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Ranking of Countries according to the Index of Economic Freedom with Multicriteria Decision making Methods

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Every investor wants to conduct their economic or commercial activity in a country with ease. Economic freedom refers to the public limitations that individual or institutional investors must abide by in order to conduct their business. Individual or institutional investors have the chance to produce, consume, and invest more in nations with high levels of economic freedom. If a nation has a high level of economic freedom, it means that institutions and norms are founded and that the economy runs under free market circumstances. Individual or institutional investors are protected and their legal rights are upheld by the public authorities. In this study, the level of tariffs in the country, the presence of restrictions on foreign investments and capital, the black market situation, the taxation system in the country, the presence and importance of the public sector in the economy, the inflation in the country, the country's inflation, and the country's level of tariffs are all taken into account on a country-by-country basis. The study was conducted by the Heritage Foundation, which has its headquarters in the United States since 1996. Independence of the banking and financial sectors, controls on the prices of products and services and employee wages, regulation and regulation, investor property rights, etc. The data of the "Economic Freedom Index", which consists of fourteen basic criteria including all stages, were examined. This index consists of ten and includes these criteria. With this study, entropy-weighted multi-qualified benefit for the criteria and weights determined in the index calculated by the Heritage Foundation. It aims to provide a fresh option by ranking the "Economic Freedom Index" for all the study's participating nations using the MAUT approach.

Keywords: *multi-criteria decision making, economic freedom index, entropy, MAUT*

JEL Codes: *C43, C44, C61, D73*

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Introduction

Economic freedom is a framework in which people or organizations are not subject to any limitations on their economic and commercial activity. Organizations like Freedom House, the Fraser Institute, and the Heritage Foundation have been sharing this idea for many years, using it to calculate economic freedom indexes for all nations worldwide. The degree of economic freedom provides details about a variety of societal issues, particularly the country's economic structure. Overall, it demonstrates how freely financial and economic activity like production, consumption, and market investment can be carried out. Economic freedom is a crucial requirement for the prosperity and development of a nation. Also, countries with high levels of economic freedom have the capacity to generate more income to attract more tourists by increasing their foreign direct investment.

According to the Heritage Foundation, the fundamental right of each person to manage their property and labor is known as economic freedom. People can work, create, consume, and invest as they like in a society where there is economic freedom. In these civilizations, there is no excessive government intervention that might restrict people's freedoms, allowing for the free flow of people, wealth, and things. The ability to manage one's own property without infringing on the rights of others is thus a necessary component of economic freedom. Governments and other institutions need to safeguard this freedom in order to create a vibrant economy and a democratic society (The Heritage Foundation 2022).

The Economic Freedom Index (EFI) examines how and at what level institutional practices and policies adopted by nations around the world effect economic freedom. From this aspect, examining the EFI has always been popular on some fields such as econometrical analysis, multivariable statistical analysis etc. (Hanke and Walters 1997, Caudill et al. 2000, De Haan and Sturm 2000, Berggren 2003, Justesen 2008, Rode and Coll 2012, Heckelman 2019). On the contrary, Multi-Criteria Decision Making Methods (MCDM) are convenient to figure out these kind of multivariable complex systems. When there are numerous competing criteria that need to be considered and need to be solved, MCDM includes techniques that can be applied under either certainty or uncertainty. Regarding this, it is possible to find studies that examining EFI in different ways with MCDM techniques. Some of these studies are focus on to create new indexes (Balcerzak and Pietrzak 2016, Ecer and Zolfani 2022) while most of them focus on ranking countries based on different economic indicators including EFI (Altin 2020, Özkaya 2022, Karakoy et al. 2023, Puska et al. 2023). Based on the rough literature researches, it has been thought that creating indexes are less preferred. Consequently, the main motivation of this study is creating EFI by one of the MCDM techniques is entropy-weighted Multi Attribute Utility Theory (MAUT). In this way the study is conducted by the Heritage Foundation and the data include ten of main fourteen basic criteria of EFI besides all stages. Within the framework of this analysis the main criteria are examined in this paper are "The economic size of the state", "The functioning of the legal system in the country and the security of the property rights of individuals", "The soundness of the country's currency", "Freedom of international trade" and "Regulations". It has been thought that the

study may provide a fresh option by ranking the EFI for all the study's participating nations using the MAUT approach.

Based on the motivation of this paper, the Materials and Methods will introduced in Section 2; Application and the Results will be shared in Section 3 and lately Conclusion and Discussion will be presented at the last section which is Section 4.

