCs are digital assets issued by a central authority, usually issued and regulated by a government and managed by a central bank. Unlike decentralized cryptocurrencies like Bitcoin, CBDCs are centralized, state-owned, and legal tender.

Helmi et. al, (2023), investigate the impact of CBDC news on financial and crypto markets with Primiceri's (2005) TVP-VAR model to analyze time-varying data from January 2015 to December 2021. The vector of endogenous variables in the VAR model are the Central Bank Digital Currency uncertainty index, cryptocurrency policy uncertainty index, S&P 500 index, VIX, and Bitcoin price. TVP-VAR analysis prove that responses to CBDC news varied over time. CBDCU shocks effect on financial markets are more prone during COVID-19.

According to Nakamoto (2008), Bitcoin takes place in people's daily life today. This article is a manifesto against the traditional financial system after the Global crisis. The answers to questions such as which financial assets drive the value of Bitcoin or which commodity and/or exchange rate affects the price have been a matter of curiosity. Pioneering studies are theoretical concerns in general. Ample academic studies on Bitcoin take place in recent years. Empirical studies started to emerged with the BTC trading on the Chicago Options Exchange.

The velocity of Bitcoin in circulation, the price of gold, and the deprecation of the Venezuelan currency (demonetization) affect the price of Bitcoin as the market declines (Bouoiyour and Selmi, 2017). Equity market returns, exchange rates, oil yields, FED and ECB (European Central Bank) fund rates and internet have no effect on Bitcoin return. Internet search volume and gold price changes determine changes in BTC price (Panagiotidis et al., 2018). In the framework of GARCH using hourly data, BTC trading volume and speculative demand drive BTC price (Ciaian et al., 2018).

Classical economic theories can not explain Bitcoin's price formation because the cryptocurrency market does not include the essential features of the money market. Therefore, there is no effect of macroeconomic factors on BTC price formation. (Vaddepalli and Antoney, 2018). Similarly, Bitcoin has no macroeconomic fundamentals, and "*rather it acts as a speculative bubble*" (Yermack 2014; Bugan, 2021; Li et al., 2021; Altunöz, 2023). Speculative transactions determine the Bitcoin price, and BTC price does not react to the economic fundamentals. The changes in the United States money supply affect Bitcoin price in the short run, (within 4 day lags), while US fund rates negatively affect (within a lag of 5 and 6 days). Also, Bitcoin price actively responds to volatility in the foreign exchange market with significant coefficients at different lags (Li and Wang, 2017). Its technology is the main factor in the formation of Bitcoin prices. The Global economic climate has absolutely no effect on price. Bitcoin is not a tool as a risk insurance against global recessions (Goczek and Skliarov, 2019).

Meegan et al. (2017) examines whether Bitcoin behaves similarly to traditional currencies. Monetary policy is as an external factor with GARCH model. The implemented policies significantly affect Bitcoin returns, but Bitcoin does not behave exactly like a traditional currency. Almansour et al (2021) conducte ARCH and GARCH analyses based on daily data for the period 2010-2020. The analyses reveal that cryptocurrencies play an important role in predicting future volatility. Moreover, past volatility of cryptocurrencies has an impact on current volatility. Wang C. (2021) analyze the daily closing prices of Bitcoin between 2013 and 2020 with ARCH and GARCH models. The GARCH(1,1) model shows that Bitcoin's returns and volatility tend to cluster in certain periods and form a continuing process, although it decreases over time. Also, Bitcoin has the potential to be a safe instrument that can absorb financial risks and contribute to investor portfolios.

The changes in Bitcoin affect other cryptocurrencies in the long term through NARDL analysis with data from January 2015 to March 2020 (Gonzalez et al., 2020). The impact of uncertainty on the crypto market with volatility models for the period January 2018 - November 2022 is a new study by Höl (2022). Höl (2022) uses the Global Economic Policy Uncertainty Index and geopolitical risks and Twitter-based uncertainties as representatives of market uncertainties. Uncertainties have a positive and significant impact on Bitcoin volatility.

Bubbles, in the simplest way, may be defined as the systematic deviation of an asset's market price from its fundamental value (Kyrazis et al., 2020). The bubble formation means that asset prices are moving away from market fundamentals. Geuder et al. (2019) point out that investors theorize that a cryptocurrency with limited supply will create a higher price in the future, ultimately creating a speculative bubble. Li et al. (2021) determined speculative bubbles using the GSADF model in the period of 2011 and 2020. Diniz et al. (2022) identify the existence of bubbles for cryptocurrencies with the GSADF test. Diniz et. al., (2022) identify the existence of bubbles for cryptocurrencies with GSADF test. Işıldak (2022) investigates the bubbles in cryptocurrencies using SADF and GSADF tests with daily Bitcoin prices between June 2019 - 2022. SADF test detects 6 balloons. GSADF test determines the presence of 13 balloons. Altunöz (2023) determines continuous speculative bubble pricing between 01.01.2017 and 01.01.2020 by GSADF. The much higher price bubble occurs in Ethereum and Bitcoin according to Ripple.

Li et. al. (2019) observe six bubble burst in republic of China and five burst in U.S cryptocurrency market using GSADF methodology. Wang et al. (2020) determine a relationship between BTC price and stock market indices. S&P 500 and Dow Jones indices are statistically significant on Bitcoin price. Prabhune et. al. (2023) point out that "*Efficient Market Hypothesis is not valid in Bitcoin market*". Nasdaq daily returns drive BTC price using the ARDL bound test from 2017 to 2021. Aththanayake and Nanayakkara (2023) indicate that Nasdaq-100 index affects positively and significantly BTC price in long and short term at the the period of January 2018 and September 2022 with ARDL bound test. Akkaya and Tuna (2023) investigate the connection between 8 stock market indices and BTC price in the period January 2016 - May 2022, and conclude that in the short run Nasdaq 100, Dow Jones index and Nikkei225 lead to changes on the Bitcoin prices.

Table 1: Variables

Abbrevation	Variable
BTC	Bitocoin US Dollar price
BRENT	Brent oil barrel price
DAX	Germany Frankfurt DAX index
EUR-USD	Euro/US Dollar Rate
GOLD	Gold Ounce price
NAS100	Nasdaq 100 index
NIK225	Japan Tokyo NIKKEI 225 index
SP500	S&Poors 500 index
USDIX	US Dollar Index
VIX	Volatility index

METHODOLOGY

The first purpose of the study is to examine the bubbles in the US Dollar price of Bitcoin (BTC), a cryptocurrency, in the period of 11 December 2017 - 31 July 2023. Also, paper aims to display the international financial variables driving the BTC prices. Table 1 shows variables added to the model. Data were obtained from yahoofinance.com and the Federal Reserve website. Bitcoin's first trading date on the Chicago Booard of Option Exchange is December 11, 2017. Thus, December 11, 2017 is the first date.

The GSADF (Generalized Supremium ADF) test is generally preferred and used to determine the presence of bubbles in financial markets. There may be difficulties and inconsistencies in the detection of balloons due to the low power in the SADF test. This problem is a major disadvantage to analyze long-running time series or rapidly changing variables where multiple vigorous periods are suspected. To overcome this weakness, they proposed a generalized supADF (GSADF) alternative test. The GSADF test carries on the idea of repeatedly applying a right-tailed ADF test. The alternative new test expands the data set to a broader and more flexible range. Rather than fixing the first observation, GSADF test expands the data set range by changing both the beginning and the end points within an appropriate flexible window range. Phillips et al. (2015) define GSADF statistic as the upper value of the statistical sequence expressed as follows:

$$GSADF(r_0) = \sup_{r_1 \in [0,\, r_2 - r_o]} \left\{ \sup_{r2 \in [0, r0,1]} ADF_{r2}^{r1} \right. \quad (1)$$

This study applies ARDL (Autoregressive Distributed Lag) Model to determine the long-term relationship of international financial variables affecting the BTC price. The ARDL bounds test is a method that has been frequently used in time series analysis in recent years, apart from the cointegration methods proposed by Engle-Granger and Johansen (Pesaran et al., 2001). This method has many advantages. In the cointegration approach, all the variables must be of the same order, but this method can also be used if the variables are stationary of different degrees. It is also not necessary to perform unit root tests of the variables beforehand. Another important advantage is that the ECM (Error Correction Model) is obtained simultaneously with a simple linear transformation. If the data used in time series analysis belong to a limited period, there is a risk of non-cointegration if all data are I(1). The ARDL model long-run equation is in the simplest form as shown below:

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{m} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{m} \beta_{2i} \Delta x_{t-i} + \beta_3 Y_{t-1} + \beta_5 x_{t-1} + \mu_t \quad (2)$$

RESULTS

Bitcion's price is highly correlated with the S&P500 (0.8777) and Nasdaq100 (0.8764) indices. The Nikkei (0.8567) and gold (0.6331) prices follow these two variables. Bitcoin's price is negatively correlated with Dax (-0,5437) and the US Dollar Index (-0.1576) (Table 2).

The GSADF test determines the bubbles in Bitcoin's price between 11 December 2017 and 31 July 2023 (Table 3).

A bubble formation has emerged in Bitcoin's price since the Chicago Booard of Option Exchange started trading (Figure 2). The bubble in the price arises sharpely in the COVID-19 era. With the end of the pandemic, the bubble in the price decreased, but increases also in 2023.-

After determining the bubbles in the BTC price from December 11, 2017, to July 31, 2023, the international financial factors affecting the Bitcoin price and the bubbles will be determined. ADF (Augmented Dickey-Fuller) test results show that there is a structural break in BTC price (Table 4).

Structural break occurs between 27.01.2021 and 15.09.2022 (Figure 3). The structural break coincides with the period of the Covid-19 outbreak. In this period, the price has seen 66,000 US Dollars.

Table 2: Correlations

	DAX	EUR-USD	GOLD	NAS100	NIK225	BRENT	SP500	USDIX	VIX
BTC	- 0.5437	0.2664	0.6331	0.8764	0.8567	0.3667	0.8777	- 0.1576	0.2084

