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Agricultural insurance and natural disasters: an assessment of the financial performance of the Turkish agricultural insurance pool (TARSIM) through selected criteria*

Tarım sigortaları ve doğal afetler: Türk tarım sigortaları havuzu (TARSİM) finansal performansının seçili kriterler dâhilinde değerlendirilmesi

Hasan Arda Burhan[a**]

[a] *Dr. Öğretim Üyesi, Kütahya Dumlupınar Üniversitesi, İktisadi ve İdari Bilimler Fakültesi, Ekonometri Bölümü, Kütahya, Türkiye, arda.burhan@dpu.edu.tr, ORCID: 0000-0003-4043-2652*

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A B S T R A C T

Agriculture is closely linked to weather and climatic conditions, rendering it vulnerable to the impact of natural disasters. While such risks are inherent in agricultural activities, the escalation in both frequency and severity of these disasters in recent years can be attributed to the interplay of climate change, global warming, and ecological degradation. In this context, agricultural insurances offer financial assistance to farmers by extending insurance coverage to mitigate potential production failures stemming from these hazards. In Turkey, the insurances included in the Agricultural Insurance Pool (TARSIM) range from crop, greenhouse, and poultry, to drought yield insurances. In this study, the financial performance of TARSIM during the period 2018-2022 has been evaluated by using Criteria Importance Through Intercriteria Correlation (CRITIC) objective criteria weighting with Evaluation based on Distance from Average Solution (EDAS) and Multi-Atributive Ideal-Real Comparative Analysis (MAIRCA) multi-criteria decision-making (MCDM) techniques. The analyses included seven financial ratios based on eight indicators, and as a result, the criterion with the highest weight was determined as the Total Premiums Received-Equity ratio, and by considering all utilized methods, the first two years with the best financial performance was identified as 2018 and 2019.

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ÖZ

Tarım, hava ve iklim koşullarına sıkı bir şekilde bağlı olması nedeniyle doğal afetlerin etkisine karşı savunmasızdır. Bu tür riskler tarımsal faaliyetlere içkin olsa da son yıllarda bu felaketlerin hem sıklığında hem de şiddetinde yaşanan artışın, iklim değişikliği, küresel ısınma ve ekolojik bozulma arasındaki etkileşimle ilgili olduğu söylenebilir. Bu bağlamda, tarım sigortaları, çeşitli risklerden kaynaklanan potansiyel üretim başarısızlıklarını hafifletmek için tarım sektöründe çalışanlara finansal yardım sunarak potansiyel verim kayıplarına karşı güvence sağlamaktadır. Türkiye'de tarım sigortalarının içeriği, Tarım Sigortaları Havuzu (TARSİM) dâhilinde bitkisel ürün, sera ve kümes hayvanlarından kuraklık verim sigortalarına kadar uzanmaktadır. Finansal performans değerlendirmelerinin sorunları tespit etmek ve yenilikçi stratejiler geliştirmek amacıyla kullanılmasına paralel olarak bu çalışmada, TARSİM'in 2018-2022 dönemindeki finansal performansı, CRITIC objektif kriter ağırlıklandırma ile EDAS ve MAIRCA Çok Kriterli Karar Verme (ÇKKV) teknikleri kullanılarak değerlendirilmiştir. Model, bilançolar ve gelir tablolarından elde edilen sekiz göstergeye dayalı yedi finansal oran içermekte olup, elde edilen sonuçlara göre, en yüksek ağırlığa sahip kriterin Alınan Prim-Öz Sermaye oranı; ele alınan dönem dâhilinde en iyi finansal performansa sahip ilk iki yılın ise 2018 ve 2019 yılları olduğu tespit edilmiştir.

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** *Sorumlu yazar / Corresponding author*

E-posta / E-mail: arda.burhan@gmail.com

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1. Introduction

Agriculture forms an essential element of human civilization. It acts as a foundational cornerstone for society, showcases deep connections with the worldwide economy, biodiversity, and the historical course of human livelihood. In addition, agriculture contributes to poverty reduction, economic growth and environmental sustainability. According to the 2022 report by the World Bank, while agriculture constitutes around 4% of the global Gross Domestic Product (GDP), it plays an even more substantial role in certain developing countries, contributing over 25% to their GDPs (World Bank, 2022). On the other hand, as events that include geophysical instances such as earthquakes and volcanic eruptions, as well as climate-induced occurrences like floods, storms, and landslides, natural disasters cause human casualties, property losses, disruptions in society, resource depletion, and other phenomena, or a series of adverse effects on both human society and the economy (Bao et al., 2021). Nonetheless, agriculture is highly vulnerability to these adverse natural disasters. It is a well-known fact that the potential cost of these incidents may increase in the future due to the impacts of climate change, which could lead to catastrophic crop losses and livestock mortality, affecting millions of individuals (Hao et al., 2023; Mahul & Stutley, 2010). It is also stated that the impact of global warming and urbanization led to changes in weather-related factors' strength and occurrence rates, as well as in the evolving exposure of crop-bearing entities, which carry significant consequences for the capacity of agricultural production to endure and recover from natural disasters (Zhang et al., 2022). Furthermore, considering the impact of the COVID-19 pandemic on the worldwide economy, it is indicated that the previously favorable mid-term projection for agricultural production and supply-demand has shifted in an unfavorable direction, and has prompted governments to implement necessary actions to adapt to the evolving situation (OECD/FAO, 2020). Consequently, it can be stated that these incidents, risks and uncertainties lead to instability in the agricultural sector and fluctuations in farmers' earnings. In this context, insurance emerges as a viable strategy for managing the effects of the factors mentioned above on national economies, given that risk analysis for such critical emergencies involves evaluating both the likelihood of these events happening and the extent of the damage they can cause. (Zhong et al., 2010). It can also be asserted that insurance offers opportunities to establish collaborations between private and public sectors, diminishing reliance on public resources during the stages of recovery and reconstruction following disasters, severe incidents and significant crisis (Ward & Zurbruegg, 2000). Therefore, adoption of insurance as a mechanism for mitigating agricultural risks has rapidly broadened and become an essential constituent of the complete set of assistance programs for farmers across both developed and developing nations; as agricultural insurance has resulted in enhanced inputs, such as investments, into cultivated lands, thereby supporting farmers' income stability and security through the improvement of their agricultural practices and the optimization of profits (Enjolras & Sentis, 2011; Kostyuchenko et al., 2015; Tsiboe & Turner, 2023). Furthermore, with the contribution of agricultural insurances, it can be stated that an increased availability of liquid capital becomes evident after crisis situations, which reduces the necessity for households to liquidate assets due to credit limitations, and this, in turn, aids farmers in breaking free from cycles of poverty and the aforementioned vulnerabilities of agriculture (Alam et al., 2020). In addition, agricultural insurance serves as an incentive for farmers to embrace eco-friendly production techniques, enhancing production efficiency and concurrently minimizing the release of chemicals into the environment (Zhichkin et al., 2023).