Materials and Methods

The term "multi-criteria decision making" (MCDM) refers to the process of making decisions based on a number of competing and often contradictory criteria. According to its definition, MCDM is "a general branch of operations research models for a comprehensive biophysical and socio-economic system in which complex problems involving high uncertainty, competing objectives, various data and information types, and multiple interests and perspectives can be addressed." (Wang et al. 2009).

When using MCDM techniques, the decision maker can choose from a variety of methodologies to determine the best alternative when searching for a solution to a specific problem. These techniques, which are based on various theoretical rules, seek to identify the most appropriate solutions to be generated for a problem. The characteristic that distinguishes this strategy as the best in this situation is the decision maker's selection of the best approach to address the issue at hand (Linkov et al. 2004).

The method's success is mostly due to how the weights of the criteria are set. The Entropy approach will be utilized to establish the criterion weights in the initial phase of the investigation. A technique for establishing the objective weights of criteria or features in the decision-making process is the entropy weights method. This approach is based on the use of probability theory to compute the entropy of uncertain information. Entropy is a metric for a system's predictability or degree of order. These entropy values are used by the decision-maker to assess the significance of each response parameter. The primary goal is to establish which criterion or attribute has a larger weight index value, as this indicates a higher value (Chodha et al. 2022). Even entropy is a technique for obtaining objective weights this approach isn't always the best or the only one that works. It should be keep on mind that depending on variables including context, data, and the decision maker's preferences, the approach employed in the decision-making process may change.

The procedure for measuring entropy weight is as follows (Hussain and Mandal 2016):

i. The decision matrix is first created. The performance of options as measured by several criteria is included in this decision matrix.
ii. This step contains the normalization of the decision matrix. This is a step toward measuring each criterion's performance on the same scale.

iii. The entropy value—the likelihood that each criterion or characteristic in the normalized decision matrix will occur—is computed. This demonstrates how consistent or predictable the requirements or characteristics are.
iv. Each response's divergence from the mean (the information it provides) is calculated. This speaks to how distinct each decision matrix element is from the others.
v. The weight index value associated with each criterion or attribute is then calculated. A lower weight index value will be assigned to criteria or attributes with higher entropy levels.

The multi attribute theory (MAUT) will be applied for the study's second phase, which aims to comparison of the nations. MAUT is very helpful in resolving complicated decision problems because it enables the decision maker to strike a balance between several goals or objectives. By giving several goals varying degrees of importance, the methodology enables the prioritization of many goals. When multiple objectives cannot be quantified or compared on the same scale, this prioritizing offers a considerable advantage (Salvendy 2001). According to Dillon and Perry (1977) states that MAUT can be applied when a number of criteria are ambiguous, and he determines the optimum course of action by weighing the significance of each criterion. The method's flexible structure enables multiple outputs to be produced in accordance with various scenarios, hence lowering uncertainty and risk.

MAUT assists decision-makers in reaching more consistent, transparent, and logical conclusions by methodically addressing the stages in the decision-making process. To execute the strategy, nevertheless, requires considerable training and experience because it can be complicated and computationally demanding (Wendt and Vlek 1973).

The stages of MAUT method implementation are defined below (Eren 2017):

i. The determination of the matrix is made as a preliminary step.
ii. The second phase is selecting the criteria that the decision-maker will take into account, as well as computing and weighting the benefit or cost function for each criterion.
iii. The choice matrix has been normalized. The advantage is computed. Finding the biggest and lowest values.
iv. The weighting criteria are chosen.
v. For each option, the weighted total utility is computed.
vi. The option with the greatest weighted overall utility is chosen.

The MAUT approach also needs a more thorough study in addition to these phases. For instance, while qualitative assessments are sometimes made, other times Go/No Go judgements (Yes/No) are made. When using MAUT, it's crucial to establish priorities, goals, mathematical models, and weighting variables. The highest usefulness level for a given attribute value is assigned a value of 1 (one), while the lowest usefulness level is assigned a value of 0 (zero). Estimation can be used to calculate values in the range of 0 and 1 (De Freitas et al. 2013).