Table 3: GSADF Results

	t-statistic	prob. *
GSADF	-1.3208	0.0000

* % 95 significancy

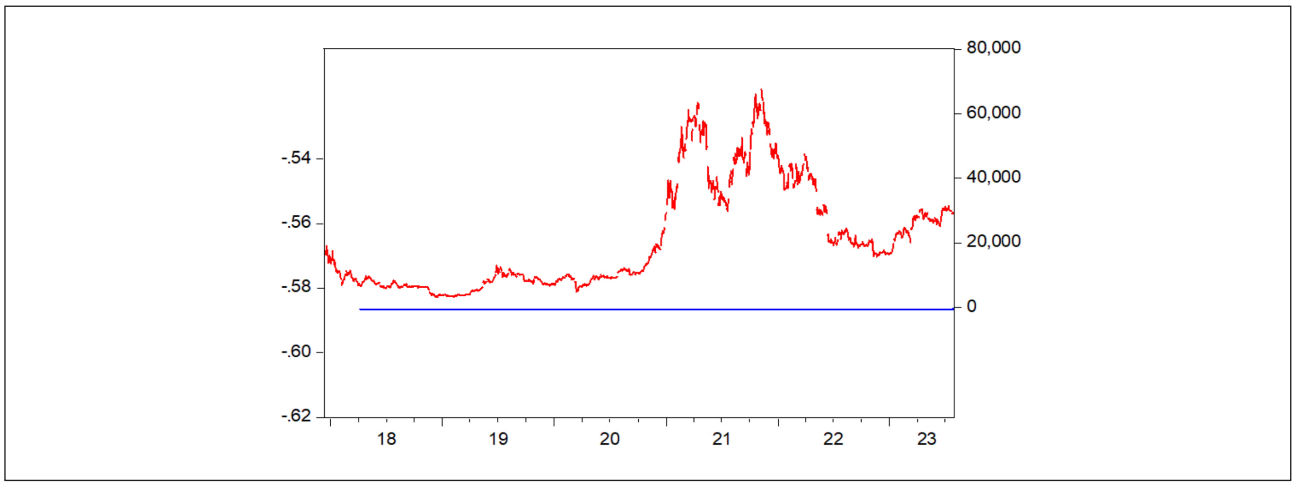

Figure 2: Bitcoin GSADF Graph

Tablo 4: ADF Structural Break Test Results

	t-statistic	prob. *
ADF	-2.9033	0.7374

* Vogelsang (1993) value

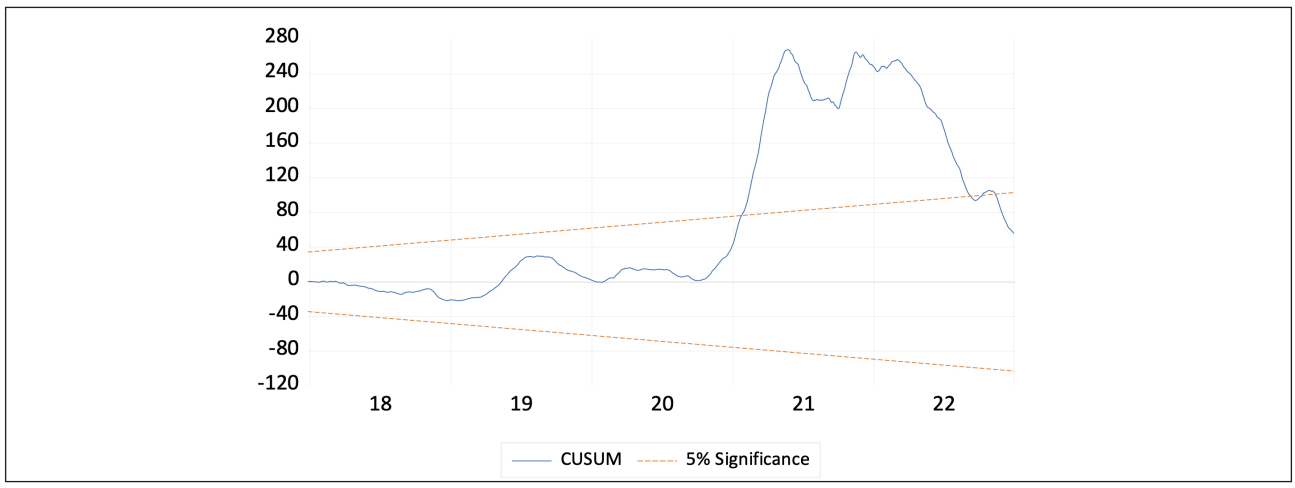

Figure 3: Bitcoin ADF Test Graph

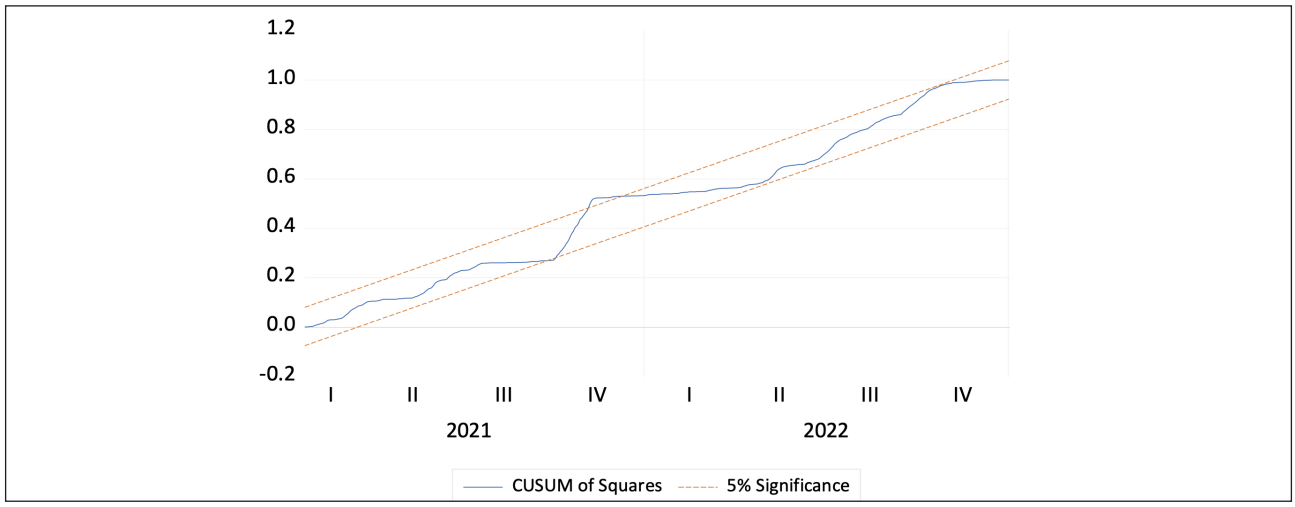

Figure 4: CUSUM Test Graph

Table 5: ADF Results

variable	t-statistic	prob.	1. diff.	prob.
BTC	- 1.3668	0.5999	- 3.8826	0.0000
BRENT	- 1.6181	0.4730	- 3.8063	0.0000
DAX	- 1.6044	0.4801	- 4.1199	0.0000
EUR-USD	- 1.6312	0.4663	- 3.7780	0.0000
GOLD	- 1.2120	0.6713	- 3.9154	0.0000
NAS100	- 1.0745	0.7278	- 4.2597	0.0000
NIK225	- 0.8025	0.8177	- 3.8352	0.0000
SP500	- 1.3260	0.6194	- 4.2303	0.0000
USDIX	0.4601	0.8138	- 3.6897	0.0000
VIX	- 1.5833	0.1068	- 4.7488	0.0001

Table 6: Zivot & Andrews Test Results

Variable	Test Statistic	Zivot ve Andrews Test
BTC	-39.9710***	0.0000
GOLD	-39.1300***	0.0000
BRENT	-37.3590***	0.0000
EUR-USD	-38.3230***	0.0000
USDIX	-37.7290***	0.0000
VIX	-5.3530***	0.0000
NAS100	-45.9040***	0.0000
NIK225	-38.7750***	0.0000
SP500	-40.7340***	0.0000
DAX	-42.3030***	0.0000

***, **, * represent significance at the %1, %5, %10 level of significance respectively.

To correct the structural break, the COVID-19 dummy variable was used between 27.01.2021 and 15.09.2022, and the structural break disappeared (Figure 4).

It is necessary to determine whether time series used in economics and finance studies are stationarity or not. In this respect, this study applies to Dickey and Fuller's (1979) Augmented ADF test. Results prove that the variables contain unit roots. They become stationary using the first (-1) difference. (Table 5).

Ziwot-Andrews (1992) unit root test includes structural changes occurring in level, slope and both slope + level (regime). If the t-statistic is smaller than the Ziwot-Andrews critical value, the basic hypothesis indicating the existence of a unit root is rejected. When accepted, it indicates that the series is trend stationary under structural breaks and does not contain a unit root.

According to Table 6, the hypothesis containing the existence of a unit root is rejected, that is, there is no unit root under structural breaks due to using logarithmic returns.

The appropriate F-tests or information criteria should be selected to determine the optimal lag length for cointegration analysis of the time series. According to the smallest value of Akaike Information Criteria (AIC) and Final Estimation Error (FPE), the lag lenght is three (3) (Table 7).

ARDL Bounds test determines the relationship between Bitcoin price and variables (Table 8). F statistic on Table 8 confirms the cointegration relationship among all variables.

The parameters reflecting the long-term relationship will be estimated for the ARDL model. No long-term relationship emerges in the results. (Table 9). Thus, unique and different variables determine BTC price formation in the long run.

We use the ARDL Error Correction Model (ECM) to estimate short-term relationships between variables. The ECM coefficient is negative and significant. Table 10 presents short-term estimate results. Error Correction Model determines a positive and significant connection between BTC and the Nasdaq100 index. The Nasdaq100 index leads to a 0.58% increase in BTC price. Also, ECM coeeficient is negative and model captures the inverse connection between USD Index, VIX and BTC prices.

Table 7: Optimal Lag Length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-64087.49	NA	2.35	98.31	98.34	98.32
1	-41349.68	45092.01	1.96	63.58	64.02*	63.75
2	-41042.06	605.33	1,42	63.27	64.10	63.58*
3	-40920.05	238.20	1.38*	63.23*	64.46	63.69
4	-40833.36	167.94	1.40	63.25	64.88	63.86
5	-40744.29	171.16	1.43	63.27	65.29	64.03
6	-40659.05	162.50	1.46	63.29	65.71	64.20
7	-40567.63	172.87	1.48	63.31	66.12	64.36
8	-40480.50	163.44*	1.51	63.33	66.54	64.53

* lag

Table 8: ARDL Bound Test Results

variable	coefficient	std. error	t-statistic	prob.*
BTC(-1)	0.9764	0.0058	167.0483	0.0000
DAX	0.0631	0.0349	1.8056	0.0712
DUMMY	216,6258	179.6615	1.2057	0.2281
EUR-USD	1009.7690	2484.9100	0.4063	0.6845
GOLD	-279.1507	333.1234	-0.8379	0.4022
NAS100	0.5766	0.2099	2.7478	**0.0061**
NAS100(-1)	0.0774	0.2729	0.2835	0.7768
NAS100(-2)	-0.5423	0.1985	-2.7313	**0.0064**
NIKKEI	0.0413	0.0308	1.3399	0.1805
BRENT	-2.0955	3.7719	-0.5556	0.5786
SP500	-0.1054	0.3726	-0.2827	0.7774
USDIX	-207.8039	83.6358	-2.4846	**0.0131**
USDIX(-1)	203.0727	79.7682	2.5458	**0.0110**
VIX	-43.6380	16.0412	-2.7204	**0.0066**
VIX(-1)	50.4646	16.2364	3.1081	**0.0019**
C	-2482.4870	5759.0750	-0.4311	0.6665
R-squared	**0.9954**	Prob (F-statistic)		**0.0000**

Table 9: ARDL Long-term Estimates

variable	coef.	std. error	t-statistic	prob.
DAX	2.6729	1.5642	1.7089	0.0877
DUMMY	9172.5990	6987.8050	1.3127	0.1895
EUR-USD	42756.7100	103648.8000	0.4125	0.6800
GOLD	-11820.1000	13999.8000	-0.8443	0.3987
NAS100	4.7327	3.8419	1.2319	0.2182
NIKKEI	1.7493	1.2604	1.3879	0.1654
OIL	-88.7313	157.5221	-0.5633	0.5733
SP500	-4.4614	16.0578	-0.2778	0.7812
USDIX	-200.3320	1244.7370	-0.1609	0.8722
VIX	289.0570	255.7632	1.1302	0.2586
C	-105116.1000	240242.5000	-0.4375	0.6618
	value	significancy	I(0)	I(1)
F-statistic	1.9871	10%	1,76	2,77
k	10	5%	**1,98**	**3,04**

Table 10: ARDL Short-term Estimates

variable	coefficient	std. error	t-statistic	prob.
D(NAS100)	0.5766	0.2068	2.7883	**0.0054**
D(NAS100(-1))	0.5422	0.1912	2.8363	**0.0046**
D(USDIX)	-207.8039	78.8055	-2.6369	**0.0085**
D(VIX)	-43.6380	15.7429	-2.7719	**0.0057**
CointEq(-1)*	-0.0236	0.0048	-4.9037	**0.0000**
F-Bounds Test				
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	**1.9871**	**10%**	**1,76**	**2,77**
k	**10**	**5%**	**1.98**	**3,04**

CONCLUSION

Innovations are the most important driving force of the knowledge or digital economy. Countries and systems with thriving innovation policies are progressing rapidly in many areas. Financial innovations speed up transactions and provide many advantages, such as offering alternatives to products and processes. The innovations and financial instruments of the future are exciting. However, the complexity of financial innovations may increase risk and uncertainty.