Today, various forms of agricultural insurance are mostly subsidized within government initiatives, although it is stated that agricultural insurances were initially provided by private companies around two hundred years ago, commencing in Europe and subsequently extending to the United States (US) (Smith & Glauber, 2012). For example, in the US, the Federal Crop Insurance Program (FCIP) is administered by the US Department of Agriculture (USDA) to provide farmers with insurance coverage against adverse agricultural circumstances (Baldwin et al., 2023). On the other hand, China initiated a pioneering full-cost insurance approach to safeguard farmers' interests, encompassing a broader spectrum of expenses including labor, fertilizers, pesticides, seeds, and losses arising from pests and natural disasters (Zhong et al., 2023). In the European Union, various member states adopt distinct agricultural insurance systems due to varying risks depending on the country. Particularly, agricultural insurance in France has expanded following the reforms of 2004, covering over 60% of the agricultural land, which is more than 80% in Germany; and on a global scale, it is asserted that Latin America's agricultural insurance sector is relatively well-developed in contrast to regions like Africa and numerous Asian nations; although in India, extensive agricultural insurances based on weather conditions were developed (Vilhelm et al., 2015; Yusuf et al., 2022). Furthermore, in the pursuit of facilitating the establishment of sustainable and cost-effective agricultural insurance programs, the World Bank endorses a country-based agricultural insurance framework, which is rooted in corporate risk management principles and extends to considerations of economic and social dimensions, including the government's fiscal resilience and the welfare of vulnerable communities (Mahul & Stutley, 2010). Hence, it can be asserted that governments and organizations offer agricultural insurance and subsidies as a strategy to mitigate the adverse consequences of extreme conditions and establish a robust, sustainable agricultural framework.

In Turkey, Şeker Insurance introduced the initial agricultural insurance policy in 1957, which was specifically designed for sugar beet producers, then, in 1960, Başak Insurance expanded its services to include a comprehensive range of insurance options, such as coverage for entire plant-based products and animal life (Tekin et al., 2017). In 1995, the Agriculture Insurance Foundation was established to give support to insurance companies by collaborating with some institutions and organizations until the agricultural insurance enacted (Özsayın, 2017). In this context, it's important to highlight that Turkey's agricultural risk management system can be categorized into two distinct periods. The first period began with the introduction of agricultural insurance in 1957 and extended until 2006, coinciding with the establishment of Agricultural Insurance Pool (TARSIM) (Berk & Uçak, 2010).

After the acceptance of the Agricultural Insurance Act on June 14, 2005, TARSIM was established and commenced its operations in 2006. In summary, TARSIM enters into reinsurance agreements with international reinsurance firms, while local insurance agencies serve as intermediaries connecting farmers with TARSIM (Gulseven, 2012). Following the inception of TARSIM, there were initially fifteen insurance companies involved in agricultural insurance. However, as TARSIM's operations expanded, the number of agricultural insurance providers subsequently increased to 24 (Tekin et al., 2017). The procurement of insurance coverage is facilitated through insurers who have received authorization from TARSIM, along with their appointed agents. It is mentioned that through TARSIM, the government offers insurance premium subsidies to farmers as part of its strategy to ensure a consistent food supply and safeguard against the effects of various risks (Oguz & Diyanah, 2021). With the introduction of new forms of agricultural insurance and increased

awareness campaigns, individuals within the agricultural sector have begun to express interest in insurance, and starting from 2014, the Turkish government offered a 50% subsidy on insurance premiums across all insurance categories (Sogue & Akcaoz, 2017). As a result of the expanded range of agricultural insurance options and enhanced awareness efforts, the number of insured producers reached 403,569 in 2016 and between 2005 and 2016, the count of insured producers grew approximately 110-fold (Tekin et al: 2017). As per the most recent official report, the present state of agricultural insurance in Turkey is outlined in Table 1 below:

Table 1. Agricultural insurance trends in Turkey from 2018 to 2022

Years	Number of Policies	Insurance Amount (TL*)	Premium Production (TL)	Government Support Premium Amount (TL)	Paid Claims (TL)
2018	1.756.408	42.217.541.073	2.050.635.088	1.072.036.127	1.065.106.035
2019	2.087.860	55.166.348.492	2.447.064.788	1.275.313.836	1.226.860.024
2020	2.235.626	83.146.049.745	3.198.743.163	1.659.280.218	1.392.944.782
2021	2.517.626	124.396.971.987	4.678.459.288	2.474.128.652	2.554.247.269
2022	3.077.908	296.149.927.061	9.005.954.305	4.822.741.665	3.393.301.958

*TL represent the Turkish Lira currency

Source: TARSIM, 2022

Table 1 indicates a consistent upward trend over the past four years across all categories. Notably, there has been a substantial increase in insurance amounts, premium production, government support premium amount, and paid claims in 2022 compared to previous year. In addition, it can be clearly stated number of policies also increased by almost 50% during the handled period.