Analysis and Results

In this study, some sub-criteria employed from the Heritage Foundation used for the calculation of EFI. These sub-criteria can be listed as: C1-Tariff Rate (%), C2-Income Tax Rate (%), C3-Corporate Tax Rate (%), C4-Tax Burden % of GDP, C5-Government Expenditure % of GDP, C6-Population (Millions), C7-GDP (Billions, PPP), C8-GDP Growth Rate (%), C9-5 Year GDP Growth Rate (%), C10-GDP per Capita (PPP), C11-Unemployment (%), C12-Inflation (%), C13-FDI Inflow (Millions), C14-Public Debt (% of GDP). For the analysis, the 2021 and 2022 EFI data set published by the Heritage Foundation is used. Also, 173 countries whose values are given in full in the relevant data set were taken as alternatives.

Using the entropy approach, weight values for 14 criteria values for each year were computed in the analysis' initial phase.

Table 1. *Normalized Decision Matrix Values for 2021*

Countries / Criteria	C1	C2	C3	C4	C5	C6	C7	.	.	C13	C14
Afghanistan	0.0044	0.0041	0.0050	0.0026	0.0053	0.0051	0.0005	.	.	0.0000	0.0007
Albania	0.0028	0.0047	0.0037	0.0051	0.0055	0.0004	0.0003	.	.	0.0008	0.0067
Algeria	0.0106	0.0071	0.0065	0.0103	0.0073	0.0057	0.0048	.	.	0.0009	0.0045
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.
Vietnam	0.0097	0.0069	0.0085	0.0066	0.0067	0.0038	0.0014	.	.	0.0006	0.0227
Zambia	0.0042	0.0071	0.0050	0.0051	0.0041	0.0129	0.0071	.	.	0.0107	0.0042
Zimbabwe	0.0065	0.0076	0.0087	0.0045	0.0050	0.0024	0.0005	.	.	0.0005	0.0084

In the second step, as it is mentioned above, using the normalized decision matrix given in Table 1, the Entropy (E_j) value and $P_jLN(P_j)$ values were found and shown in Table 2.

Table 2. *$P_jLN(P_j)$ Values for 2021*

Countries / Criteria	C1	C2	C3	C4	C5	C6	C7	.	.	C13	C14
Afghanistan	-0.024	-0.022	-0.026	-0.015	-0.028	-0.027	-0.004	.	.	0.000	-0.005
Albania	-0.016	-0.025	-0.021	-0.027	-0.029	-0.003	-0.002	.	.	-0.006	-0.034
Algeria	-0.048	-0.035	-0.033	-0.047	-0.036	-0.030	-0.025	.	.	-0.006	-0.024
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.
Vietnam	-0.045	-0.034	-0.040	-0.033	-0.034	-0.021	-0.009	.	.	-0.005	-0.086
Zambia	-0.023	-0.035	-0.026	-0.027	-0.022	-0.056	-0.035	.	.	-0.048	-0.023
Zimbabwe	-0.033	-0.037	-0.041	-0.024	-0.027	-0.014	-0.004	.	.	-0.004	-0.040

After finding the $P_jLN(P_j)$ values in Table 2 above, the next stage was finding the Entropy (E_j) value and (d_j) values showing the uncertainty of the E_j value. These values are displayed in Table 3. In that time during the analysis, following formula is used $k = 1 / LN(N) = 1 / LN (173) = 0.194$ for the calculation of Entropy (E_j) value which shown in Table 3.

Table 3. *Entropy (E_j) and (d_j) Values for 2021*

Criteria	C1	C2	C3	C4	C5	C6	C7	.	.	C13	C14
Entropy (E_j)	0.957	0.964	0.977	0.972	0.984	0.692	0.667	.	.	0.693	0.963
d_J	0.043	0.036	0.023	0.028	0.016	0.308	0.333	.	.	0.307	0.037

In the last step, weight values were calculated for each criterion value using the (d_j) values, which indicate the uncertainty of the E_j value, and are given in Table 4. Accordingly, the weight values calculated for the year are given in Table 5. The total value of the importance levels of all criteria is equal to 1 (one). It should be noted here that, all the steps given above are implemented and illustrated in the 2021 dataset. Only the final results of the 2022 analysis were published here because doing so would take up a substantial amount of space. These findings can also be made available by the authors upon request. To sum up, the weight values calculated for the year 2022 after all similar steps are given in Table 5.

Table 4. *Entropy Criteria Weights for 2021*

Criteria	C1	C2	C3	C4	C5	C6	C7	.	.	C13	C14
Weights	0.019	0.016	0.010	0.012	0.007	0.132	0.143	.	.	0.132	0.016

Table 5. *Entropy Criteria Weights for 2022*

Criteria	C1	C2	C3	C4	C5	C6	C7	.	.	C13	C14
Weights	0.029	0.013	0.009	0.011	0.006	0.115	0.122	.	.	0.122	0.015

When the weight values given in Table 4 and Table 5 are examined, in the evaluation of the countries; while the C5 - Government Expenditure % of GDP criterion has the least importance, the C12 - Inflation (%) criterion has the highest importance level.