The adventure of money has continued to improve over the centuries, and with the Bitcoin article by Nakamoto in 2008, it became the first cornerstone of a new era. Bitcoin, an important financial innovation and a decentralized payment tool that cannot be controlled by any government organization, has entered people's daily lives. Specialists have expectations for the creation of an innovative monetary system that is integrated with the positive aspects of Bitcoin, such as the facts that transactions can be carried out between two parties with a peer-to-peer network architecture without the need for any intermediary, money can travel around the world in a very short time with a single click, these transactions have no cost, and it is a system that can be used at any time.

The creation of Bitcoin is realized with a distributed network based on blockchain technology. Bitcoin has led to the development and proliferation of cryptocurrencies and blockchain technologies. Today, Bitcoin is recognized as one of the most valuable cryptocurrencies worldwide. With the spread of Bitcoin around the world, its usage areas in our social life have also started to increase. Some companies trying to turn this situation into an opportunity, have started to accept payments via Bitcoin. Cryptocurrencies are likely a powerful exchange element. However, whatever the outcome, Bitcoin has been a source of inspiration with Blockchain technology and the understanding of financial freedom that forms the basis of the idea of cryptocurrency.

This study analyzes the bubble formations in the price of Bitcoin between 11 December 2017 and 31 July 2023 using GSADF test. GSADF test proves bubbles in the BTC price throughout all period. This result is consistent with Altunöz (2023) and others. The second aim is to identify the international variables driving the BTC price using the ARDL model. ARDL bound test indicates a cointegration between all variables. ARDL bound test indicates a cointegration between all variables. ECM proves the short-term relationship between Nasdaq100, USD Index, VIX and Bitcoin. Nasdaq100, USD Index, VIX canalize the Bitcoin (BTC) price in the short term. Hovewer, ARDL model can not determine relationship in the long-term. Short-term findings are consistent with Aththanayake & Nanayakkara (2023) and Akkaya & Tuna (2023).

BTC investors shoul be careful. This study advices short position due to bubble in the Bitcoin price since December 2017. It is also recommended to be ready for speculations and bear market in Bitcoin transactions, which is a high-risk asset, especially since the US Federal Reserve (FED) will continue to increase interest rates, and interest rates will remain above 4% until the autumn of 2024. In addition, Bitcoin investors should follow Nasdaq 100 Index and USD Index carefully, and may take position according to the sudden changes in these indices.

In future studies, intraday data and other macroeconomic variables would be useful. It is also recommended to test bubbles and variables with advanced models such as Favar, Svar, nonlinear models, artificial neural networks, etc.

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Collaborative Supply Chain Management in the Sharing Economy: An Empirical Research

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ABSTRACT

This study examines the impact of the sharing economy on collaborative supply chain management among Turkish international trade firms. The sharing economy, which involves temporary access to underutilized resources via digital platforms, has challenged traditional supply chain models, necessitating resilient and flexible collaborations. The research utilizes the Inter-organizational Relationships (IOR), Unified Theory of Acceptance and Use of Technology (UTAUT), and Resource-Based View (RBV) frameworks, highlighting dynamic capabilities. Through structural equation modeling (SEM) and expert interviews, the findings reveal that trust and information sharing are essential, but their effects on e-collaboration are complex. Trust negatively correlates with e-collaboration, indicating that electronic platforms may mediate trust in low-trust environments. On the other hand, performance expectancy and facilitating conditions significantly boost e-collaboration adoption. The study identifies e-collaboration as a dynamic capability, improving operational performance, customer/supplier satisfaction, growth, and profitability. This research contributes theoretically by integrating organizational and individual perspectives on e-collaboration and elucidates the intricate relationships between trust, information sharing, and technology in supply chains. Practical recommendations are provided for leveraging technological innovations to enhance trust and information sharing in collaborative supply chains.

Keywords: Collaborative supply chain management, e-Collaboration, Sharing economy, Structural Equation Modeling.

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INTRODUCTION

Traditional business models consist of companies that produce goods or services, market them to potential customers, and deliver them through a distribution channel in exchange for a profit. (Demary, 2014). The underutilization of economic resources, environmental assets and social capital presents a significant obstacle in modern economies (Schor et al., 2015; Shmidt, 2023). The sharing economy surpasses the traditional supplier model by unlocking access to underutilized resources and redefining the concepts of access, ownership, and employment (Ferrel et al., 2017; Öberg, 2024). Income is obtained through temporary access to a service or product rather than product ownership (Daunoriene et al., 2015).

Revolutionized by the internet, the sharing economy introduces innovative business models grounded in disruptive technologies, promoting resource sharing over individual ownership and enabling businesses to act as both suppliers and customers. This shift has been further driven by global economic crises and growing skepticism towards capitalism, leading consumers to embrace ethical and sustainable consumption patterns (Banning, 2016; Hairam et al., 2023). Consequently, changes in societal values and the influence of digital platforms have propelled the sharing economy into widespread popularity (Cheng and Edwards, 2017).

The sharing economy, also known as the collaborative or platform economy, is a marketplace that connects users with temporary access to a vast pool of crowdsourced resources, both tangible and intangible, enabling actors like consumers and organizations to participate in the life-cycle use of products while leveraging technology for scalability (Eckhardt et al., 2019; Lim, 2020; Tham et al., 2023). Despite the ongoing debates about its advantages, including resource efficiency, community building, and access over ownership, as well as its drawbacks related to labor rights, regulatory challenges, and unequal distribution of benefits (Schor, 2021), the sharing economy model, shaped by social, technological, economic, and legal factors, has the potential to cultivate

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a collaborative and sustainable society (Heinrichs, 2013; Cohen and Kietzmann, 2014). It achieves this by disrupting traditional seller-buyer dynamics by enabling direct consumer interaction and shared utilization of underutilized assets and circumventing certain traditional supply chain processes through peer-to-peer platforms, thus creating a marketplace where resources are shared, maximizing their use, and reducing waste (Scaraboto, 2015; Frenken and Schor, 2017; Schor and Attwood-Charles, 2017; Tham et al., 2023).

Traditional supply chains are siloed and risk-averse, struggling to adapt. Collaborative models, where risks and rewards are shared, offer a more resilient, long-term and value-driven approach (Simatupang and Sridharan, 2005; Pramatari, 2007; Camarinha-Matos et al., 2024). Collaborative supply chain management reduces costs and enhances flexibility in the face of uncertainties (Vachon and Klassen, 2006; Carter and Rogers, 2008), collaborative innovation and supply chain agility (Al-Omoush et al., 2023). Globalization and information technology spurred the collaborative supply chain approach (Bowersox, 1990; Barratt, 2004; Rust and Espinoza, 2006; Hrouga, 2023), with digitalization lowering costs and enabling new models (Bloom et al., 2014; Lusch and Nambisan, 2015).

However, short-term negative returns on technology investments can hinder collaboration (Richey et al., 2010). Establishing healthy collaborations can be challenging due to cultural and structural barriers (Fawcett et al., 2012a; Govindan and Jha, 2023). It requires collaboration among independent businesses to reach shared objectives, decrease expenses, and improve service levels, relying on trust-based partnerships to align supply chain activities and overhaul traditional business processes (Sheu et al., 2006; Fawcett et al., 2008; Olorunniwo and Li, 2010; Richey et al., 2012; Submitter et al., 2021). Successful collaboration requires nurturing a culture of collaboration, promoting transparent information sharing, risk sharing, and harnessing innovative information technologies (Barratt, 2004; Simatupang and Sridharan, 2005; Cao and Zhang, 2011; Soosay and Hyland, 2015; Acquah, 2023).

The existing literature extensively explores how technological innovations can enhance collaborative supply chain management (Wuni and Shen, 2021; Wei, 2023). While highlighting the benefits of these innovations in promoting collaboration, the literature also underscores significant challenges, limitations, and gaps (Kamble et al., 2020; Cui et al., 2023; Kumari et al., 2023; Chen, 2024). Thus, further investigation is warranted into the barriers hindering effective implementation and the dynamics of technology diffusion within collaborative supply chains. This dual perspective underscores the complex nature of leveraging technology to foster collaboration in supply chains, acknowledging both promising benefits and persistent practical hurdles.

This study seeks to address this gap by examining the intersection of collaborative supply chains with the sharing economy. The sharing economy, characterized by digital platforms facilitating temporary access to underutilized resources, poses challenges to traditional supply chain models and necessitates more resilient and adaptable collaborative partnerships. Specifically focusing on Turkish international trade firms, this research employs quantitative methods and interviews with information technology company founders to explore the sharing economy's impact on collaborative supply chains. The article is structured as follows: it begins with a conceptual framework and hypotheses derived from an extensive literature review. Subsequently, the research methodology is delineated, followed by a comprehensive data analysis incorporating findings from structural equation modeling (SEM). Finally, the article concludes with a discussion that interprets the results, underscores theoretical and managerial implications, and outlines avenues for future research.

CONCEPTUAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

Inter-organizational Relationships (IOR)

Amid resource constraints and the accelerating pace of technological advancement and globalization, the demand for adaptability, innovation, and operational efficiency has grown significantly. This heightened need underscores the critical role of inter-organizational relationships and transactions within relational networks (Oliver, 1990; Chong et al., 2009; Chan et al., 2012). The core principle of this approach is its emphasis on the dynamics of organizational relationships, where each entity maintains autonomy and protects its own interests yet collaborates toward achieving mutual goals. (Cropper et al., 2008).

Inter-organizational relationships flourish through the continuous exchange of valuable technical, administrative, and logistical resources, fostering mutual benefits and leading to the institutionalization of long-term partnerships (Johnsen et al., 2008). Sustaining these relationships and demonstrating mutual commitment necessitates building trust, sharing information, and

strengthening partnerships, which significantly influence inter-organizational interactions and their performance outcomes (Panteli and Sockalingam, 2005; Cai et al., 2013; Chen et al., 2014; Skipworth et al., 2015; Huong Tran et al., 2016; Qian et al., 2020; Adaku and Amanor-Boadu, 2022).

Trust

Trust, the belief in a partner's competence and integrity (Connelly et al., 2018), is fundamental to effective collaboration within supply chain management (Chen et al., 2014). It serves as a critical mediator in inter-organizational relationships (IORs), mitigating opportunistic behaviors and fostering a more collaborative environment (Yu, 2018). Beyond enhancing cooperation, trust cultivates a shared commitment to common objectives, which is essential for maintaining long-term partnerships. TMoreover, trust plays a vital role in managing the complexities inherent in IORs. Högberg and Sköld (2023) illustrate how boundary spanners navigate these complexities, shaping and reinforcing trust within these relationships. This highlights the importance of understanding the contextual factors influencing trust dynamics, as organizations must continuously adapt their strategies to sustain trust while managing diverse expectations and external pressures.