On the other hand, Multi-Criteria Decision Making (MCDM) represents a prominent subfield within the domain of operational research, exerting a significant influence across diverse fields such as, engineering, business management, politics, environmental sciences, and healthcare (Huang & Moh, 2017). As a subset of operational research, MCDM methods provide decision-makers with the means to make well-informed choices that take into account a range of criteria, which can sometimes be conflicting. Additionally, MCDM methods are used for performance evaluations within above mentioned fields. One of the most important steps of the MCDM process is the prioritization of criteria, often referred to as the weighting process. According to the related literature, it can be stated that this step can be carried out through subjective weighting, involving expert input, through objective weighting, which relies on quantifiable values associated with the criteria or the combination of both of these approaches (Odu, 2019). In this context, this research assesses TARSIM's financial performance from 2018 to 2022 using an MCDM methodology that relies on objective criteria weighting. To accomplish this, the Criteria Importance Through Intercriteria Correlation (CRITIC) method was employed to establish the weights for the criteria. To facilitate comparisons among the outcomes, two distinct MCDM methods—namely Evaluation based on Distance from Average Solution (EDAS) and Multi-Atributive Ideal-Real Comparative Analysis (MAIRCA)—were chosen as tools for evaluating performance. The analysis encompassed seven financial ratios derived from eight indicators drawn from balance sheets and income statements. The EDAS method stands as one of the recent additions to the MCDM literature, drawing considerable interest from researchers. EDAS primarily relies on measuring the distances from the average and is frequently employed in comprehensive decision-making models (Peng, et al., 2022). The benefits of EDAS include its ease of application, capability to accommodate both subjective and objective criteria, rational and comprehensible nature, and straightforward computation processes (Özmen & Aydoğan, 2020). Finally, as highlighted by Qahtan et al. (2023), the MAIRCA method has exhibited higher stability in comparison to frequently employed MCDM ranking methods. Additionally, its capacity to compute the probability associated with each alternative can be regarded as a distinguishing feature that contributes to the method's superiority. Hence, the aim of this study can be stated as to perform a financial evaluation of TARSIM, providing an annual perspective. The structure of the paper is as follows: The next section entails a review of pertinent literature. In the third section, a succinct explanation of the data and methodologies employed are given. Section four includes empirical analyses conducted to determine rankings and presents the results obtained using MCDM methods. The concluding section offers an overview and brief analysis of these findings.

2. Literature Review

Agriculture is typically conducted outdoors, and it's evident that agricultural endeavors inherently carry risk, particularly when considering the impact of natural disasters, which can have detrimental effects on farmers, consumers, and the overall economy (Sogue & Akcaoz, 2017). Furthermore, recent developments such as escalating food prices and the influence of climate change and other natural risk factors in the global economy have heightened the significance of agricultural production (Berk & Uçak, 2010). Consequently, policymakers have increasingly focused on integrating agricultural sustainability into government policies. Within this context, various strategies and tools are available to help farmers manage these risks, with agricultural insurance being one of the notable options (Oguz & Diyanah, 2021). In this regard, it's worth noting that agricultural insurance has garnered significant attention in the relevant literature. Numerous studies have been undertaken to evaluate the efficacy of this risk management tool. Furthermore, within the literature, Multi-Criteria Decision Making (MCDM) methods have proven to be valuable in conducting financial performance assessments. However, it is worth noting that the existing literature lacks studies specifically dedicated to the direct evaluation of the financial performance of agricultural insurance, especially when considering the application of MCDM techniques. Conversely, there are numerous studies that employ MCDM methods to conduct financial performance analyses in various other sectors of the insurance industry. In this context, the related studies are presented below:

Akyüz & Kaya (2013) conducted an evaluation of both non-life insurance companies and life/retirement insurance sectors during the period from 2007 to 2011 by using the Technique for Order Preference by Similarity to Ideal Solutions (TOPSIS) method. The study incorporated a set of 10 sector-specific financial performance ratios, including measures like the premium-to-equity ratio and the equity-to-total assets ratio and the findings revealed that the non-life insurance sector's most profitable fiscal year occurred in 2007, while its least successful year was 2008. Similarly, for life/retirement insurance companies, the most profitable year was identified as 2007, with the least successful year being 2009. Alenjagh (2013) employed various MCDM methods to assess the performance of insurance companies listed on the Tehran Stock Exchange. The model utilized in this study encompassed seventeen crucial financial ratios. The Analytic Network Process (ANP) was applied to determine the relative significance of each criterion. Subsequently, the Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE)

technique was employed to rank these companies based on their financial performance. The results of the study indicated that liquidity level emerged as the most critical criterion, with Parsian Insurance Company demonstrating the highest performance. In Çakır (2016)'s study, the performances of six insurance companies listed on Istanbul stock exchange (Borsa Istanbul) were assessed. In the research, evaluation criteria were assigned weights using the Analytic Hierarchy Process (AHP) method. Subsequently, an interval Vise Kriterijumska Optimizacija I Kompromisno Resenje (VIKOR) model was applied in the second phase of the analysis. The study utilized a model based on 2014 data for criteria such as personnel expenses, written premiums, total assets, and equity. This model was employed to evaluate the financial performance of six unnamed companies.