At this point in the study, an alternative index value was generated for each country employing the MAUT technique in place of the Heritage Foundation's economic freedom index, using the weight values listed in Tables 4 and 5.

Table 6. *Decision Matrix for the MAUT Methods for 2021*

Countries / Criteria	Min C1	Max C2	Min C3	Min C4	Max C5	Max C6	Max C7	Makx .	Min .	Max C13	Min C14
Afghanistan	5.7	20.0	20.0	9.3	28.2	38.0	76.6	.	.	38.5	7.3
Albania	3.6	23.0	15.0	18.6	29.1	2.9	39.8	.	.	1281.3	68.8
Algeria	13.8	35.0	26.0	37.2	38.5	43.1	668.8	.	.	1381.9	46.3
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.
Vietnam	5.5	35.0	20.0	18.5	21.6	96.5	1001.5	.	.	16120.0	42.9
Zambia	8.4	37.5	35.0	16.2	26.8	17.9	75.9	.	.	753.2	85.7
Zimbabwe	12.0	51.5	24.0	20.7	18.8	14.6	39.7	.	.	280.0	11.0
Max. value	***22.1***	***60.0***	***50.0***	***46.1***	***86.9***	***1397.7***	***27307.0***	.	.	***246215.0***	***265.8***
Min value	***0.00***	***0.00***	***0.00***	***0.06***	***11.48***	***0.10***	***0.40***	.	.	***0.00***	***2.50***
Max - Min	***22.1***	***60.0***	***50.0***	***46.0***	***75.4***	***1397.6***	***27306.6***	.	.	***246215.0***	***263.3***

Table 7. *Normalized Decision Matrix Values for 2021*

Countries / Criteria	C1	C2	C3	C4	C5	C6	C7	.	.	C13	C14
Afghanistan	0.7421	0.3333	0.6000	0.8003	0.2219	0.0271	0.0028	.	.	0.0002	0.9818
Albania	0.8371	0.3833	0.7000	0.5981	0.2337	0.0020	0.0014	.	.	0.0052	0.7482
Algeria	0.3756	0.5833	0.4800	0.1936	0.3581	0.0308	0.0245	.	.	0.0056	0.8336
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.
Vietnam	0.7511	0.5833	0.6000	0.6005	0.1344	0.0690	0.0367	.	.	0.0655	0.8466
Zambia	0.6199	0.6250	0.3000	0.6502	0.2025	0.0127	0.0028	.	.	0.0031	0.6840
Zimbabwe	0.4570	0.8583	0.5200	0.5525	0.0973	0.0104	0.0014	.	.	0.0011	0.9677

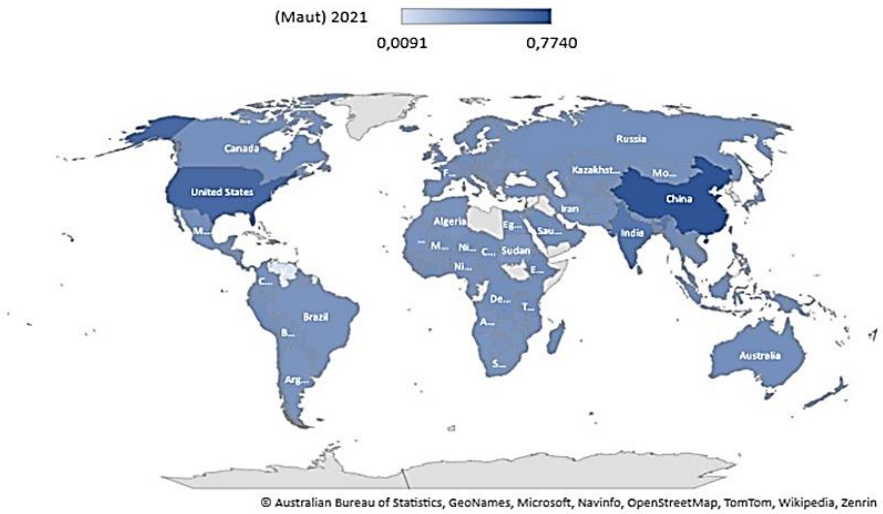
Table 8. *Marginal Utility Scores (R_i) for 2021*