In an inter-organizational context, trust fosters collaboration (Goffin et al., 2006; Tsanos and Zografos, 2016), information sharing, and innovation (Ammeter et al., 2004; Cheng, 2011; Hoejmose et al., 2012; Jen et al., 2020; Wang and Schweizer, 2023). Establishing trust among supply chain members is vital for realizing mutual benefits; it decreases transaction costs, cultivates loyalty, and diminishes uncertainty, while its absence fosters inefficiencies and undermines performance (Fawcett et al., 2012b; Yang, 2014; de Oliveira and Rabechini, 2019; Yang et al., 2019; Han et al., 2021; Adomako and Nguyen, 2023). In this direction, it is assumed that the relationship to be established between supply chain members based on trust will have a positive impact on the parties' e-collaboration adaptation process.

H1: Trust positively impacts the adoption of e-collaboration within supply chains.

Information Sharing

Enhancing organizations' access to new knowledge, information sharing plays a pivotal role (Chen et al., 2014). In collaborative supply chains, it ensures smooth business processes and adaptation to innovations (Zeiringer and Thalmann, 2021), focusing on common goals, seizing market opportunities, and enhancing value-added processes (Shih et al., 2012). Secure sharing among members is crucial for resource coordination and process integration, boosting agility, performance, adaptability, and resilience (Kim et al., 2012; Shih et al., 2012; Panahifar et al., 2015; Mishra et al., 2018; Sugito and Kusrini, 2023). It also encourages innovative practices (Zhou and Benton, 2007), with small and medium-sized enterprises more likely to adopt electronic processes when critical information is shared (Chong et al., 2009). The utilization of information technologies for facilitating information sharing has been steadily expanding (Chen et al., 2014), with e-collaboration playing an increasingly prominent role in supply chains. E-collaboration enables more efficient and effective information sharing (Choi and Ko, 2012; Hoove-Sibanda and Pooe, 2018; Zeng and Yi, 2023), leading to the assumption that an effective and well-managed information-sharing process between organizations within the supply chain will positively influence the adaptation of e-collaboration among supply chain members.

H2: Effective information sharing positively impacts the adoption of e-collaboration within supply chains.

Partner Power

*Power within a supply chain de*notes the capability of one member to influence the behavior and decisions of others (Yeung et al., 2009), directly affecting operational performance (Ke et al., 2009; Liu et al., 2010; Morgan et al., 2018) and the outcomes of collaboration (Cuevas et al., 2015; Huo et al., 2019). In interconnected supply chains, the decisions of one member have repercussions on the performance of others (Moldoveanu and Baum, 2011). Dominant members hold the ability to uphold supply chain security and sustainability by insisting on critical information sharing and establishing contracts focused on building trust (Muthusamy and White, 2005; Chen et al., 2014). Recent research (Krczal and Behren, 2024; Reynolds, 2024; van Oijen et al., 2024) has demonstrated that the constructive use of power generates benefits across the entire supply chain. Considering these findings, it is assumed that partner power is a key factor influencing the adoption of e-collaboration within supply chains.

H3: The influence of partners' power positively impacts the adoption of e-collaboration within supply chains.

Unified Theory of Acceptance and Use of Technology

Developed by Venkatesh et al. (2003), UTAUT identifies key factors that predict behavioral intentions toward technology use, especially in organizational contexts (Venkatesh et al., 2012). The UTAUT model posits that performance expectancy, effort expectancy, and social influence influence behavioral intention to use technology, while facilitating conditions and behavioral intention drive actual technology use, with gender, age, experience, and willingness to use serving as moderating variables (Venkatesh et al., 2016). In line with previous studies (Dabliz et al., 2021; Engku Hassan Ashari et al., 2023), it is evident that the relevance of specific variables may vary depending on the study context, leading to the addition or removal of certain factors when applying the model. In this study, the key variables of the UTAUT model—performance expectancy, effort expectancy, social influence, and facilitating conditions—are assessed as critical determinants influencing the acceptance of e-collaboration within supply chains.

Performance Expectancy

*Performance expectancy, the belief that using a technology improves job performance, is the strongest factor determining user adoption (Venkatesh et al., 2003:447; Venkatesh et al., 2012). Research consistently identifies performance expectancy as the strongest predictor of users' willingness to adopt a new technology (Venkatesh et al., 2012; Sumak and Sorgo, 2016). Research has consistently shown that performance expectancy plays a crucial role in influencing employees' willingness to adopt and use different technological tools (Chauhan and Jaiswal, 2016; Cimperman e*t al., 2016; Hoque and Sorwar, 2017; Cao and Niu, 2019; Chao, 2019; Queiroz and Wamba, 2019; Avcı, 2022).

Jain et al. (2022) investigated the adoption of blockchain enabled e-commerce platforms, finding that consumers are primarily driven by their perceived advantages these platforms offer compared to traditional methods. Kapnisis et al. (2022) studied Greek bulk shipping companies and found a positive relationship between performance expectancy and the intention to adopt blockchain technology, suggesting that as employees' expectations for improved job performance increase, so does their willingness to embrace it. Another study analyzing the factors influencing the acceptance and use of distance education systems among medical educators in Turkey during the COVID-19 pandemic found significant positive effects of performance expectancy (Çiftçi et al., 2023). Based on the literature, this study predicts that employees who believe e-collaboration tools will enhance their job performance will be more likely to adopt and use them.

H4: Performance expectancy positively impacts the adoption of e-collaboration in supply chains.

Effort Expectancy

*Effort expectancy refers to the level of ease associated with using a technology (Venkatesh et al., 2003:450). It has consistently demonstrated a positive impact on intentions to use technology across diverse contexts (Boontarig et al., 2012; Sun et al., 2013; Chauhan and Jaiswal, 2016; Cimperman et al., 2016; Hoque and Sorwar, 2017; Cao and Niu, 2019; Chao, 20*19).

Shaikh and Amin (2023) examined the factors affecting bank customers' acceptance of financial technologies. Effort expectancy was the most influential variable after performance expectancy. Zhang et al. (2023) explored blockchain adoption in operations and supply chain management in Pakistan, revealing that perceived ease of use enhances users' intention to adopt the technology. VanDerSchaaf et al. (2023) investigated the main determinants of student information technology adoption and found that effort expectancy has a significant impact. Based on the literature, it is suggested that when employees perceive themselves as proficient in using such systems, this self-assessment is likely to enhance their adaptation to e-collaboration.

H5: Effort expectancy positively impacts the adoption of e-collaboration in supply chains.

Social Influence

*Social influence, comprising subjective norms, social factors, and image, denotes the perception that influential individuals expect technology usage, significantly impacting user adoption (Venkatesh et al., 2003:451). Studies have consistently demonstrated its positive correlation with the adoption of diverse technologies (Sumak and Sorgo, 2016; Ahmad and Kh*alid, 2017; Hoque and Sorwar, 2017; Khalilzadeh et al., 2017; Zhang et al., 2018; Queiroz and Wamba, 2019).

Yang et al. (2022) investigated the effects on older adults' smartphone usage intentions and behaviors. Social influence was found to significantly affect behavioral intention and attitude towards smartphone use. Zhang et al. (2023) confirmed a strong positive correlation between social influence and the intention to adopt blockchain technology, indicating that encouragement from colleagues enhances adoption likelihood. Kapnisis

et al. (2022) noted that shipping company employees recognized the necessity of adopting blockchain to remain competitive, as many industry peers had already implemented it. Based on the literature, it is suggested that employees will be positively influenced by their work environment and peers in adopting e-collaboration tools, facilitating a smoother adaptation to e-collaboration.

H6: Social influence positively impacts the adoption of e-collaboration in supply chains.

Facilitating Conditions

Facilitating conditions refer to users' users' perceptions of the available resources and support for performing a specific behavior, encompassing beliefs about the existing organizational and technical infrastructure that enables technology use (Venkatesh et al., 2003). Research suggests that robust technological infrastructure plays a significant role in facilitating technology adoption (Oliveira et al., 2014; Chauhan and Jaiswal, 2016; Cimperman et al., 2016; Sabi et al., 2016; Sumak and Sorgo, 2016; Queiroz and Wamba, 2019).

Jain et al. (2022) showed that facilitating conditions significantly influence the intention to adopt blockchain-enabled e-commerce platforms. Similarly, another study on online education adoption found that facilitating conditions positively affect both individuals' behavioral intentions and actual usage behaviors (Tahir, 2023). Drawing from this literature, it is suggested that adequate technical infrastructure and organizational support will positively influence the adaptation process to e-collaboration.

H7: Facilitating conditions positively impacts the adoption of e-collaboration in supply chains.

Resource-Based View (RBV) and Dynamic Capabilities

The RBV h emphasizes the importance of a firm's core competencies and dynamic capabilities, identifying valuable, rare, inimitable, and non-substitutable resources as strategic assets (Barney, 1991). Supply chain collaboration exemplifies such a resource that fosters competitive advantage, while information technology resources function as strategic tools that enhance firm performance (Wu et al., 2006; Al-Khatib and Valeri, 2022). The RBV framework enables firms to cultivate dynamic capabilities that align with their strategic objectives (Budidarma, 2022; Yi et al., 2023; Wu and Ku, 2024). Dynamic capabilities, defined as advanced skills, enable firms to integrate, develop, and reconfigure both internal and external resources to adapt to rapidly changing market conditions. Collaboration brings together these resources to create customer value (Teece, 2012; Mukhtar et al., 2023). In supply chains, the core principle of collaboration is building relationships between parties to foster dynamic capabilities (Kumar et al., 2018; Lyu et al., 2023). They, strengthened through collaboration, enhance supply chain performance and drive accelerated growth (Baah et al., 2021; Zhang et al., 2023). As supply chains become increasingly complex and data-driven, traditional processes are shifting from conventional forms (Zeiringer and Thalmann, 2021). E-collaboration, in particular, has transformed business operations by reshaping inter-organizational processes (Alsaad et al., 2018; Nezami et al., 2023), enabling information sharing, joint decision-making, and process integration (Johnson and Whang, 2002; Thomassen, 2024). In response, firms are adopting e-collaboration as a dynamic capability, aligning their processes with those of other organizations to gain a competitive edge, improve customer satisfaction, and boost overall supply chain efficiency (Alsaad et al., 2014; Trebilcock, 2015; Panahifar et al., 2018; Shahadat et al., 2023).

The significance of e-collaboration is increasing, especially in coordinating and cooperating within international trade, where cultural and geographical distances pose challenges (Jean et al., 2014; Genhua, 2023). To capitalize on this trend, organizations have made significant investments in information technologies (Colicchia et al., 2018) , using e-collaboration as a strategic tool to gain a competitive edge in global markets (Jen et al., 2020). E-collaboration enhances the supply chain's responsiveness to market demands by facilitating the exchange of critical information (Rosenzweig, 2009; Guo, 2023). This results in higher sales, improved operational performance, enhanced customer satisfaction, greater resilience to disruptions (Cao and Zhang, 2011; Ko et al., 2011; Lu and Al-Hakim, 2016; Kareem and Kummitha, 2020; Tukamuhabwa et al., 2021), and overall improved supply chain performance (Ardyan et al., 2018; Hoove-Sibanda and Pooe, 2018). In line with all these studies, e-collaboration as a dynamic capability is expected to positively influence operational performance, customer and supplier satisfaction, growth, and profitability.

