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Comparing universities' activities: A study of the Thrace Region

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ABSTRACT

Many researchers in the economic literature have accepted capital as one of the elements of economic development. Capital is generally classified into two groups: human capital and physical capital. The concept of human capital includes efforts to provide qualifications to the workforce. Education is considered to be one of the most important factors that provide qualifications for the workforce. The most important wealth of universities is their human resources, which are not only limited to technological infrastructure and devices, but also provide a high level of interaction in education, research and social contributions. In addition, universities supply the workforce with the requisite skills of the day and facilitate the flow of information to industries utilizing technical advancements through the human resources they cultivate. Thus, the efficiency and effectiveness of universities become important for economic development. In this context, in the study, universities in the Thrace Region are compared in terms of effectiveness. Comparisons were made using data between 2019 and 2021 as input to the entropy weighted TOPSIS method, which is one of the decision-making methods. According to the findings of the entropy method, it was found that the most important criterion was the rate of expenditure on R&D.

Keywords: university, entropy, TOPSIS

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INTRODUCTION

According to Deming (2023), a significant accomplishment of the economics profession, including both forecasting and policy influence, is human capital theory. Over the last 70 years, the global percentage of individuals possessing at least some secondary education has risen from 13 percent to 51 percent, and the proportion with some university education has escalated from 2.2 percent to 14.6 percent, virtually a sevenfold increase (Lee & Lee, 2016). In the same timeframe, US education expenditures as a proportion of GDP have more than quadrupled, with growth rates surpassing those of emerging nations. Human capital theory posits that education and training are investments, with initial expenses incurred upfront and subsequent gains realized via enhanced productivity and profits (Deming, 2023). Thus far, the dominant emphasis of labor and education economists has been on microeconomic applications of human capital theory. Education enhances the marginal productivity of labor, therefore elevating income levels. Increased financial returns lead individuals to engage more in their education, among other pursuits. A fundamental and well-documented finding in the social sciences is the causal link between education and income. Harmon and Walker (1995) analyzed the education reforms enacted in England and Wales in 1947 and 1972, concluding that these measures considerably elevated the population's income by 15%. Further study using the same technique indicates that compulsory schooling positively influenced earnings in Spain and Italy (Brunello & Miniaci, 1999; Pons & Gonzalo, 2002). The value of skills obtained in educational institutions is contingent upon the production technology used in the workplace and the overarching macroeconomic context (Deming, 2023). Higher education and the workplace are distinct social domains, each with its own history, customs, roles, and requirements. This does not imply that work and further education are disconnected (Marginson, 2015). Graduation correlated with enhanced employability and income (OECD, 2014).

Many investigations have shown the advantageous impact of university scientific research on regional innovation via knowledge spillovers (Bai, 2013; Hong et al., 2019). The enactment of the Bayh-Dole act in 1980, which integrated the objectives of education, research, and scientific commercialization for socioeconomic advancement, sparked an academic revolution in the United States. The legislation conferred to universities the authority to patent discoveries created with government financing. Universities were authorized to have commercial partnerships with enterprises. The link between R&D and university research in American business has historically existed; but,

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Table 1. Criteria

No	Criterion
1	Number of print books per student
2	Number of publications per faculty member published in nationally refereed journals
3	R&D budget rate
4	Number of e-publications per student
5	Number of publications per faculty member published in SCI, SCI-Expanded, SSCI, and AHCI indexed journals
6	Amount of expenditure per student

current developments, especially the rise in university patenting and technology licensing to private enterprises, have markedly intensified since the enactment of the Bayh-Dole act. Following the enactment of the 1980 Bayh-Dole act, patenting and licensing activities at USA colleges saw a substantial surge (Mowery et al., 2002). Cristo-Andrade and Ferreira (2018) assert that this legislation converted conventional teaching and research universities into entrepreneurial institutions. Entrepreneurial universities engage in creative institutional arrangements with companies and research centers to develop and implement new, sustainable technologies and knowledge.

Contemporary universities prioritize innovation, striving to not only develop novel ideas but also to implement knowledge in practical applications. It is widely accepted that innovations may address future challenges by amalgamating concepts and creative endeavors from past experiences (Bartel & Garud, 2009). Traditionally regarded as technical events, innovations may also include enhancements and discoveries that improve corporate or institutional operations and elevate living standards (Marczewska et al., 2023). Alongside the present socioeconomic developments, innovation systems are seen to have developed via the contributions of universities. Innovative concepts are surfacing in both public and scientific domains about the evolving responsibilities of universities in modern society. The function of universities has seen to have broadened in the last two decades. University-society interaction is recognized as a complex phenomenon with three primary elements: reciprocal advantage, diverse partnerships and collaborative efforts, and the objective of promoting societal advancement (Farnell, 2020, p. 32). Universities are interconnected via an extensive network of linkages and interdependencies with many local, regional, and global institutions. The influence of universities on communities and society mostly pertains to the residents in proximity to university campuses. Universities influence not just their students but also the surrounding community. Moreover, technological advancements facilitate a worldwide influence (Morawska-Jancelewicz, 2022). The efficacy of universities is vital due to their substantial contributions to society. This research will evaluate the efficacy of universities in the Thrace area.

