8. THE EVALUATION OF ECONOMIC FREEDOM INDEXES OF EU COUNTRIES WITH A GREY HYBRID MCDM MODEL

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Abstract

The Economic Freedom Index is a valuable comparison tool in terms of helping countries to consider in which areas they are better and determining priorities accordingly, as well as ensuring full economic freedom. There are many studies in the literature on this index. However, no study that deals with the criteria of the economic freedom index with grey MCDM methods has been found in the literature. In this study, the 5-year (2018-2022) economic freedom sub-criteria of 27 countries that are members of the European Union are handled with Grey PSI and WEDBA-G methods. This study has two contributions to the literature. First, a new grey MCDM method, called the WEDBA-G method, was developed. Second, a new grey hybrid model including grey PSI and grey WEDBA is presented.

Keywords: MCDM, grey PSI, WEDBA-G, Economic Freedom Index, grey theory

JEL Classification: O10, E60, F10, A10, C60

1. Introduction

There are many different interpretations of what economic freedom is, however; at its core, economic freedom is the ability of individuals to make their own economic decisions without government interference. This includes the right to own property, engage in free enterprise

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and enjoy the fruits of their labour. Economic freedom is important as it allows individuals to achieve their own economic goals and dreams. It also encourages competition and innovation, which can lead to economic growth and prosperity. There are many studies in the literature on this subject. De Haan and Sturm (2000) and Cole (2003) proved in their studies that "more economic freedom leads to greater economic growth". While economic freedom is a fundamental human right that should be respected by all governments, there are those who argue that it cannot be fully achieved. The fact that even in the developed countries there must be "limited" government intervention in the economy by means of taxes, laws or regulations is accepted by many economists, including John Locke, Adam Smith, Milton Friedman, and Robert Nozick (De Haan and Sturm, 2000). Since many countries, including developed countries, do not have a strong tradition of economic freedom, developments in this area are progressing slowly. There are several ways to promote economic freedom. The first is to reduce government interference in the economy by the relative waiver of taxes, regulations and trade barriers. Another way to promote economic freedom is to increase it through education and public awareness. In addition, countries can make laws and constitutional amendments that guarantee economic freedom. It is important to remember that economic freedom is not an absolute right. It may be restricted under certain circumstances, such as when it conflicts with other rights or it is necessary to achieve other important goals. In general, however, economic freedom is a vital part of a free and prosperous society.

Tangible evidence is needed so that countries can understand their own level of economic freedom, compare themselves with other countries, and set targets for themselves in this direction. There are indices created with different methods by many foundations and organizations to serve this purpose. One of the most well-known of these indices is the Economic Freedom Index created by the Heritage Foundation. The index in question consists of 12 sub-criteria in 4 different categories every year since 1995 and is published by taking the average of these sub-criteria equally. The sub-criteria that make up the economic freedom index are: business freedom, monetary freedom, labour freedom under the Regulatory Efficiency category; government spending, fiscal health, tax burden under the Government Size category; government integrity, property rights, judicial effectiveness under Rule of Law category and trade freedom, investment freedom, financial freedom under Open Markets category. Each sub-category is evaluated with scores between 0 and 100, with 100 being the highest (Miller et al., 2022).

Of course, the fact that there are many sub-criteria of economic freedom brings the question of "which criterion is more important for countries" in the minds of many researchers. Researchers use Multi-Criteria Decision Making (MCDM) methods to answer such questions and determine the degree of importance between variables (Aytekin, 2022; Ulutaş et al., 2022a; Ulutaş et al., 2021a; Đukić, 2022; Popović et al., 2021). Many researchers such as Ahmet and Mehmet (2002), Ali and Veli (2003), Altın (2020), Dinç and Erilli (2022), Ecer and Zolfani (2022) have also conducted studies on this subject using MCDM methods.