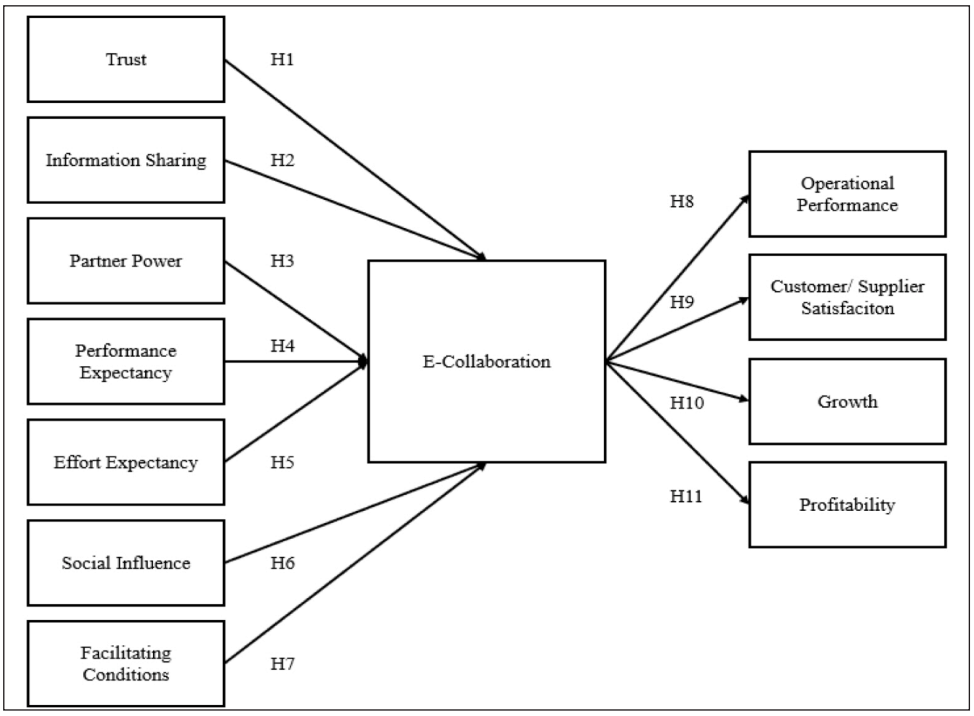

Figure 1: Research Model and Hypotheses

H8: E-collaboration positively impacts firms' operational performance.

H9: E-collaboration positively impacts firms' customer/ supplier satisfaction.

H10: E-collaboration positively impacts firms' growth.

H11: E-collaboration positively impacts firms' profitability.

RESEARCH METHODOLOGY

The research framework encompasses three key stages: literature review, data evaluation, and analysis. It began with a comprehensive literature review to identify research problems and hypotheses, followed by confirmatory factor analysis to assess the dataset's validity and reliability. SEM and path analysis were then used to interpret the findings. To better interpret survey results, interviews were conducted with founders of two logistics IT firms, serving as platform providers. Finally, the findings are interpreted in a literature-based/ comparative manner and managerial and theoretical implications are expressed.

Quantitative data were collected through a survey featuring sections on participant demographics, individual e-collaboration usage, and firm perspectives on e-collaboration with partners and competitors. The model and scales were adapted from Fawcett et al. (2011) and Chan et al. (2012), with scale explanations provided in Table 1.

The study focuses on Turkish businesses involved in international trade, assuming their engagement in global supply chains and proficiency in e-collaboration due to modern technology. A survey was emailed to companies listed in the "Top 1000 Exporters Survey" by the Türkiye Exporters Assembly (TİM, 2019) and those registered with the Exporters' Associations. Email addresses were sourced from membership lists, and the survey was distributed to approximately 30,000 corporate contacts, receiving 401 responses between January 3 and April 1, 2022. Participants were requested to include top executives and department managers to ensure that respondents had the necessary strategic management knowledge. The demographics of the participants are presented in Table 2.

In Table 2, 38.9% of participants are CEOs. 66.8% of companies operate in manufacturing, with 51.1% having 0-50 employees. Additionally, 57.4% of participants have over 21 years of sector experience, and 29.7% report annual revenues of 1 to 10 million TL.

To ensure the trustworthiness of the survey findings, face-to-face interviews were conducted with two experts to gain insights into the major results. These experts were purposefully sampled using the 'sampling for representativeness or comparability' approach (Maxwell, 2013; Teddlie and Yu, 2007), focusing on their relevance to

Table 1. Research Model Variables

		Number of Items	Measure	References
IOR	Trust	3	5-Point Likert	Chan et al. (2012)
	Information Sharing	2		
	Partner Power	3		
UTAUT	Performance Expectancy	2	5-Point Likert	Venkatesh et al. (2012)
	Effort Expectancy	2		
	Social Influence	3		
	Facilitating Conditions	4		
E-Collaboration	Evaluation	4	5-Point Likert	Chan et al. (2012)
	Adaptation	8		
	Routinization	5		
RBV outcomes	Operational Performance	6	5-Point Likert	Fawcett et al. (2011)
	Customer/Supplier Satisfaction	3		
	Growth	3		
	Profitability	1	3-Point Likert	

Table 2. Demographic Profile

Participant's Position	n	%	**Company's Industry Experience (Years)**	n	%
CIO	25	6.2	1 – 2	13	3.2
CEO	156	38.9	3 – 5	17	4.2
COO	40	10.0	6 – 10	48	12.0
CFO	46	11.5	11 – 20	93	23.2
Other	134	33.4	21 and above	230	57.4
Total	401	100	Total	401	100
Industry	n	%	**Company's Annual Revenue (Million TL)**	n	%
Manufacturing	268	66.8	Less than 1	26	6.5
Service	63	15.7	1 – 10	119	29.7
Retail/Wholesale Distribution	70	17.5	11 – 50	93	23.2
Total	401	100	51 – 100	38	9.5
			101 – 500	41	10.2
Company Size	n	%	501 – 1000	37	9.2
0 – 50	205	51.1	More than 1000	47	11.7
51 – 100	62	15.5	Total	401	100
101 – 300	56	14.0			
301 – 500	16	4.0			
501 – 1000	25	6.2			
1001 and above	37	9.2			
Total	401	100			

the study's purpose and their expertise (Neuman, 2020). The interview form crafted for this study comprised two sections: the first section contained questions derived from the survey, while the second section presented the statistical findings from the analysis. Each interview, conducted with participants' consent, lasted approximately 60 minutes. The objective was to elicit expert insights regarding the survey findings and to generate new perspectives aligned with the research objectives, thereby enhancing the study's validity and reliability (Creswell, 2015).

RESULTS

As the surveys were conducted online with mandatory questions, no data was missing. To ensure participant focus, responses with a standard deviation of zero were excluded, resulting in 401 usable responses for analysis. Skewness and kurtosis values were checked for each variable to assess normal distribution. The variable 'Facilitating Conditions 1' was removed from the dataset as it fell outside the acceptable range (-2 to +2) (Markoulis and Neofytou, 2016). Data were obtained from knowledgeable company executives, ensuring reliability and reducing common method bias (Narayanan et al., 2011). Harman's Single Factor Test revealed that a single factor explained only 26.344% of the cumulative variance, below the 50% threshold, indicating no common method bias in the research model (Podsakoff et al., 2003). Cook's Distance values were scrutinized to detect outliers, with all values below the recommended threshold of

Table 3: Results of Confirmatory Factor Analysis

Variable	Factor Load	R^2	CA	CR	AVE
Trust					
Implementing e-collaboration tools requires trusting your trading partners to share information such as designs, plans, and forecast demands.	0.66	0.44	0.73	0.75	0.51
Prior to adopting integrated supply chain management with e-collaboration tools, trust in our trading partners is crucial.	0.83	0.69			
We prioritize long-term relationships over short-term gains with our trading partners.	0.63	0.40			
Information Sharing					
We are ready to exchange critical supply chain information with our partners to implement e-collaboration tools.	0.82	0.67	0.82	0.84	0.72
Our partners are ready to exchange critical supply chain information with us to implement e-collaboration tools.	0.88	0.77			
Partner Power					
Supplier/client dependence on our firm enhances e-collaboration adoption.	0.73	0.53	0.66	0.69	0.52
Incentives from customers/suppliers, like cost sharing or financial rewards, promote e-collaboration tool implementation in the supply chain.	0.71	0.50			
Greater bargaining power allows companies to mandate e-collaboration tool adoption by their suppliers/customers.	*	*			
Performance Expectancy					
E-collaboration tools are beneficial for my work.	0.77	0.59	0.76	0.78	0.64
Employing e-collaboration tools enhances my productivity.	0.83	0.69			
Effort Expectancy					
Becoming proficient at using e-collaboration tools is easy for me.	0.91	0.83	0.85	0.86	0.76
I find e-collaboration tools easy to use.	0.83	0.69			
Social Influence					
My influencers believe I should use e-collaboration tools.	0.86	0.74	0.82	0.85	0.66
Those significant to me advocate for e-collaboration tool use.	0.89	0.79			
The senior management has supported e-collaboration tool adoption.	0.66	0.44			
Facilitating Conditions					
We have ample computers in our company.	*	*	0.79	0.80	0.59
Our company has both quantity and quality of IT specialists.	0.70	0.49			
We possess the technological resources for e-collaboration in our supply chain.	0.87	0.76			
We are knowledgeable about using e-collaboration tools.	0.72	0.52			
Operational Performance (To what extent do the following statements enhance collaboration with your supply chain partners?)					
Purchased item costs	0.89	0.79	0.93	0.94	0.74
Inventory performance (e.g., cost, levels, turns)	0.84	0.71			
Overall product and supply chain costs (productivity)	0.87	0.76			
Overall product quality	0.91	0.83			
New product development capability (e.g., cost, time, uniqueness)	0.86	0.74			
Transportation costs	0.77	0.59			
Customer/Supplier Satisfaction (To what extent do the following statements enhance cooperation with supply chain partners?)					
Responsiveness to customer/supplier demands and unexpected challenges	0.92	0.85	0.93	0.94	0.85
On-time service/performance delivery	0.92	0.85			
Total customer satisfaction	0.92	0.85			
Growth (How does your company's performance compare with your competitors for the following?)					
E-collaboration boosts our sales (Sales growth in the last 3 years)	0.96	0.92	0.95	0.96	0.90
E-collaboration enhances our market share (Market share growth in the last 3 years)	0.94	0.88			
E-collaboration improves our return on assets (ROA growth in the last 3 years)	0.94	0.88			
Profitability (Single Item)					
How does e-collaboration impact your company's profitability?					
E-Collaboration (Upper Dimension)			0.89	0.80	0.57
E-Collaboration Evaluation	***0.73***	***0.53***			

(Please rate the significance of these potential benefits of e-collaboration tools when your organization considered using them for your supply chain activities.)					
Cost reduction	0.92	0.85			
Market expansion for existing products/services	0.82	0.67			
Entry into new businesses or markets	0.76	0.58			
Enhanced coordination with customers and suppliers	0.81	0.66			
E-Collaboration Adaptation (Please rate the frequency of usage for the following e-collaboration tools in your supply chain)	***0.74***	***0.55***			
Direct procurement	0.75	0.56			
Replenishment	0.72	0.52			
Projected shortages	0.76	0.58			
Delivery and tracking	0.83	0.69			
Design	0.75	0.56			
Supply chain planning forecasting	0.78	0.61			
Capacity planning	0.76	0.58			
Business strategy	0.77	0.59			
E-Collaboration Routinization	***0.80***	***0.64***			
We have integrated e-collaboration tools with existing backend/legacy/supply chain systems.	0.78	0.61			
We have utilized e-collaboration tools to share information like forecasts, business strategies, and designs with our suppliers/customers.	0.85	0.72			
Real-time distribution information is gathered by integrating distribution systems with e-collaboration tools.	0.84	0.71			
Real-time inventory information is collected by integrating inventory systems with e-collaboration tools.	0.80	0.64			
Ordering and purchasing are entirely conducted with our customers and suppliers via e-collaboration tools.	0.85	0.72			

* Excluded from analysis due to pre-analysis stage conditions not being met.