Countries / Criteria	C1	C2	C3	C4	C5	C6	C7	.	.	C13	C14
Afghanistan	0.4295	0.0687	0.2534	0.5248	0.0295	0.0004	0.0000	.	.	0.0000	0.9484
Albania	0.5937	0.0926	0.3698	0.2515	0.0328	0.0000	0.0000	.	.	0.0000	0.4388
Algeria	0.0886	0.2370	0.1515	0.0223	0.0800	0.0006	0.0004	.	.	0.0000	0.5869
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.
Vietnam	0.4433	0.2370	0.2534	0.2539	0.0107	0.0028	0.0008	.	.	0.0025	0.6126
Zambia	0.2740	0.2795	0.0551	0.3077	0.0245	0.0001	0.0000	.	.	0.0000	0.3489
Zimbabwe	0.1358	0.6369	0.1816	0.2087	0.0056	0.0001	0.0000	.	.	0.0000	0.9070

Table 9. *Ultimate Benefit Points for 2021*

Countries	R_i^*
Afghanistan	0.4472
Albania	0.4394
Algeria	0.4292
.	.
.	.
Vietnam	0.4700
Zambia	0.4321
Zimbabwe	0.4345

Figure 1. *Country Rankings by Entropy-Weighted MAUT Model for 2021*



After all initial calculations, it is possible to see middle steps to reach new ranking scores of countries between Table 6 to 9. Then finally a map is generated based on these ranking scores in Figure 1. Figure 1 demonstrates the country comparisons performed using the entropy-weighted MAUT model (2021) as map. Based on the map on Figure 1, China, the United States, India, Ireland, Luxembourg, Singapore, Rwanda, Qatar, Ethiopia, the United Arab Emirates, and the Netherlands hold the top spots for the economic liberties index. The following are the nations with the lowest scores on the economic freedoms index: Venezuela, Sudan, Saint Vincent and the Grenadines, Saint Lucia, Argentina, Lesotho, Tunisia, Belize, Namibia, So Tomé and Principe, and Barbados. According to the research, island nations come in last.

The 2022 data set performed each of the procedures described above, and Table 10 contains the final benefit point values that were computed for the calendar year 2022.

Table 10. *Ultimate Benefit Points for 2022*

Countries	$\mathbf{R_i^*}$
Afghanistan	0.3089
Albania	0.3031
Algeria	0.2920
.	.
.	.
Vietnam	0.3208
Zambia	0.2900
Zimbabwe	0.1492

Figure 2. *Country Rankings by Entropy-Weighted MAUT Model for 2022*

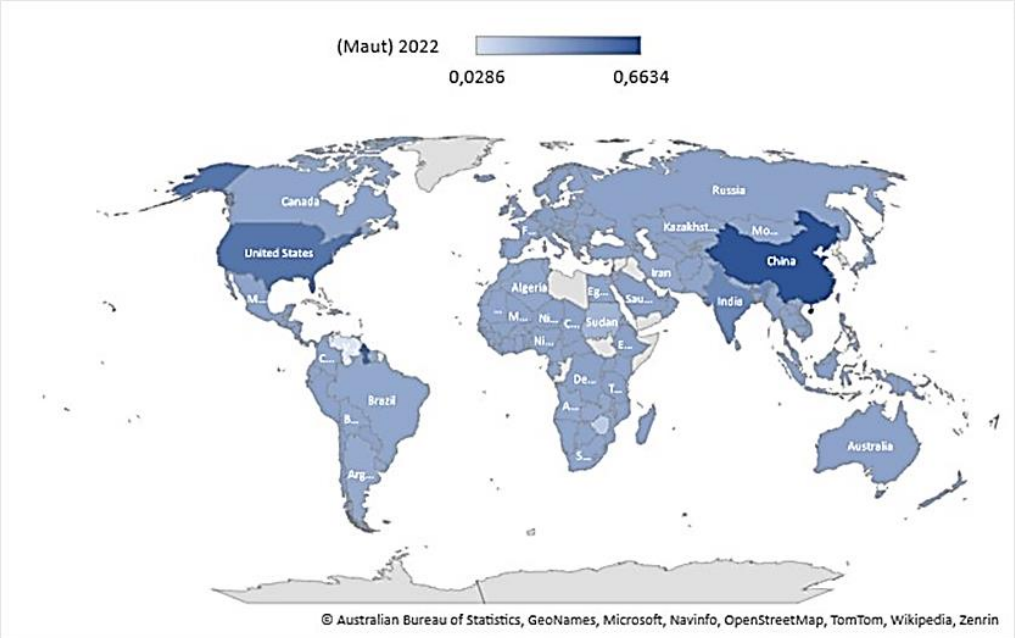


Figure 2 demonstrates the country comparisons performed using the entropy-weighted MAUT model as map for 2022. Based on this map on Figure 2, country