Bülbül & Köse (2016) focused on the performance of companies operating in the non-life insurance sector within the Turkish insurance industry for the period spanning from 2010 to 2013. They employed the PROMETHEE method for their analysis and eight financial ratios were utilized, including indicators such as the equity-to-technical reserves ratio and the current assets-to-total assets ratio. The study's results highlighted the strong financial performance of Axa and Anadolu Insurance companies. Ksenija et al. (2017) introduced a fuzzy multi-criteria model aimed at streamlining the evaluation of insurance companies operating in Serbia during the period spanning from 2007 to 2014. This model relied on five essential financial indicators and involved the use of Fuzzy Analytic Hierarchy Process (FAHP) and TOPSIS methods. The results of the assessment underscored the significance of equity reserves and business assets as the most critical criteria. Among the companies assessed, Dunav Osiguranje (Dunav Insurance) emerged as the top-ranking company when considering all the criteria, which is followed closely by the DDOR Novi Sad. Perçin & Sönmez (2018) conducted an assessment of the financial performance of various Turkish insurance companies listed on Borsa Istanbul. They employed a combination of Entropy Weight and TOPSIS methods for this evaluation. To facilitate their analysis, they considered profitability, activity, leverage, and liquidity ratios within the dataset from the year 2016. The results highlighted that the most influential criterion for evaluating financial performance was the short-term debts-to-assets ratio, and Ak Insurance was identified as the company demonstrating the most favorable financial performance.

Tayyar et al. (2018) worked on a financial performance analysis using the Reference Ideal Method (RIM) on Turkish insurance companies listed on Borsa Istanbul. They employed 17 financial ratios, including metrics such as premiums earned/equity, liquidity ratio, and loss premium ratio with data spanning from 2015 to 2017. As a result of the analysis, Ray Insurance. emerged as the most successful company, which is followed by the Anadolu Insurance and Ak Insurance corporations. Akyüz et al. (2020) performed a ranking of 38 non-life insurance companies, taking into account their performance indicators for the year 2016. They employed a two-step hybrid MCDM method that combined the Best-Worst Method (BWM) and TOPSIS. The model incorporated various financial indicators, such as period net profit, equity, total premium generation, ıncome and expense balance, based on data from 2016. The results of the analysis revealed that the top three companies in terms of performance were Allianz, Anadolu, and Axa Insurance Companies, and these companies also occupied the first three positions in the market share ranking, based on total premium generation in 2016. In a study that do not include a MCDM analysis, Prasada (2020) employed various financial indicators and associated statistics to visually depict and present the performance and potential of agricultural insurance from a global perspective, with a specific focus on Sri Lanka. Two distinct cultivation seasons are observed in this region known as Maha (from September to March) and Yala (from May to the end of August), which align with two different monsoon periods and based on the research findings, it is reported that the viability of the insurance scheme has shown slightly better results during the Yala season, primarily reflected in lower loss ratios.

Köse & Dikme (2021) assessed the performance of non-life insurance companies in Turkey within a TOPSIS framework. They utilized a model that incorporated input and output variables such as equity, total expenses, period profit/loss, and total premium production based on data from 2013 to 2017. In summary, the analysis identified Allianz, Mapfre, Anadolu, and Axa as the top-performing companies in general during the specified period. However, the companies ranked at the bottom of the list showed variations over the same period. Bilbao Terol et al. (2022) applied the Extended Best–Worst (EBW) and Multiple Reference Point (MRP) methods to establish rankings for non-life insurance companies in Spain from 2009 to 2017. Data for this analysis were gathered from the balance sheets and accounts, encompassing various ratios including premium growth, loss, and expenses and the outcomes of the study unveiled that private companies exhibited superior performance and higher profitability compared to others. Notably, return on equity emerged as the most pivotal criterion in the evaluation. Rahmati & Darestani (2022) conducted an evaluation of insurance companies in the northern region of Iran. They employed the Balanced Scorecard (BSC) framework in conjunction with MCDM techniques. This analysis involved case studies of three specific companies and took into account nine distinct criteria and the findings underscored the paramount importance of increasing service quality as the most critical criterion, which is followed by the criteria of improving the quality of services to attract both new and existing customers and enhancing the flexibility of the service system. In a study aligned with the focus of this research, Pehlivan & Akpınar (2022) assessed the performance of the Agricultural Insurance Pool (TARSIM) over the period from 2011 to 2020. They employed the Criteria Importance Through Intercriteria Correlation (CRITIC) method to assign weights to the criteria and used the Additive Ratio Assessment (ARAS) method for financial performance analysis, based on data spanning from 2011 to 2020. The selected criteria for the evaluation included gross premium production, gross paid claims, technical profitability ratio, current ratio, and policy count. According to the CRITIC analysis, the most significant criterion was the technical profitability ratio, while the current ratio held the least importance. In terms of the MCDM application, it was observed that TARSIM performed at its highest level in the year 2020 and exhibited its lowest performance in 2014 during the ten-year period. Puška et al. (2023) employed a comprehensive approach to determine the optimal choice among five companies offering agricultural insurance services in the Republic of Serbia. Their approach combined fuzzy Logarithm Methodology of Additive Weights (LMAW), the Entropy method, and Compromise Ranking of Alternatives from Distance to Ideal Solution (CRADIS) method. The outcomes of these methods revealed that the price criterion carried the most significant weight in the evaluation. Furthermore, the CRADIS method indicated that DDOR insurance company provided the most favorable terms for agricultural insurance for farmers.