1 (Aguinis et al., 2013), indicating no outliers present. Variance inflation factor (VIF) values were checked for multicollinearity among independent variables, all of which were below the threshold of 5 (Kline, 2005; Hair et al., 2010), suggesting no multicollinearity in the study.

Confirmatory Factor Analysis (CFA)

Before proceeding to SEM, CFA was conducted using SPSS Amos 25 to evaluate each item's contribution to the scales and assess how effectively each scale measured its intended concept. Table 3 demonstrates that composite reliability (CR) values exceed the threshold of 0.7 (Hair et al., 2010), ensuring reliability. Moreover, standardized factor loadings and average variance extracted (AVE) values surpass the minimum threshold of 0.5, affirming scale validity.

Validity is demonstrated through convergent and discriminant validity, assessed by structural validity measurement. Discriminant validity is tested using the following criteria: (1) maximum shared variance (MSV)<AVE, (2) average shared variance (ASV)<AVE, and (3) the square root of AVE>correlation between factors (Hair et al., 2010). Findings for discriminant validity based on Table 3 are as follows:

1. For Partner Power, MSV>AVE, requiring its exclusion.

2. ASV<AVE, meeting the condition.

3. The square root of AVE for Partner Power<correlation with Information Sharing, necessitating its exclusion.

Convergent validity is assessed by ensuring CR>AVE>0.5 (Hair et al., 2010), as shown in Table 4 for all variables.

Assessment of Goodness of Fit in CFA

Fit indices, as outlined by McDonald and Ho (2002), evaluate model alignment with reality. Table 5 demonstrates that the specified fit indices fall within both good and acceptable ranges.

Structural Equation Modeling and Path Analysis

SEM was conducted using Amos 25 to assess the alignment between the proposed model and research hypotheses. The primary objectives of employing SEM for data analysis include its capacity to estimate and test hypothesized relationships between observed and latent variables (Rigdon, 1996), its ability to explain variances in the proposed model with minimal error (Kline, 2005), its capability to conduct multiple analyses concurrently by examining all relationships within a complex model

Table 4: Validity and Reliability Assessment

	CR	AVE	MSV	ASV	1	2	3	4	5	6	7	8	9	10	11
Trust	0.75	0.51	0.44	0.16	**0.71**										
Information Sharing	0.84	0.72	0.63	0.24	0.35	**0.85**									
Partner Power	0.69	0.52	0.63	0.37	0.67	0.79	**0.72**								
Performance Expectancy	0.78	0.64	0.58	0.35	0.56	0.49	0.70	**0.80**							
Effort Expectancy	0.86	0.76	0.52	0.22	0.45	0.42	0.58	0.72	**0.87**						
Social Influence	0.85	0.66	0.58	0.31	0.43	0.54	0.72	0.76	0.52	**0.81**					
Facilitating Conditions	0.80	0.59	0.42	0.15	0.14*	0.27	0.33	0.35	0.34	0.38	**0.78**				
E-Collaboration	0.80	0.57	0.50	0.36	0.30	0.55	0.63	0.59	0.48	0.62	0.65	**0.78**			
Operational Performance	0.94	0.74	0.74	0.31	0.31	0.42	0.57	0.58	0.37	0.48	0.46	0.70	**0.86**		
Customer/Supplier Satisfaction	0.94	0.85	0.75	0.31	0.36	0.42	0.58	0.57	0.43	0.47	0.43	0.66	0.86	**0.92**	
Growth	0.96	0.90	0.47	0.25	0.23	0.48	0.68	0.52	0.31	0.49	0.39	0.69	0.62	0.60	**0.95**

*($p<0.05$), others ($p<0.01$), The AVE square root values are in **bold.**

Table 5: Model Fit Results

	Fit Index	Model Fit Results	Good Fit	Acceptable Fit
Absolute fit index	X^2/sd	1.597	X^2/sd≤3	X^2/sd≤5
	GFI	0.88*	0.95≤GFI	0.90≤GFI
	AGFI	0.85	0.90≤AGFI	0.80≤AGFI
	RMSEA	0.039	RMSEA≤0.05	RMSEA≤0.10
Comperative fit index	NFI	0.90	0.95≤NFI	0.90≤NFI
	CFI	0.96	0.95≤CFI	0.90≤CFI

* Given the model's complexity and sample size, a GFI of 0.8 or above is deemed acceptable (Doll et al., 1994; Baumgartner and Homburg, 1996; Schermelleh-Engel et al., 2003).

simultaneously, and its provision of opportunities for iteratively refining the model through repeated testing (Hoyle, 1995; Tabachnick and Fidell, 2012). Figure 2 presents results, with key findings discussed in the following sections.

Table 6 displays goodness-of-fit values for SEM path analysis, used to test research hypotheses, indicating an acceptable model fit.

Table 7 presents the acceptance and rejection statuses of proposed hypotheses. While hypotheses (H1, H2) regarding positive and significant relationships between trust and information sharing dimensions under the inter-organizational relationships approach and e-collaboration were not supported, hypothesis (H3) regarding the significant and positive relationship of partnership power on e-collaboration was supported.

Within the UTAUT framework, positive relationships between performance expectancy and facilitating conditions with e-collaboration were supported (H4, H7), while no significant relationship was found between effort expectancy and social influence with e-collaboration (H5, H6). E-collaboration, assessed as a dynamic capability, exhibited significant and positive relationships with operational performance, customer/supplier satisfaction, growth, and profitability (H8, H9, H10, H11).

Discussion of Survey Findings and Insights from Expert Interviews in E-Collaboration Dynamics

This study explores e-collaboration as a dynamic capability in supply chains within the contexts of inter-organizational relationships and the UTAUT. Findings from a survey with international trade firms in Turkey and expert interviews are summarized below:

1. Model testing reveals that, contrary to the proposed hypothesis, interfirm trust has a significant, albeit moderately negative, significant effect on e-collaboration

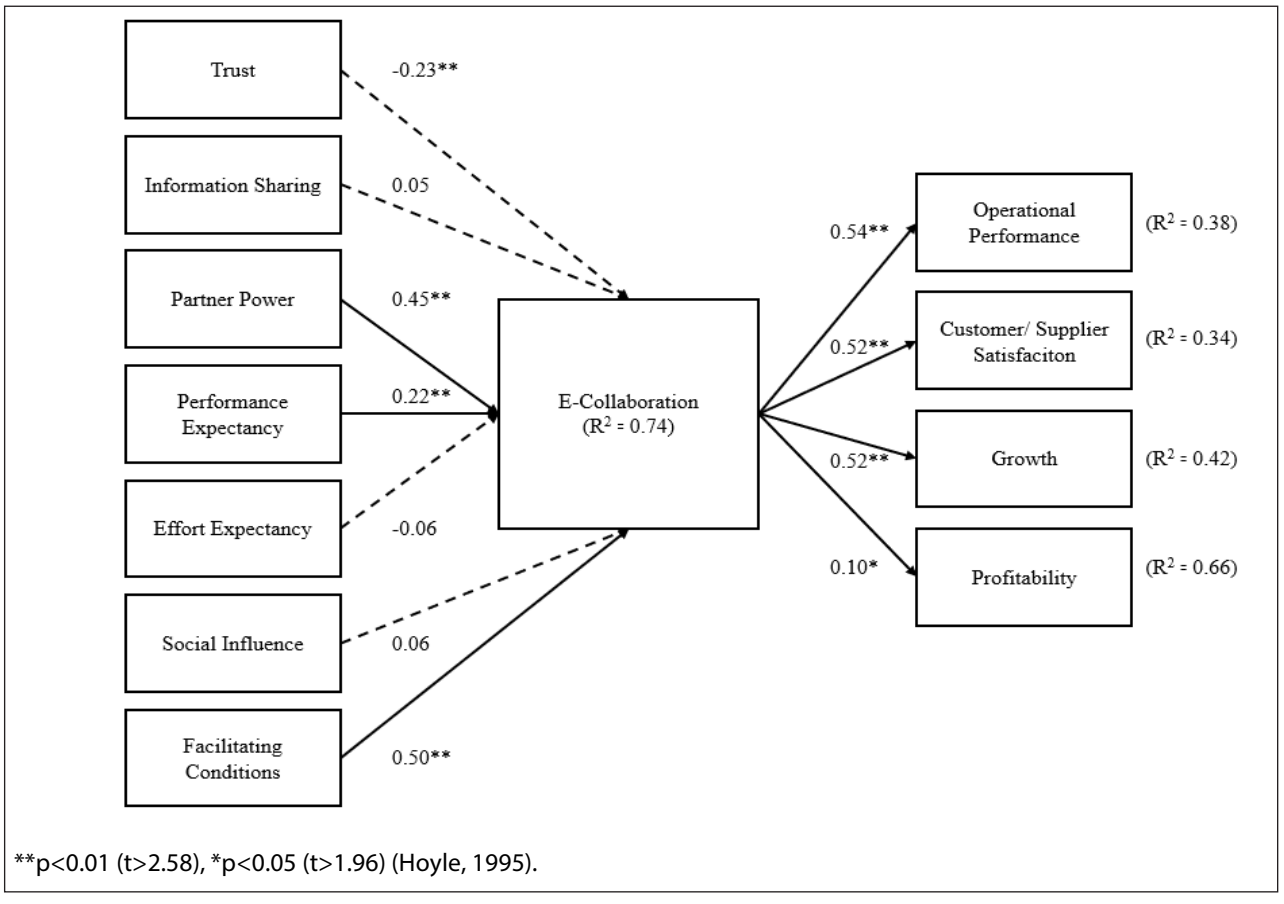

Figure 2: Standardized Estimation Results

Table 6: Model Fit Results

	Fit Index	Model Fit Results	Good Fit	Acceptable Fit
Absolute fit index	X^2/sd	4.45	X^2/sd≤3	X^2/sd≤5
	GFI	0.98	0.95≤GFI	0.90≤GFI
	AGFI	0.87	0.90≤AGFI	0.80≤AGFI
	RMSEA	0.093	RMSEA≤0.05	RMSEA≤0.10
Comperative fit index	NFI	0.99	0.95≤NFI	0.90≤NFI
	CFI	0.99	0.95≤CFI	0.90≤CFI

(β=-0.23; t=-4.82). Previous literature underscores trust's pivotal role in inter-organizational relationships, emphasizing its positive impact on the collaboration process (Chong and Ooi, 2008; Chan et al., 2012; Chen et al., 2014; Tsanos and Zografos, 2016; Mora-Monge et al., 2019). Unlike conventional literature findings, this study diverges on trust, necessitating a thorough examination and interpretation of trust-related research and findings.