However, no study that deals with the criteria of the economic freedom index with grey MCDM methods has been found in the literature. While a 5-year period can be evaluated with grey MCDM methods, performances can only be evaluated in a single year with crisp MCDM methods. Therefore, in our study, we aimed to determine the importance levels of the criteria of economic freedom by using Grey PSI (Preference Selection Index) method and to rank the EU countries with respect to their performance by Grey WEDBA (WEDBA-G) (Weighted Euclidean Distance Based Approach) method. In our study, the 5-year (2018-2022) economic freedom sub-criteria of 27 countries that are members of the European

Union are handled with Grey PSI and WEDBA-G methods. This study has two contributions to the literature. First, a new grey MCDM method called the WEDBA-G method was developed. Second, a new grey hybrid model including grey PSI and grey WEDBA is presented.

2. Literature Review

More than one study in the literature has evaluated the economic freedom indexes of countries. Some of these studies are summarized in this section.

De Haan and Sturm (2000) compare the relationship between economic freedom and growth with correlation analysis. According to the results obtained, it has been determined that economic freedom encourages economic growth and, however, the level of economic freedom is not affected by growth.

Chen and Huang (2009) examined whether a country's economic freedom is related to that country's stock market performance and volatility. The results show that economic freedom has slight effect on stock market returns and increases in investment efficiency in an environment of increased economic freedom.

Carlos Díaz-Casero *et al.* (2012) examine whether economic freedom affects entrepreneurial activities with correlation and regression analysis. The results show that as a country's economic freedom increases, the rate of total entrepreneurial activity decreases. Calcagno and Benefield (2013) show that, in addition to state economic performance, state economic policies also affect the state bond ratings. Using a sample of 39 states from the period 1998-2008, regression analysis was used to determine whether various economic freedom indices contributed to state bond ratings.

Gohmann *et al. (*2013) analyse the effect of economic freedom on employment in the North American Industry Classification System (NAICS) service industries with regression analysis. The study found that economic freedom improves job growth; however, not for all industries.

Sufian and Habibullah (2014) aimed to investigate the effect of economic freedom on the productivity of the Malaysian banking sector. Regression analysis was used to examine the effect of economic freedom on bank efficiency. The results reveal that restrictions on the activities that banks can undertake have a negative impact on productivity levels.

Ghosh (2016) aimed to examine the impact of economic freedom on MENA banks' risk taking. In this context, economic freedom and its subcomponents, annual bank-level financial data and annual country-level data were obtained from Bankscope, IMF, World Bank and the Fraser Institute. According to the results obtained by panel data analysis, it was noticed that economic freedom had a significant effect on bank risk taking.

Dempster and Isaacs (2017) examine the relationship between economic freedom and productive and unproductive entrepreneurial activities. The authors analysed these hypotheses using the least squares method by incorporating data collected from the Economic Freedom of the World into their model of international entrepreneurial activity.

Dove (2017) examines the relationship between economic freedom and bond ratings with Tobit and OLS regression. The results show that greater economic freedom is associated with higher bond ratings and lower borrowing costs.

Alabede (2018) examines whether economic freedom (freedom of property rights, freedom from corruption and freedom of investment) has an impact on tax revenues in sub-Saharan

Africa. The study uses data from 42 countries from four sub-regions of Sub-Saharan Africa from 2005 to 2012. According to the results, it was determined that economic freedom had a positive effect on tax revenues.

Altın (2020) analysed the Economic Freedom Index with TOPSIS and MAUT methods, and then compared the results with the results obtained from the CETOPSIS and CEMAUT methods using the Spearman Correlation approach.

DeBode *et al.* (2020) explored how different cultural dimensions, religions and legal origins can affect a country's economic freedom. The researchers used the data of freedom of trade, freedom of investment, freedom of business, freedom of work and monetary freedom from 52 different countries as sub-criteria of economic freedom, and they used regression analysis as a method.

Harkati *et al.* (2020) explore the impact of economic freedom on risk-taking behaviour of Malaysian banks for both traditional and Islamic banks. Data were obtained from the Heritage Foundation and the FitchConnect database for the period 2011–2017 and analysed using the generalized least squares technique.