comparisons performed using the entropy-weighted MAUT model (2022), China, Guyana, the United States, India, Luxembourg, Singapore, Ireland, Qatar, the United Arab Emirates, and Taiwan hold the top spots for the economic liberties index. Venezuela, Zimbabwe, Sudan, Lebanon, Argentina, Suriname, Belize, Saint Vincent and the Grenadines, Saint Lucia, Iran, and Barbados made the list of the least free economies. Like in 2021, island nations continue to rank bottom in 2022.

The Spearman rank correlation values between the rankings of the countries made according to the Heritage Foundation's Economic Freedom Index and the rankings of the countries made according to the Entropy-weighted MAUT model suggested in the study were examined to see how well the proposed model agreed with the original model. The results of the Spearman correlation are presented in Tables 11 and 12.

Table 11. *Spearman Rank Correlation Results for 2021*

		Heritage 2021	MAUT 2021
Heritage 2021	Spearman Rho Correlation Coef.	**1.000**	0.400**
	Sig. Level (P)		0.000
MAUT 2021	Spearman Rho Correlation Coef.	0.400**	**1.000**
	Sig. Level (P)	0.000	

** Correlation is significant at the 0.01 level (2-tailed).

Table 12. *Spearman Rank Correlation Results for 2022*

		Heritage 2022	MAUT 2022
Heritage 2022	Spearman Rho Correlation Coef.	**1,000**	0.412**
	Sig. Level (P)		0.000
MAUT 2022	Spearman Rho Correlation Coef.	0.412**	**1.000**
	Sig. Level (P)	0.000	

** Correlation is significant at the 0.01 level (2-tailed).

Based on Tables 11 and 12 above, it was determined that there was a statistically significant correlation between the proposed alternative ranking mechanism and the Heritage Foundation's ranking for economic freedom in both periods.

Discussion and Conclusion

Investors and business owners can compete freely on the market and provide cutting-edge goods and services because of economic freedom. Economic growth and welfare are thereby increased. However, there are several issues that can arise in a perfectly free market. For this reason, the state should be effective in handling issues like market regulation, preventing the establishment of cartels and monopolies, and eliminating unfair competition in the market. However, these interventions should be reasonable and shouldn't cause the market to become unstable. Economic freedom, therefore, benefits consumers as well as investors and business owners.

The market becomes more competitive as a result of consumer demands and preferences, which leads to lower pricing, higher quality, and a wider variety of goods. In this sense, economic independence is crucial for nations with advantageous investment climates and markets where conducting business is simple and secure. As a result, it is simpler to entice investment in the nation, unemployment is decreased, national income is raised, and living situations for the populace are improved. The state must nevertheless play a regulatory role in the market during this process, and its interventions must not be excessive.

This study's main motivation is generate a different approach to calculation of Economic Freedom Index (EFI) that used by the Heritage Foundation. Based on this aim, the entropy-weighted MAUT was applied in light of the significance of economic freedom for countries as it is thought that using multi-criteria decision-making approach may help to generate an alternative index for such a complex system. The Heritage Foundation's 2021 and 2022 economic freedom index statistics are analyzed and the new rankings of countries are suggested depend on the weights using this methodology. In here, it is important to point that the rankings of countries can vary depend on the weight matrixes produced and different outcomes may be attained as a result of various evaluation standards. In this regard, the entropy-weighted MAUT model has ranked the countries by considering a wide range of variables which then of main fourteen basic criteria of EFI. The variables are taken into consideration are economic freedom, investment climate, competitiveness, workforce capability, and technological infrastructure. The compatibility of this ranking with the actual ranking has also been examined by Spearman rank correlation.

According to the main results of this study, the entropy-weighted MAUT model suggested in this work can therefore be a good substitute for computing the economic freedom index, it is claimed. As a result, the generated model might be a crucial instrument in assessing the economic position of the countries. The focus of the study's subsequent phases is expected to be on factors that can raise the economic freedom index.

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