Villena et al. (2016) highlighted a downside to trust in inter-organizational relationships, observing a 'reverse U' shaped relationship between trust and performance. Their findings suggest that when trust among trading partners reaches a certain level, potential benefits are balanced, leading to subsequent performance declines. Connelly et al. (2018) suggested that trust based on competencies motivates organizations to engage in collaboration, while trust grounded in subjective factors like honesty raises concerns about collaboration. In another study, it was emphasized that while trust is important, it is not sufficient on its own; there is a need for supply chain members to evaluate and monitor each other transparently (Zeiringer and Thalmann, 2021). Wang et al. (2019) also noted that in multi-tier supply chains, where transparency is crucial, the level of trust among members is generally low. Another study suggested

Table 7: Summary of Hypotheses Test Results

Hypothesis	Path Coefficient	t value	Assumption Results
H1: Trust→E-Collaboration	-0.23	-4.82**	**Not Supported**
H2: Information Sharing→E-Collaboration	0.05	0.81	**Not Supported**
H3: Partner Power→E-Collaboration	0.45	4.22**	Supported
H4: Performance Expectancy→E-Collaboration	0.22	3.56**	Supported
H5: Effort Expectancy→E-Collaboration	-0.06	-1.53	**Not Supported**
H6: Social Influence→E-Collaboration	0.06	1.14	**Not Supported**
H7: Facilitating Conditions→E-Collaboration	0.50	17.50**	Supported
H8: E-Collaboration→Operational Performance	0.54	14.88**	Supported
H9: E-Collaboration→Customer/Supplier Satisfaction	0.52	13.28**	Supported
H10: E-Collaboration→Growth	0.52	8.23**	Supported
H11: E-Collaboration→Profitability	0.10	2.35*	Supported

**p<0.01 (t>2.58), *p<0.05 (t>1.96)

that insufficient trust can hinder the advancement of sustainability in the supply chain, highlighting the need for careful management of trust to prevent excessive dependence, which may result in reduced innovation and responsiveness (Asif et al., 2023). Moreover, Kim and Lee (2024) indicated that placing too much focus on trust could lead to a lack of proper attention to risk assessment and mitigation measures, both of which are crucial for ensuring the resilience of supply chains.

The highly dynamic nature of collaboration, coupled with various influences such as cultural diversity and competition, further complicates the already complex concept of trust, making its impact on supply chain management more significant (Huang et al., 2020). In the context of inter-organizational relationships, no significant relationship was found regarding the role of trust in influencing the adoption of e-collaboration processes in the supply chains of small and medium-sized enterprises (SMEs) in Malaysia (Chong et al., 2009).

The interplay between trust and distrust is a debated topic in the literature. Connelly et al. (2012) examined the balance between trust and distrust in inter-organizational relationships, suggesting that reducing distrust may offer greater benefits than increasing mutual trust. Han et al. (2021) argued that assuming constant high levels of trust overlooks associated risks. Distrust, on the other hand, pertains to negative situations that trust can foster in inter-organizational relationships (Skinner et al., 2014). Both Liu et al. (2009) and Connelly et al. (2012) proposed that distrust may prompt protective activities among supply chain partners, underscoring the importance of legal contracts emphasizing control and legal protection. Hence, rather than evaluating trust and distrust separately, they should be viewed as complementary elements in supply chain management, necessitating careful management (Lumineau, 2017; Han et al., 2021).

The connection between trust and collaboration is dynamic. Han et al. (2021) suggested that although trust typically grows over the course of a relationship, it doesn't always guarantee a healthy inter-organizational relationship (IOR), implying that trust must be continually cultivated and managed. This aligns with the findings of Biswas and Akroyd (2022), which highlight that sustained collaborative efforts require investments in relationship-specific factors, ultimately leading to higher levels of trust.

In one-on-one interviews, participants shared findings and insights on the issue at hand. A recurring theme emerged, emphasizing the role of technology platforms as trust providers for firms engaging in collaboration. The following participant statements illustrate this:

"Our platform serves as an intermediary, facilitating business between two firms. Essentially, we become the trusted service provider. With our infrastructure, including software and systems ensuring cybersecurity, we instill confidence. For instance, as we handle cash flow, upon transaction completion, funds are promptly transferred to the parties' accounts. This, in itself, fosters trust." (Participant 2)

"These platforms enhance trust and reliability within the system. The data we provide isn't obscure; it could be obtained from the shipowner, albeit not as swiftly, systematically, or reliably. Moreover, we add value to it..." (Participant 1)

There is minimal emphasis on the importance of digital technologies in building inter-organizational trust (Qian and Papadonikolaki, 2021). The findings of this research reveal a significant negative relationship between trust and e-collaboration. It is observed that when organizations trust each other, they may not feel the need for e-collaboration; however, when trust diminishes, the presence of an electronic platform facilitating collaboration and building trust could steer them towards this process. A similar approach was also articulated in the studies by Panahifar et al. (2018), Guo (2023), and Mohaved et al. (2023). Accordingly, when there is a lack of trust between parties, it is suggested that this void be filled through a secure information sharing system.

Based on findings and the literature, one possible explanation for the negative correlation is that high levels of trust might reduce the perceived need for formalized electronic systems to monitor and facilitate collaboration. When firms trust each other deeply, they may rely more on informal agreements and personal relationships, thus diminishing the perceived necessity for structured e-collaboration platforms. This phenomenon can be particularly pronounced in cultures or industries where personal relationships and face-to-face interactions are highly valued. Moreover, the negative impact of trust on e-collaboration could be attributed to the potential complacency that excessive trust might induce. High trust levels may lead to a reduction in vigilance and a lower propensity to engage in proactive information sharing and monitoring, which are critical components of effective e-collaboration. This aligns with the findings of Villena et al. (2016) regarding the 'reverse U' shaped relationship, where too much trust can lead to complacency and a subsequent decline in performance.

Additionally, the role of digital technologies as trust facilitators, as highlighted by interview participants, underscores the evolving nature of trust in the digital age. Technology platforms can provide the necessary transparency, security, and efficiency that might be lacking in traditional trust-based relationships. These platforms can serve as neutral intermediaries, ensuring that transactions and collaborations are conducted smoothly and securely, thereby compensating for any lack of inter-organizational trust.

2. Additionally, model test results indicate no significant effect of information sharing on e-collaboration (β=0.05; t=0.81). It remains unclear whether firms are willing to share crucial information with supply chain partners to utilize e-collaboration tools, or vice versa. This finding diverges from existing literature.

Chong et al. (2009) identified information sharing as a critical factor influencing the adoption of e-collaboration processes in supply chains of small and medium-sized enterprises in Malaysia. Conversely, Hoove-Sibanda and Poove (2018) explored the relationships among e-collaboration, information sharing, and supply chain performance. They discovered that e-collaboration within the supply chain significantly influences strategic information sharing. However, they observed that while strategic information sharing has notable effects on supply chain capability and performance, these effects are relatively weak. The authors suggested that while strategic information sharing may not be a potent determinant on its own, its integration with factors like competitive advantage and supply chain learning enhances its impact on capability and performance.

Consistent with this study's findings, Chan et al. (2012), in their investigation into factors influencing the adoption of e-collaboration in small and medium-sized enterprises, also found no significant impact regarding the significance of information sharing. Zeiringer and Thalmann (2021) highlighted that excessive and unnecessary information sharing among parties can entail potential risks. Thus, they stress the importance of sharing only essential information, even with trusted partners. Moreover, it is observed that in many supply chains, parties are reluctant to disclose their strategic information (Chu and Lee, 2006; Prajogo and Olhager, 2012), leading to unsuccessful attempts at establishing numerous collaborations due to insufficient information sharing (Skippari et al., 2017; Yuen and Thai, 2017; Panahifar et al., 2018; Singh et al., 2018). Recent studies (Susanto et al., 2023; Zaman et al., 2023) have highlighted the complexities that complicate the traditional view of information sharing as wholly beneficial. While information sharing is essential for successful collaboration, these studies indicate that it can lead to misunderstandings, conflicts, and inefficiencies if not managed effectively.

Studies (Panteli and Sockalingam, 2005; Cai et al., 2013; Huong Tran et al., 2016; Jen et al., 2020) have suggested that trust serves as a foundation for information sharing, implying that when trust between parties strengthens, information sharing tends to increase. Additionally, the connection between trust and information sharing

is commonly depicted as reciprocal, with effective information sharing contributing to the development of trust (Gattiker et al., 2007; Ou et al., 2014; Lee and Kim, 2023). Hence, a strong association between trust and information sharing is apparent. It is speculated that the noteworthy yet negative relationship between trust and e-collaboration, as identified in this study, might have impacted the absence of a significant relationship between information sharing and e-collaboration.

During the expert interviews, it became evident that reservations about information sharing in collaborations often stem from a lack of understanding on this matter. It is believed that raising awareness about the functioning of online platforms in supply chains and providing information could alleviate concerns regarding information sharing.

According to one interviewee: "Whether to share information or not doesn't actually change much for the companies. The same information was being shared through traditional methods, and our platform also requests and shares the same information. No extra confidential information is being obtained, so there is no reason for them to be hesitant about sharing their data." (Participant 2)

Companies exhibit serious concerns, particularly regarding the sharing of strategic information with their supply chain partners. This apprehension about information security in traditional business practices can be addressed with the assistance of electronic platforms acting as intermediaries. Sharing economy platforms offer features such as information security, sharing only necessary information, transparency, and traceability of shared information.

3.The hypothesis results examining individuals' attitudes toward e-collaboration within the UTAUT framework yield significant insights. As per the model test results, users' performance expectations exhibit a significant and moderately positive effect on e-collaboration (β=0.22; t=3.56), while the facilitating conditions provided to users demonstrate a significant and highly positive effect on e-collaboration (β = 0.50; t = 17.50). These findings align with existing literature (Oliveira et al., 2014; Chauhan and Jaiswal, 2016; Cimperman et al., 2016; Sabi et al., 2016; Sumak and Sorgo, 2016; Hoque and Sorwar, 2017; Cao and Niu, 2019; Chao, 2019; Queiroz and Wamba, 2019; Avcı, 2022; Jain et al, 2022; Kapnissis et al., 2022; Çiftçi et al., 2023; Zhang et al., 2023). Users perceive e-collaboration tools as advantageous for their work, anticipating enhanced productivity and job performance. Moreover, they believe their organizations possess sufficient technological resources and IT personnel, along with access to requisite resources and information, to effectively utilize e-collaboration tools within their supply chain networks.

The study findings reveal that users' effort expectancy (β = -0.06; t = 1.14) and the social influence they experience (β = 0.06; t = 1.14) do not significantly impact e-collaboration. Previous research on technology adoption has highlighted the significant influence of effort expectancy (Chauhan and Jaiswal, 2016; Cimperman et al., 2016; Hoque and Sorwar, 2017; Cao and Niu, 2019; Chao, 2019) and social influence (Oliveira et al., 2014; Chauhan and Jaiswal, 2016; Cimperman et al., 2016; Sumak and Sorgo, 2016) on usage intentions. However, this study diverges from these findings. Participants did not perceive a significant correlation with the ease of using e-collaboration tools. This could be attributed to their familiarity with existing IT applications and the advanced technological landscape. Furthermore, participants did not feel compelled by colleagues, friends, or senior management to adopt e-collaboration tools.

From a corporate standpoint, raising awareness about e-collaboration is crucial. Educating both employees and organizations about the benefits of e-collaboration tools, providing necessary training, and encouraging internal and supply chain-wide discussions can facilitate their adoption.

4. The model test results indicate that e-collaboration significantly and positively impacts firms' operational performance, customer/supplier satisfaction, and growth (β=0.54, 0.52, 0.52; t=14.88, 13.28, 8.23, respectively), and has a significant but modest positive effect on profitability (β=0.10; t=2.35). These findings align with previous research in the literature (Chang, 2014; Jean et al., 2014; Hoove-Sibanda and Poove, 2018; Panahifar et al., 2018; Yang et al., 2019; Baah et al., 2022; Sheyadi and Shaukat, 2023; Al-Khateeb, 2024).

E-collaboration, recognized as a sophisticated IT innovation, has become pivotal in fostering robust inter-organizational relationships (Jean et al., 2014). Within supply chains, collaborative endeavors yield significant enhancements in meeting member needs, building loyalty and trust, and enhancing overall performance (Yang et al., 2019; Baah et al., 2022).