LITERATURE REVIEW

The efficacy of universities has lately emerged as a significant study domain owing to their societal benefits. A literature study indicates that several studies assess institutions based on their efficacy.

Özgüven (2011) used the AHP approach to compare foundation universities in Izmir in order to analyze students' university selections. The research identified the primary factors as follows: tuition, academic personnel, course offerings, and enrollment limits.

Ömürbek et al. (2014) conducted a comparative analysis of 10 institutions in Anatolia, founded in 1992 and 1993, using the VIKOR and TOPSIS methodologies across 21 categories. The authors' results indicate that Süleyman Demirel University is the most effective institution.

Aliyev et al. (2020) conducted a comparative analysis of five United Kingdom colleges using the fuzzy AHP approach, utilizing four criteria: teaching, research, citations, and worldwide reputation. The authors propose that the fuzzy AHP method may enhance system consistency by computing the coefficient of variation for each solution and aid in prioritizing. Utilizing the emphasized fuzzy AHP feature, five colleges were rated based on the eigenvectors derived from the computed binary matrices, after a consistency verification across all criteria and alternatives.

Wang et al. (2022) conducted a research analyzing Taiwanese institutions via the entropy-weighted TOPSIS approach based on seven criteria. The authors' data indicate that HUTECH is the most effective university.

Karahan and Kızkapan's (2022) research used the Promethee technique to assess institutions based on scientific competency, intellectual property, cooperation and interaction, economic contribution, and commercialization data derived from the TUBITAK innovative university index. The data indicate that METU and Sabancı University were the two most effective institutions in 2021.

DATA AND METHODOLOGY

The entropy-weighted TOPSIS approach was chosen because of its ability to combine a proven ranking mechanism (TOPSIS) with an objective weighting process (entropy) (Hwang & Yoon, 1981). In contrast to AHP, which depends on subjective pairwise comparisons (Saaty, 2013), and PROMETHEE, which necessitates preference functions that could introduce bias (Brans & Vincke, 1985), entropy-weighted TOPSIS makes things more transparent and less subjective (Wang & Lee, 2009). Therefore, given the nature of our dataset and the objective of this study, entropy-weighted TOPSIS was considered the most appropriate method. This assessment assesses the performance of Trakya University, Kırklareli University, and Tekirdağ Namık Kemal University based on six factors from 2019 to 2021. The criteria used are enumerated in **Table 1**.

The entropy approach is a methodology used to impartially assign weights to data. The components of the decision matrix are first normalized by dividing them by their respective column totals. The standardization procedure yields the p-value. p-values are transformed into E_j using the following formula: $E_j = -k \sum_{i=1}^{m} p_{ij} \ln p_{ij}$.

Entropy-weighted TOPSIS, a prevalent methodology, was used to do the study. TOPSIS, a method first presented by Hwang and Young (1981), is an efficient multi-criteria decision-making technique. The

Table 2. Criteria weights

Criterion	Weight
Number of print books per student	0.022255300
Number of publications per faculty member published in nationally refereed journals	0.012784745
R&D budget rate	0.800533245
Number of e-publications per student	0.087815800
Number of publications per faculty member published in SCI, SCI-Expanded, SSCI, and AHCI indexed journals	0.031259200
Amount of expenditure per student	0.045351720

core principle of TOPSIS is predicated on the proximity of a chosen alternative to the ideal positive solution and its distance from the least favorable alternative, the negative solution (Hwang & Young, 1981). The TOPSIS approach, when applied to intricate decision-making processes, facilitates the analysis of many factors and yields valuable insights for identifying the ideal answer (Karşılı & Öncü, 2022). The procedures of the TOPSIS approach are outlined below (Karşılı & Öncü, 2022):

Step 1. Creating the Decision Matrix

The first phase of the procedure involves the collection of data as well as the creation of the matrix: $A_{ij} = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \cdots & a_{mn} \end{bmatrix}$. A_{ij} matrix is denoted by the letter m, which stands for the number of decision points, and the letter n, which stands for the number of evaluation factors.

Step 2. Creating the Standard Decision Matrix

Through the process of standardizing the information included inside the decision matrix, the following decision matrix may be generated: $r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}}$. The structure of the R matrix is given below: $R_{ij} = \begin{bmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{bmatrix}$.