Considering the methodologies employed in this study, it can also be stated that both the Evaluation based on Distance from Average Solution (EDAS) and Multi-Attributive Ideal-Real Comparative Analysis (MAIRCA) were applied across diverse fields. Torkayesh et al. (2023) conducted a comprehensive review, revealing the successful integration of EDAS in nine fields, including agriculture, business management, construction management, energy and natural resources, healthcare

management, technology, manufacturing, supply chain management, and transportation management. Likewise, a literature review indicates the extensive application of MAIRCA in various domains, ranging from supplier selection (Badi & Ballem, 2018; Chatterjee et al., 2018) to material selection (Chatterjee et al., 2020; Haq et al., 2023) and from economic and financial evaluations (Aksoy, 2021; Günay & Ecer, 2022) to studies on energy resources (Hezam et al., 2023; Narayanamoorthy et al., 2023). However, it is seen that studies combining the EDAS and MAIRCA methods are limited in the literature. These methods have been utilized in research across various domains, including finance, digital divide, e-commerce, supply chain management, and sustainable growth. Examples of such studies include those by Bączkiewicz (2021), Akbari (2022), Dagli (2022), Ecer et al. (2022), and Więckowski (2023).

3. Data & Methodology

3.1. Data

The assessment of the financial performance of the Agricultural Insurance Pool (TARSIM) between 2018-2022 was carried out using data extracted from TARSIM's annual reports (TARSIM, 2018; TARSIM, 2019; TARSIM, 2020; TARSIM, 2021; TARSIM, 2022). Although these reports are available starting from 2006, the years up to 2018 were excluded from the analysis due to missing data for certain financial indicators, such as equity data. Considering the relevant literature (see Bülbül & Köse (2016) and Tayyar et al. (2018) for details) and data availability, eight indicators were extracted from TARSIM's balance sheets and income statements within the annual reports. Subsequently, calculations were made to derive seven financial performance ratios based on these criteria. These ratios are categorized under different headings as mentioned by Tayyar et al. (2018):

- Current Assets-to-Total Assets (CATA), also known as Liquidity Ratio is included in the "Asset Quality and Liquidity Ratios", which are used to measure the company's ability to cover short-term debts and the strength of its capital,
- Current Assets-to-Short Term Liabilities (Current Ratio) also included in the "Asset Quality and Liquidity Ratios"
- Claims-to-Total Premiums Received, also known as Loss Ratio is categorized under "Profitability Ratios" and are used to measure the company's profitability, calculated with accounting items affecting the company's profitability performance,
- Technical Profit-to-Total Premiums Received is also categorized under "Profitability Ratios"
- The Equity-to-Assets ratio is included in the "Capital Adequacy Ratios" and is generally used to assess how accurately the company's financing is done.
- Total Premiums Received-to-Equity ratio is also included in the "Capital Adequacy Ratios"
- Equity-to-Technical Reserves ratio also appears in the "Capital Adequacy Ratios"

The abbreviated criteria (ratios) and whether they are to be maximized or minimized are provided as follows:

Table 2. Financial performance evaluation criteria for TARSIM

Ratios	Maximize /Minimize
1. Current Assets-to-Total Assets a.k.a. Liqudity Ratio **(CATA)**	Maximize
2. Current Assets-to-Short-Term Liabilities a.k.a. Current Ratio **(CR)**	Maximize
3. Claims-to-Total Premiums Received a.k.a. Loss Ratio **(LR)**	Minimize
4. Technical Profit-to-Total Premiums Received (**TPTP)**	Maximize
5. Equity-to-Assets **(ETA)**	Maximize
6. Total Premiums Received-to-Equity **(TPE)**	Maximize
7. Equity-to-Technical Reserves **(ETR)**	Maximize

Source: TARSIM (2018) to TARSIM (2022)

Initially, a data preparation process was executed as a follow-up to the data acquisition phase. This step encompassed the computation of the ratios listed in Table 2 and the organization of the dataset for objective criteria weighting and Multi-Criteria Decision Making (MCDM) analysis. In the subsequent section, concise explanations of the employed methods in this step are presented.

3.2. Methodology

3.2.1. Criteria Importance Through Intercriteria Correlation (CRITIC)

To determine the objective weights for the given criteria, the CRITIC method, introduced by Diakoulaki et al. (1995), utilizes standard deviation and correlation values. The operational steps of this approach are delineated as follows (Žižović & Marinković, 2020):

- Once the decision matrix is constructed, the performance metrics within this matrix undergo normalization via:

$$x_{ij}^{T} = \begin{cases} \frac{x_{ij}-\bar{x}_j}{x_j^{+}-\bar{x}_j}, x_j^{+} = \max_i x_{ij}, \bar{x}_j = \min_i x_{ij} \\ \frac{\bar{x}_j - x_{ij}}{x_j^{+}-\bar{x}_j}, x_j^{+} = \min_i x_{ij}, \bar{x}_j = \max_i x_{ij} \end{cases} \quad \textbf{(1)}$$

where x_{ij}^{T} is the outcome of normalization applied to the i^{th} alternative on j^{th} criterion.

- The standard deviation values are calculated for individual criteria within the normalized matrix.
- Additionally, the correlation for each criterion in the normalized matrix is determined.
- The conflict measure of a specific criterion with respect to other criteria is then computed using the formula below, utilizing each element of the correlation matrix r_{jk}:

$$\sum_{j'=1}^{n}(1 - r_{jk}) \quad \textbf{(2)}$$

- By combining the two measures mentioned earlier, we calculate C_j, the amount of information encapsulated within criterion j:

$$C_j = \sigma \sum_{j'=1}^{n}\left(1 - r_{jk}\right), j = 1, \dots, n \quad \textbf{(3)}$$

- The weights of criteria (W_j), are obtained by calculating the sums of C_j values:

$$C_k = \sum_{k=1}^{m} C_j \quad \textbf{(4)}$$

- The criteria weights are calculated by utilizing the following formula:

$$W_j = \frac{C_j}{\sum_{k=1}^{n} C_k}, j, k = 1, \dots, n \quad \textbf{(5)}$$

3.2.2. Evaluation based on Distance from Average Solution (EDAS)

Proposed by Keshavarz Ghorabaee et al. (2015), the EDAS method, one of the recent addition to the MCDM literature, has garnered considerable interest among researchers. The evaluation process in this methodology revolves around ranking alternatives based on their proximity to the Average Solution (AV) (Torkayesh et al., 2020). The procedural steps of the method are outlined as follows (Keshavarz Ghorabaee et al., 2015):

- Calculating the AV for all the criteria by given equation below:

$$AV_j = \frac{\sum_{i=1}^{n} X_{ij}}{n} \quad \textbf{(6)}$$

where X_{ij} again indicates the value of i^{th} alternative with regard to j^{th} criteria.