Viewed through a RBV and dynamic capabilities framework, e-collaboration emerges as a pivotal capability, offering firms and their supply chains a

competitive edge. The outcomes, including enhanced operational performance, satisfaction, growth, and profitability, underscore its role as a valuable and unique strategic resource, empowering firms to navigate dynamic markets effectively.

In expert interviews, participants discussed the potential outcomes of e-collaboration adoption for firms and supply chains, especially in Turkey. They emphasized that the benefits of these evolving processes may become more evident as they develop over time.

"The benefits derived from e-collaboration hinge on its effective utilization and the organization's capacity to leverage it. Overall, I anticipate that e-collaboration will positively impact various parameters. Our ongoing activities affirm this belief." (Participant 1)

Electronic platforms in supply chains are increasingly utilizing concrete data to assess the benefits they offer to customers. Participants highlighted that their customers are indeed benefiting from their engagement in these processes, as evidenced by the data they have gathered. This realization prompts further investment in such applications.

"Do our customers reuse our systems? Have they repurchased our products? How efficiently do they utilize them? Have they continued to pursue these collaborations? When I collect this data from our system, I can conclude that firms providing positive answers to these questions benefit from these collaborations. Our results further confirm this trend: we are establishing long-term collaborations with existing customers and attracting new ones. Therefore, I can assert that these processes are beneficial for companies, with these benefits increasingly apparent." (Participant 2)

Theoretical Contributions

This study offers notable theoretical contributions. It delves into the factors influencing e-collaboration by examining both inter-organizational relationships and individual user perspectives. This approach not only broadens the scope of understanding by integrating different levels of analysis but also addresses a significant gap in the literature where the interplay between organizational and individual factors in e-collaboration has been underexplored (Chan et al., 2012).

The study challenges the established assumption in the literature that trust unequivocally enhances e-collaboration in supply chains. While prior studies (e.g., Chong and Ooi, 2008; Chan et al., 2012; Chen et al., 2014) emphasized the positive role of trust, our findings suggest a nuanced relationship. The observed moderately negative effect of trust on e-collaboration ($\beta = -0.23$) indicates that when trust levels are high, firms may not feel compelled to adopt formal e-collaboration tools. This finding contributes to a growing body of literature (Villena et al., 2016; Connelly et al., 2018) that questions the simplistic positive portrayal of trust and suggests that excessive trust may lead to complacency, reducing the perceived need for structured electronic systems. This insight encourages scholars to explore the dual role of trust and distrust as complementary, rather than mutually exclusive, elements in supply chain management (Lumineau, 2017; Han et al., 2021).

The study provides a theoretical extension by introducing digital platforms as potential trust facilitators within supply chain networks. This perspective aligns with recent discussions in the literature (Qian and Papadonikolaki, 2021; Carlini et al., 2023; Guo, 2023; Mohaved et al., 2023; Um, 2023; Ferro-Soto et al., 2024) but advances it by empirically demonstrating that in contexts where trust diminishes, digital platforms can act as intermediaries that foster confidence and encourage e-collaboration. This underscores a shift in the understanding of trust, transitioning from a purely relational construct to one that can be mediated by technology. Consequently, it enriches the literature on technology adoption and trust by indicating that digital technologies can offer the transparency, security, and efficiency that are often absent in traditional trust-based relationships.

This study suggests that the relationship between information sharing, and e-collaboration may be contingent on other factors, such as the nature of the information being shared and the existing levels of trust. It also aligns with studies that indicate excessive information sharing may entail risks (Zeiringer and Thalmann, 2021). This finding broadens the theoretical understanding by suggesting that firms may prioritize strategic and selective information sharing over sheer volume, thereby refining the conceptualization of information sharing in e-collaboration literature.

The study's findings extend the UTAUT model by providing insights into the specific factors influencing e-collaboration adoption. While performance expectancy ($\beta = 0.22$) and facilitating conditions ($\beta = 0.50$) were found to significantly affect e-collaboration, effort expectancy and social influence did not show a significant impact. This departure from previous research (Oliveira et al., 2014; Chauhan and Jaiswal, 2016) indicates that, in

international trade firms familiar with IT applications, ease of use and social pressures may be less significant than previously assumed, suggesting that the UTAUT model may require contextual adaptation for specific technological innovations like e-collaboration in supply chain management.

By framing e-collaboration as a dynamic capability within the RBV and dynamic capabilities frameworks, the study reinforces the concept of e-collaboration as a strategic resource that provides competitive advantage. The positive effects of e-collaboration on operational performance, customer/supplier satisfaction, growth, and profitability underscore its value as a unique capability that allows firms to respond to dynamic market conditions effectively. This perspective contributes to the strategic management literature by emphasizing e-collaboration's role in enhancing supply chain agility and adaptability, thereby providing a robust foundation for future research on dynamic capabilities in supply chains.

By employing SEM, the study elucidates the correlations and covariances among multiple variables, enhancing the model's explanatory power (Kline, 2005). This methodological contribution is crucial as it not only provides robust statistical validation of the proposed relationships but also offers a nuanced understanding of the complex interactions within the e-collaboration framework. The findings suggest specific avenues for refining the model, potentially leading to more accurate predictions and deeper insights into the mechanisms of e-collaboration.

Finally, to ensure the validity of the quantitatively collected data in practical scenarios, expert evaluations were conducted via one-on-one interviews. This mixed-method approach enhances the study's coherence and comprehensiveness by triangulating quantitative findings with qualitative insights. The expert evaluations provide practical validation and contextual depth, ensuring that the theoretical contributions are grounded in real-world applicability and enhancing the overall robustness and reliability of the study's conclusions (Bryman, 2006; Creswell, 2015).

Managerial Implications

In the realm of inter-organizational relationships, practitioners should capitalize on opportunities to cultivate trust throughout collaborative endeavors. To harness the benefits of e-collaboration while managing the complexities of trust, organizations should focus on developing robust digital infrastructures that can complement and enhance inter-organizational trust (Wang et al., 2023). Robust trust facilitates information sharing behaviors, enabling the exploitation of novel insights from external sources to seize emerging opportunities. Furthermore, training and development programs aimed at fostering digital literacy and trust-building skills among employees can help bridge the gap between traditional trust mechanisms and modern digital collaboration tools. These programs should go beyond technical skills and prioritize interpersonal communication, empathy, and conflict resolution within digital environments (Dennis et al., 2013).

By integrating these approaches, organizations can create a balanced ecosystem where trust and e-collaboration coexist and reinforce each other, ultimately leading to improved supply chain performance and innovation. Additionally, organizations wielding significant partnership power within their supply chains and industries are positioned to influence the adoption of innovative practices among peer firms, including competitors (Fares and Lloret, 2023). Strategically leveraging this influence could involve establishing industry-wide forums or working groups to encourage collaborative standards, joint investments in technology, and the sharing of best practices, all of which can contribute to creating collective value.

Another strategic directive for practitioners pertains to individual users, particularly employees directly engaging with e-collaboration tools. These users prioritize leveraging technological capabilities to enhance their job performance, anticipating that such enhancements will yield benefits at both individual and organizational levels (Zhang and Tur, 2023). Managers should thus acknowledge the potential for performance improvements through investments in technological advancements, empowering employees to drive innovation and contribute to overall firm success (Turyadi et al., 2023). This can be accomplished by developing incentive structures that recognize and reward both individual and team-driven innovative efforts, thereby fostering a culture that prioritizes continuous improvement and learning.

Furthermore, leadership is crucial in steering and supporting a trust-focused e-collaboration strategy (Li et al., 2024). Management should actively foster a digital mindset, not only by setting strategic direction and policies but also by leading by example—showing openness, transparency, and trust in digital engagements. This can be further strengthened by forming cross-

functional teams that combine diverse expertise and perspectives, thereby enhancing problem-solving abilities and fostering innovative solutions through collaboration.

Broadening e-collaboration efforts to encompass not only internal teams but also external stakeholders—such as suppliers, customers, and even competitors in co-opetition settings—can significantly enhance the benefits (Ardakani et al., 2023). By cultivating a more extensive network of digital collaboration, organizations can improve their agility and resilience in fast-evolving environments, thereby strengthening their competitive advantage.

In addition, in line with the findings on trust and information sharing, businesses can make more use of sharing economy platforms in their supply chains. The sharing economy causes power transformations in industrial economies, making the service sector the main driver of economic growth and creating opportunities for sustainable development for industries (Pu and Pathranarakul, 2019). With the sharing economy, access to information and sharing of detailed information has become easier and trust between users has increased (Curtis and Lehner, 2019; Rossmannek and Chen, 2023).

CONCLUSION

This study advances the theoretical understanding of e-collaboration in supply chains by examining its complex relationship with trust within the context of inter-organizational relationships and the UTAUT framework, while also exploring how trust and knowledge sharing can be strengthened through sharing economy platforms, particularly in low-trust environments. Findings from a survey with international trade firms in Türkiye and expert interviews reveal that while trust is a crucial factor in supply chain management, its impact on e-collaboration is nuanced and multifaceted.

The findings reveal that trust can have a complex, and at times counterintuitive, influence on e-collaboration processes. Notably, the discovery of a negative relationship between interfirm trust and e-collaboration challenges established notions within the literature, suggesting that excessive trust may diminish the perceived necessity for structured collaborative frameworks.

The investigation also sheds light on the reciprocal relationship between trust and information sharing, indicating that while these elements are traditionally viewed as mutually reinforcing, their interaction can be influenced by contextual factors, including organizational culture and the perceived risks associated with information exchange.

Moreover, the role of digital platforms as facilitators of trust highlights the evolving dynamics in inter-organizational relationships, emphasizing the importance of transparency and security in fostering collaboration. The study's emphasis on user performance expectations and facilitating conditions further underscores the need for organizations to cultivate an environment conducive to e-collaboration adoption. Ultimately, e-collaboration can enhance operational performance, customer/supplier satisfaction, growth, and profitability, demonstrating its significant impact on supply chain management.

The study confronts several limitations stemming from both methodological approaches and study specifics. One constraint arises from the dearth of literature exploring the implementation of the sharing economy concept within business and supply chain contexts. Additionally, accessing all foreign trade businesses operating in Turkey, the study's sample, necessitates substantial time and financial resources. While efforts were made to uphold validity and reliability by adhering to scientific principles and securing a sufficient sample size, restricting the sample to Turkish firms precludes comparative analysis with others.

The study hypothesized that trust and information sharing, key drivers of collaboration, would positively impact e-collaboration. However, these hypotheses were not supported. While the findings section sheds light on this outcome, future research is warranted to more thoroughly examine the influence of trust and information sharing on e-collaboration. It would be particularly valuable to explore the specific conditions under which trust, and information sharing might become more significant, such as in varying organizational cultures, sizes, or sectors. This could help to identify contextual factors that could either strengthen or weaken these relationships. Moreover, stakeholder theory can be used to analyze how sharing economy platforms respond to stakeholder expectations and build organizational capabilities to increase trust and encourage knowledge sharing.

Additionally, investigating the moderating effect of technology use on these relationships could yield novel insights, suggesting a valuable avenue for further exploration. Future studies could employ longitudinal research designs to capture how the dynamics of trust and information sharing evolve over time with

continued technology use. Mixed-method approaches, combining qualitative and quantitative data, could also be advantageous in uncovering deeper insights into the mechanisms underlying these relationships.

Moreover, further research could examine other potential moderating or mediating variables, such as organizational readiness for digital transformation, employee digital literacy, and the role of leadership in fostering a collaborative e-environment. Understanding these variables' interplay may reveal new pathways for enhancing e-collaboration.

Note: This article is based on the first author's PhD thesis.

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