Step 3. Creating the Weighted Standard Decision Matrix

To create the weighted standard decision matrix, the weights found using the entropy method are multiplied by the elements of the R matrix: $V_{ij} = \begin{bmatrix} w_1 r_{11} & \cdots & w_n r_{1n} \\ \vdots & \ddots & \vdots \\ w_1 r_{m1} & \cdots & w_n r_{mn} \end{bmatrix}$.

Step 4. Ideal (A^*) and Negative Ideal (A^-) Solutions

For the purpose of determining the optimal solution values, the highest values taken from the V matrix are used. The minimal value of the relevant unit will be taken into consideration in the event that a negative component is present in the matrix.

$$A^* = \left\{\left(\max_i v_{ij} | j \in J\right), \left(\min_i v_{ij} | j \in J\right)\right\}.$$

The set to be calculated from the above formula can be expressed as $A^* = \{v_1^*, v_2^*, \ldots, v_n^*\}$.

The minimum values in the V matrix are taken into consideration in order to generate negative ideal solution values. When a negative component is present in the matrix, the highest possible value of that unit will be used to calculate the result.

$$A^- = \left\{\left(\min_i v_{ij} | j \in J\right), \left(\max_i v_{ij} | j \in J'\right)\right\}.$$

The set to be calculated from the above formula can be expressed as $A^- = \{v_1^-, v_2^-, \ldots, v_n^-\}$.

Table 3. TOPSIS ranks

	2019	2020	2021
Trakya University	1	1	1
Kırklareli University	3	3	2
Tekirdağ Namık Kemal University	2	2	3

In the equations, J represents the value of the gain (maximization), while J' represents the value of the loss (minimization).

Step 5. Calculating Separation Measures

Measures of ideal separation (S_i^*) and negative ideal separation (S_i^-) are used in the process of calculating the deviation values for the decision points. This is accomplished via the utilization of the Euclidean distance approach: $S_i^* = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^*)^2}$ and $S_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^-)^2}$.

The quantity of S_i^* and S_i^- that has to be computed in this situation will, of course, be equivalent to the total number of choice points.

Step 6. Calculating Relative Closeness to the Ideal Solution

Ideal and negative ideal separation values are used to determine the relative closeness of each decision point to the ideal. In order to rank the solutions according to their magnitude, this relative proximity to the solution is taken into consideration: $C_i^* = \frac{S_i^-}{S_i^- + S_i^*}$.

FINDINGS

In the beginning, the entropy approach was used to determine the weights of the criterion for the year 2021. **Table 2** offers a breakdown of the weights. The budget that is spent on research and development is the most essential factor, as shown in **Table 2**.

The results of the TOPSIS approach, which are based on the weights that were discussed before, are shown in **Table 3**.

The findings of the TOPSIS rating indicate that Trakya University has obtained the highest efficiency scores. The most essential factor for this ranking is the amount of money spent on research and development. A gain in efficiency ratings was seen at Kırklareli University in 2021, however Tekirdağ Namık Kemal University had a decline in efficiency scores during the same year.

CONCLUSION

All of the intellectual property that was produced by colleges in the United States as a result of research that was financed by the government was held by the state. As a result, it was unusual for educational institutions to commercialize their results before to the year 1980 (Mowery et al., 2002). However, with the passage of the trademark

disclosure act in 1984 and the Bayh-Dole act in 1980, colleges were allowed the authority to protect their intellectual property for discoveries that were developed with government assistance. Due to the fact that these legislation developed the infrastructure for technology transfer, higher education institutions were supplied with considerable extra incentives to patent and license their ideas (Hausmann, 2022). The modification of this law resulted in an increase in the number of contacts that colleges have with the business sector and made it easier for institutions to share their creative ideas with industry. Universities, as a result, became significant players in the process of economic growth. When seen in this light, the activities of universities stand out as very important for growth.

Ranking studies on universities based on criteria are revealed by a survey of the literature (Ömürbek et al., 2014; Wang et al., 2022). Similar to this study, several studies have assessed institutions according to certain standards and have consistently demonstrated the top performance. The purpose of this research was to evaluate institutions located in the Thrace area by using six criteria that were contained in the reports produced by the Council of Higher Education. According to the findings of the study, the most significant factor was the amount of money allocated to research and development. University R&D initiatives promote the creation of scientific knowledge and creative solutions, which advances both academic and societal advancement. By increasing the university's competitiveness on a national and worldwide scale, they also promote sustainable development. According to the results of TOPSIS, Trakya University was the university that received the highest overall performance. The three years of data used in the study don't represent long-term changes. Changes throughout time can therefore be seen if future research has access to lengthier data periods.

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