Sharma (2020) looked at how economic freedom affected four key health indicators in sub-Saharan African countries. The study used data from the World Bank and Fraser Institute's World Development Indicators (WDI). Fixed effects regression was used to estimate the impact of economic freedom on health outcomes and the author tried to solve endogeneity problems using two-stage least squares regression (2SLS).

Sarpong-Kumankoma *et al.* (2021) aimed to analyse the effects of economic freedom and competition on bank stability. Data obtained from 139 banks in 11 Sub-Saharan African countries (SSA) during the period 2006-2012 was analysed with the Generalized Method of Moments (GMM). The results show that financial freedom has a negative effect on bank stability.

Üre *et al.* (2021) conducted a panel data analysis using Worldwide Governance Indicators data obtained from the World Bank for the years 2005-2019 in order to measure the impact of economic and political freedom on imports and exports in the transition economies. As a result of the analysis, it was determined that all variables, except the regulatory structure, are effective on imports. In addition, it was determined that corruption control and political stability had a positive effect on exports.

Ecer and Zolfani (2022) used DNMA and MEREC methods to determine the importance levels of the sub-criteria of the economic freedom index published by the Heritage Foundation and to determine the OPEC country with the highest economic freedom. According to the results, the most important sub-criteria are investment freedom, property rights and financial health. In addition, the UAE has the highest economic freedom among the 14 OPEC countries.

Other versions (crisp and fuzzy) of the PSI and WEDBA methods used in this study have been used in the literature. Table 1 shows these studies.

Table 1. Literature Review on the PSI and WEBDA Methods

Author(s)	Problem	Method(s)
Rao (2012)	Facility location and facility layout design selection for industrial organizations	WEDBA
Khorshidi and Hassani (2013)	Selection of materials required to form an aluminium matrix composite (AMC) with both strength and machinability	PSI, TOPSIS
Attri and Grover (2015)	Various decision-making problems encountered during the design phase of the production system lifecycle.	PSI
Nagarajan and Subashini (2015)	Create an American Sign Language recognition system using images of hand gestures recorded with a camera	WEDBA
Sahir *et al.* (2018)	Selecting an accessible and visible marketplace to sell used laptops based on similar vendor, distance, price and visitor criteria	PSI
Tuş and Adalı (2018)	Making decisions such as recruitment, promotion, qualification and creation of a talented workforce in order to increase the overall performance in a textile company	PSI, CODAS
Al-Hawari *et al.* (2019)	Solution of two examples in construction and automotive industry to create a new fuzzy approach of Weighted Euclidean Distance Based Approximation (WEDBA)	Fuzzy-WEDBA
Ulutaş *et al.* (2021b)	Implementing a hybrid model to cost-effectively distribute to geographically dispersed customers	Fuzzy-PSI, Fuzzy-PIPRECIA, Fuzzy-CoCoSo
Toslak, Aktürk and Ulutaş (2022b)	Evaluation of the performance of a logistics company between 2010-2020 with eight different criteria	MEREC and WEDBA

4. Methodology

In this study, the Grey PSI method is used to obtain the weights for criteria of the economic freedom index, while the WEDBA-G method is used to evaluate the five-year economic freedom index performance of the EU countries.

3.1. Grey PSI

In this study, the Grey PSI method is used to determine the importance level of the economic freedom index criteria and the steps of this method are given below (Ulutaş *et al.*, 2021b).

Step 1: A grey decision matrix ($\otimes G$) including alternatives and criteria is formed.

$$\otimes G = \left[\otimes g_{ij} \right]_{m \times n} \tag{1}$$

In Eq. 1, $\otimes g_{ij}$ ($\otimes g_{ij} = \left[g_{ij}^{l}, g_{ij}^{u} \right]$) presents the grey performance value of the i th alternative on j th criterion.