- Obtaining the *PDA* and *NDA* values for both maximization and minimization criteria:

For maximization criteria;

$$PDA_{ij} = \frac{\max(0,\ (X_{ij} - AV_j))}{AV_j} \quad \textbf{(7)}$$

$$NDA_{ij} = \frac{\max(0,\ (AV_j - X_{ij}))}{AV_j} \quad \textbf{(8)}$$

For minimization criteria;

$$PDA_{ij} = \frac{\max(0,\ (AV_j - X_{ij}))}{AV_j} \quad \textbf{(9)}$$

$$NDA_{ij} = \frac{\max(0,\ (X_{ij} - AV_j))}{AV_j} \quad \textbf{(10)}$$

where PDA_{ij} indicates the positive distance of ith alternative from the *AV* and NDA_{ij} denotes the negative distance.

- The weighted sum of *PDA* (*SP*) and *NDA* (*SN*) scores are obtained:

$$SP_i = \sum_{j=1}^{m} w_j\ PDA_{ij} \quad \textbf{(11)}$$

$$SN_i = \sum_{j=1}^{m} w_j\ NDA_{ij} \quad \textbf{(12)}$$

where w_j accounts for the weight of the jth criteria.

- The SP and SN values are normalized for all alternatives:

$$NSP_i = \frac{SP_i}{max_i(SP_i)} \quad \textbf{(13)}$$

$$NSN_i = 1 - \frac{SN_i}{max_i(SN_i)} \quad \textbf{(14)}$$

- The appraisal scores (*AS*) for all alternatives are obtained:

$$AS_i = \frac{1}{2}(NSP_i + NSN_i) \quad \textbf{(15)}$$

where $0 \leq AS_i \leq 1$.

- Assigning the top rank to alternatives with the highest AS value signifies the optimal choice.

3.2.3. Multi-Atributive Ideal-Real Comparative Analysis (MAIRCA)

The MAIRCA method, initially proposed by Pamučar et al. (2014), is fundamentally based on the distinction between ideal and actual solutions. The procedural steps of this method are delineated as follows (Trung & Thinh, 2021; Günay & Ecer, 2022):

- After formulating the decision matrix, the preference values for alternatives P_{Aj} are derived through the application of the subsequent equation:

$$P_{Aj} = \frac{1}{m} \text{ and } \sum_{i=1}^{m} P_{Aj} = 1, i = 1, \dots, m \quad \textbf{(16)}$$

where number of alternatives are denoted by *m*.

- Obtaining the theoretical ranking matrix (K_p) by the following formula:

$$K_p = P_{Aj} * W_j \quad \textbf{(17)}$$

where W_j is the weight of the j^{th} criteria.

- Utilizing the normalized decision matrix x_{ij}^T from equation (1) and K_p values from equation (17), the effective evaluation matrix is calculated through the subsequent equation:

$$K_r = K_{pij} * x_{ij}^T \quad \textbf{(18)}$$

- Then, the gap matrix (F) is calculated:

$$F = K_p - K_r \quad \textbf{(19)}$$

- By utilizing the following formula, the criteria function values are obtained:

$$Q_i = \sum_{j=1}^{n} f_{ij} \quad \textbf{(20)}$$

- Finally, the rankings of the alternatives are obtained by considering the ascending order of the Q_i values.

4. Empirical Findings

This study includes two different Multi-Criteria Decision Making (MCDM) applications intended for evaluating the financial performance of the Agricultural Insurance Pool (TARSIM) from 2018 to 2022 based on objective criteria weighting approach. The steps of the analysis is given below in Figure 1:

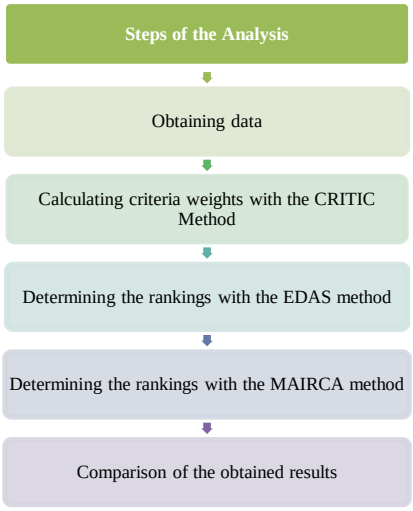

Figure 1. Steps of the performed analysis

In this study, the research proceeded in accordance with the steps illustrated in Figure 1. To begin, the essential datasets were gathered. In order to account for conflicting criteria, the Criteria Importance Through Intercriteria Correlation (CRITIC) method was utilized to calculate the weights of the criteria. Subsequently, the years were ranked based on financial performance criteria using the Evaluation based on Distance from Average Solution (EDAS) and Multi-Atributive Ideal-Real Comparative Analysis (MAIRCA) methods in succession. The final step involved a comprehensive comparison of the results obtained. Following the data acquisition, the criteria weights derived from the CRITIC method are given below in Table 3:

Table 3. Weights of the criteria from 2018 to 2022

Criteria	Weights
CATA	0.229014501
CR	0.16946319
LR	0.195163796
TPTP	0.244092497
ETA	0.162266016
TPE	**0.488559621**
ETR	0.149755512