Step 2: This grey matrix is normalized by utilising Eq. 2 (for beneficial criteria) and Eq. 3 (for non-beneficial criteria).

$$\otimes t_{ij} = \frac{\otimes g_{ij}}{\max(\otimes g_{ij})} = \left[\frac{g_{ij}^{l}}{\max(g_{ij}^{u})}, \frac{g_{ij}^{u}}{\max(g_{ij}^{u})} \right] \qquad (2)$$

$$\otimes t_{ij} = \frac{\min(\otimes g_{ij})}{\otimes g_{ij}} = \left[\frac{\min(g_{ij}^{l})}{g_{ij}^{u}}, \frac{\min(g_{ij}^{l})}{g_{ij}^{l}} \right] \qquad (3)$$

In Equations 2 and 3, $\otimes t_{ij}$ presents the normalized version of $\otimes g_{ij}$.

Step 3: The mean value of grey normalized values ($\otimes \overline{t_{ij}}$) for each criterion is computed as.

$$\otimes \overline{t_{ij}} = \frac{\sum_{i=1}^{m} \otimes t_{ij}}{m} = \left[\frac{\sum_{i=1}^{m} t_{ij}^{l}}{m}, \frac{\sum_{i=1}^{m} t_{ij}^{u}}{m} \right] \qquad (4)$$

Step 4: The grey preference value ($\otimes \rho_{j} = \left[\rho_{j}^{l}, \rho_{j}^{u} \right]$) for each criterion is computed by using Eq. 5.

$$\otimes \rho_{j} = \sum_{i=1}^{m} \left(\otimes t_{ij} - \otimes \overline{t_{ij}} \right)^{2} = \left[\min \left(\sum_{i=1}^{m} \left(t_{ij}^{l} - \overline{t}_{ij}^{l} \right)^{2}, \sum_{i=1}^{m} \left(t_{ij}^{u} - \overline{t}_{ij}^{u} \right)^{2} \right), \max \left(\sum_{i=1}^{m} \left(t_{ij}^{l} - \overline{t}_{ij}^{l} \right)^{2}, \sum_{i=1}^{m} \left(t_{ij}^{u} - \overline{t}_{ij}^{u} \right)^{2} \right) \right] \quad (5)$$

Step 5: The grey deviation values ($\otimes \beta_{j}$)(by Eq. 6) and grey weights of criteria ($\otimes w_{j}$)(by Eq. 7) are computed as.

$$\otimes \beta_{j} = \left[\beta_{j}^{l}, \beta_{j}^{u} \right] = \left| 1 - \otimes \rho_{j} \right| = \left[\left| 1 - p_{j}^{u} \right|, \left| 1 - p_{j}^{l} \right| \right] \qquad (6)$$

$$\otimes w_{j} = \frac{\otimes \beta_{j}}{\sum_{j=1}^{n} \otimes \beta_{j}} = \left[\frac{\beta_{j}^{l}}{\sum_{j=1}^{n} \beta_{j}^{u}}, \frac{\beta_{j}^{u}}{\sum_{j=1}^{n} \beta_{j}^{l}} \right] \qquad (7)$$

After obtaining the grey weights of the criteria, the performance of the EU countries is computed by WEDBA-G.

3.2. WEDBA-G

In this study, EU countries are listed with the developed WEDBA-G method. The steps of the developed WEDBA-G method are as follows.

Step 1: The grey decision matrix is constructed. This matrix is shown in Eq. 1.

Step 2: This grey matrix is normalized by Eq.2 and Eq.3.