According to the results shown in Table 3, by far the Total Premiums Received-to-Equity (TPE) criteria stand out as the most influential factor, which is followed by the Technical Profit-to-Total Premiums Received (TPTP) and Current Assets-to-Total Assets (CATA) criterions. Considering the related literature, the TPE ratio is a crucial metric, indicating how many times the equity is generated through premium production and serving as a fundamental indicator of the accuracy of financial management (Tayyar et al., 2018). Simultaneously, it's important to note that an excessively high ratio can contribute to insurers facing insolvency due to the rapid growth of premium volume (Chen & Wong, 2004). In addition, according to the Regulation on the Measurement and Evaluation of the Capital Adequacy of Insurance and Reinsurance Companies and Pension Companies prepared by the Republic of Turkey Ministry of Treasury and Finance, a TPE ratio exceeding 4 is indicative of heightened risk exposure by the company, while a lower ratio is deemed unfavorable for the financial performance of the entity (Ministry of Treasury and Finance, 2015). Based on the calculations obtained before the analysis, the TPE value was obtained as 4.32 in the year 2019, with subsequent years consistently exceeding the threshold of 5. Thereby, it can be stated that during the examined period, TARSIM is discerned to be subject to financial risk. On the other hand, since the last three criterion (Equity-to-Technical Reserves, Equity-to-Assets and Current Ratio) yielded close values, indicating a similar level of criteria importance over the observed period according to the CRITIC application. In the next phase of the study, the financial performance of TARSIM over the analyzed period was assessed and compared using the EDAS and MAIRCA methods. The results generated through these MCDM methods are displayed in Table 4:

Table 4. Rankings between 2018 and 2022 by considering TARSIM's financial performance

Ranking	EDAS	MAIRCA
1	2018	2019
2	2019	2018
3	2021	2022
4	2020	2020
5	2022	2021

The results indicate that in 2018 and 2019, the best performances were observed by considering the EDAS and MAIRCA methods. Conversely, the last three years in the dataset stood out as the years with the worst financial performances. Specifically, it can be stated that these outcomes signify an overall decline in financial performance of TARSIM between 2020 and 2022. After reviewing the relevant literature to compare the outcomes of the analysis, it's apparent that there is only one study in the literature that the findings can be compared to, namely the study conducted by Pehlivan & Akpınar (2022). In light of this comparison, it can be noted that there is a similarity between the findings, as both studies include 2019 and 2018 as the years with the successful financial performances. Also when analyzing the results within the studies that utilize both methods in the literature, it can be asserted that, as observed in these studies, the EDAS and MAIRCA methods produced comparable outcomes. The overall evaluation of TARSIM's financial performance, as determined by the annual rankings from 2018 to 2022 using a double MCDM analysis, is illustrated in Figure 2 below.

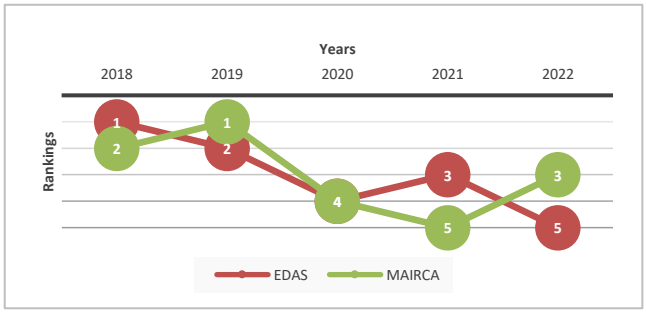

Figure 2. Financial performance comparisons based on EDAS and MAIRCA

As depicted in Figure 2, 2018 and 2019 presented favorable outlooks compared to the previous years. over the past five years. It can also be stated that TARSIM's financial performance has exhibited a consistent decline in after 2019 and persisted into 2021 by considering the MAIRCA method. Although an improvement was seen in performance of 2021 according to

the EDAS method, a notable decrease was evident in 2022. To summarize, 2018 and 2019 stands out as the year exhibiting the most robust financial performance when taking all two methods into account.

5. Discussion & Conclusion

Agriculture constitutes a crucial aspect of human civilization, serving as a fundamental pillar for society with profound ties to the global economy, biodiversity, and the historical evolution of human livelihoods. Furthermore, it plays a significant role in poverty alleviation, economic expansion, and environmental sustainability. The risks in the agricultural production are categorized into risks related to diseases, price risks caused by volatility, crimes such as theft, and risks concerning adverse weather conditions etc. (Pehlivan & Akpınar, 2022). Among these, it can be clearly stated that agriculture is exceptionally susceptible to unforeseeable natural disasters, resulting in substantial harm to human life, property, the environment, and agricultural products (Yalaz, 2023). Additionally, it is evident that the potential costs associated with these occurrences may rise in the future due to the influences of climate change. Hence, it can be affirmed that these events, risks, and uncertainties contribute to instability in the agricultural sector and variations in farmers' incomes. Hence, policymakers and governments globally adopt a direct institutional approach to minimize risks in agricultural production through the implementation of insurance coverage. In this sense, agricultural insurance is recognized as a promising tool for mitigating climate-related risks and bolstering food security (Zou et al., 2022). Agricultural insurance has a history dating back to the early 1800s, with German insurance companies initially offering protection for livestock; however, private sector offerings have primarily centered around specific products (Smith & Glauber, 2012). Today, the delivery systems for insurance exhibit wide variations across nations, and it is evident that many countries utilize agricultural insurance and subsidies as a strategic approach to mitigate the negative effects of extreme conditions, fostering a resilient and sustainable agricultural landscape. In Turkey, Şeker Insurance pioneered agricultural insurance in 1957, subsequently, in 1960, Başak Insurance broadened the coverage for a wide spectrum of plant-based products and animal life (Tekin et al., 2017). Following the approval of the Agricultural Insurance Act on June 14, 2005, TARSIM, commonly known as the Agricultural Insurance Pool, was established and initiated its activities in 2006.

In this study, the financial performance of TARSIM from 2018 to 2022 is evaluated through a comparative Multi-Criteria Decision Making (MCDM) methodology, incorporating the Evaluation based on Distance from Average Solution (EDAS) and Multi-Atributive Ideal-Real Comparative Analysis (MAIRCA) methods, utilizing objective criteria weighting via the Criteria Importance Through Intercriteria Correlation (CRITIC) method. Although TARSIM's annual reports have been accessible since 2006, the analysis excluded years up to 2018 due to the absence of data for specific financial indicators, including equity data. In this context, it can also be expressed that the study encompasses not only the global COVID-19 pandemic but also economic crisis periods. Following the guidelines of the relevant literature, eight indicators were extracted from these reports, and calculations were performed to derive seven financial performance ratios based on these criteria. On the other hand, considering some of the ratios, a threshold has also been defined in the related regulatory framework for insurance and pension companies in Turkey and an exceeding Total Premiums Received-to-Equity (TPE) ratio of 4 indicates heightened risk exposure for the company, while a lower ratio is unfavorable for financial performance. Since, calculations in this study reveal a TPE ratio of 4.32 in 2019, with subsequent years consistently surpassing the threshold of 5, it can be stated that a financial risk for TARSIM can be mentioned as a pre-analysis evaluation.

After the data collection and calculation of ratios as multiple-criteria, the CRITIC method was used to assess the importance of criteria weights. The results indicated that the TPE ratio took precedence as the most crucial criterion, followed by the Technical Profit-to-Total Premiums Received (TPTP) ratio and the Current Assets-to-Total Assets (CATA) ratio. In the next step, the financial performance of TARSIM over the studied period was investigated, employing the EDAS and MAIRCA methods for assessment and comparison. The results highlight the years 2018 and 2019 as the most successful in terms of financial performance according to both methods. Conversely, the last three years in the dataset appear as having the least favorable financial performances. To be more specific, these findings suggest an overall downturn in TARSIM's financial performance from 2020 to 2022. Given the limited availability of studies in the literature for comparison, it is noteworthy that this study shares similarities with the findings of Pehlivan & Akpınar (2022) since both studies converge in recognizing 2019 and 2018 as the years exhibiting successful financial performances. On the other hand, there are also differences in the findings, since Pehlivan & Akpınar (2022) identified 2020 as the most financially stable year; while this study's findings portray it as one of the least successful years. By analyzing the criteria weights, Pehlivan & Akpınar (2022) identified the TPTP ratio as the most crucial criterion, with the current ratio (CR) deemed of least importance; while, our findings revealed TPTP as the second most important criterion, whereas CR held the lowest level of significance. Thus, a similarity can be acknowledged in the analysis of criteria weights. When the results are compared in the context of studies that employ both EDAS and MAIRCA methods in the literature, such as those conducted by Akbari (2022), Dagli (2022), and Ecer et al. (2022), it can also be stated, as observed in these studies presented in the literature review section, the EDAS and MAIRCA methods yield similar outcomes.

The study makes a valuable contribution to the literature through several key elements. Firstly, it enhances the existing literature on TARSIM by incorporating the latest data, employing an objective criteria weighting approach, and adopting a comparative MCDM methodology. This enriches the understanding of TARSIM, an area that has been insufficiently explored in previous studies. Moreover, the research adds to academic discourse by conducting a financial evaluation of TARSIM, utilizing empirically validated financial ratios. This not only provides an analysis of TARSIM's financial stability but also offers noteworthy insights into its success. Lastly, the study contributes to the broader literature by offering a monitoring opportunity, allowing for the identification of factors contributing to the financial success observed during the top-ranked years. It is also essential to acknowledge the limitations inherent in this study. Primarily, the analysis centers on specific ratios within the realm of financial performance assessment. Furthermore, the existence of incomplete data compelled the exclusion of years predating 2018, introducing the possibility of impacting the conclusive findings. Additionally, the employed methodology restricted itself to only two MCDM methods, neglecting various other methodologies present in the existing literature. On the other hand, the study includes not only the global COVID-19 pandemic but also periods of economic crisis. Consequently, when analyzing the obtained results, the limitations associated with this factor should also be taken into consideration. In terms of the implications for policymakers and stakeholders, an exploration and replication of the factors contributing to the financial success observed in 2018 and 2019 would be valuable. Understanding the strategies and practices that led to

positive outcomes can inform future policy decisions. Furthermore, given the fluctuating financial performance across the studied years, regular assessments are crucial for policymakers to identify trends, promptly address challenges, and capitalize on successful periods. As the dataset excludes years before 2018, prioritizing efforts to enhance data availability and quality is imperative for comprehensive and accurate analyses, ensuring a thorough understanding of TARSIM's financial performance. Finally, considering the Total Profitability Equity ratio surpassing the regulatory threshold, policymakers should investigate the reasons behind this deviation, since a thorough examination of potential impacts on risk exposure is essential, leading to the implementation of proactive measures to mitigate emerging financial risks in the agricultural insurance sector. In future studies, a comparative analysis focusing on the periods before and after the pandemic could be conducted. Furthermore, as the content of the dataset increases in the coming years, it may be feasible to undertake a study exclusively concentrating on the post-pandemic period. It is also advisable to include a more comprehensive set of ratios validated by existing literature, enabling the utilization of more extensive datasets for similar performance analyses. Additionally, broadening the scope of this study can be achieved by exploring alternative and integrated approaches, such as data mining and other MCDM methods. Finally, conducting cross-country comparisons of agricultural insurance can provide insights into proactive measures aimed at enhancing the financial performance of these insurance schemes.

Author Contribution Rate Statement

The study was carried out by author Hasan Arda Burhan.

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