Step 3: Normalized grey values are standardized by Eq. 8.

$$\otimes k_{ij} = \frac{\otimes t_{ij} - \otimes \mu_j}{\otimes \sigma_j} = \left[\min\left(\frac{t_{ij}^l - \mu_j^l}{\sigma_j^l}, \frac{t_{ij}^u - \mu_j^u}{\sigma_j^u} \right), \max\left(\frac{t_{ij}^l - \mu_j^l}{\sigma_j^l}, \frac{t_{ij}^u - \mu_j^u}{\sigma_j^u} \right) \right] \tag{8}$$

where:

$$\otimes \mu_j = \left[\mu_j^l, \mu_j^u \right] = \frac{\sum_{i=1}^m \otimes t_{ij}}{m} = \left[\frac{t_{ij}^l}{m}, \frac{t_{ij}^u}{m} \right] \tag{9}$$

$$\otimes \sigma_j = \sqrt{\frac{\sum_{i=1}^m \left(\otimes t_{ij} - \otimes \mu_j \right)^2}{m}} = \left[\sqrt{\frac{\sum_{i=1}^m \left(t_{ij}^l - \mu_j^l \right)^2}{m}}, \sqrt{\frac{\sum_{i=1}^m \left(t_{ij}^u - \mu_j^u \right)^2}{m}} \right] \tag{10}$$

In Equations 9 and 10, $\otimes \mu_j$ indicates the grey mean value of jth criterion and $\otimes \sigma_j$ shows the grey standard deviation value of jth criterion.

Step 4: The grey anti ideal ($\otimes k_{ij}^-$) and ideal ($\otimes k_{ij}^+$) values are computed as:

$$\otimes k_{ij}^+ = \max\left(\otimes k_{ij} \right) = \left[\max(k_{ij}^l), \max(k_{ij}^u) \right] \tag{11}$$

$$\otimes k_{ij}^- = \min\left(\otimes k_{ij} \right) = \left[\min(k_{ij}^l), \min(k_{ij}^u) \right] \tag{12}$$

Step 5: For each alternative, grey Weighted Euclidean Distances ($\otimes WED_i^+ = \left[WED_i^{l+}, WED_i^{u+} \right]$ and $\otimes WED_i^- = \left[WED_i^{l-}, WED_i^{u-} \right]$) are calculated and then these grey values are converted into crisp values by Equations 15 and 16. Finally, index score (IS_i) for each alternative is computed by Eq.17.

$$\otimes WED_i^+ = \sqrt{\sum_{j=1}^n \left\{ \otimes w_j \left(\otimes t_{ij} - \otimes t_{ij}^+ \right) \right\}^2} = \left[\begin{array}{c} \min\left(\sqrt{\sum_{j=1}^n \left\{ w_j^l \left(t_{ij}^l - t_{ij}^{u+} \right) \right\}^2}, \sqrt{\sum_{j=1}^n \left\{ w_j^u \left(t_{ij}^u - t_{ij}^{l+} \right) \right\}^2} \right), \\ \max\left(\sqrt{\sum_{j=1}^n \left\{ w_j^l \left(t_{ij}^l - t_{ij}^{u+} \right) \right\}^2}, \sqrt{\sum_{j=1}^n \left\{ w_j^u \left(t_{ij}^u - t_{ij}^{l+} \right) \right\}^2} \right) \end{array} \right] \tag{13}$$

$$\otimes WED_i^- = \sqrt{\sum_{j=1}^{n}\left\{\otimes w_j\left(\otimes t_{ij}-\otimes t_{ij}^-\right)\right\}^2} = \begin{bmatrix} \min\left(\sqrt{\sum_{j=1}^{n}\left\{w_j^l\left(t_{ij}^l-t_{ij}^{u-}\right)\right\}^2}, \sqrt{\sum_{j=1}^{n}\left\{w_j^u\left(t_{ij}^u-t_{ij}^{l-}\right)\right\}^2}\right), \\ \max\left(\sqrt{\sum_{j=1}^{n}\left\{w_j^l\left(t_{ij}^l-t_{ij}^{u-}\right)\right\}^2}, \sqrt{\sum_{j=1}^{n}\left\{w_j^u\left(t_{ij}^u-t_{ij}^{l-}\right)\right\}^2}\right) \end{bmatrix} \quad (14)$$

$$WED_i^+ = \frac{WED_i^{l+}+WED_i^{u+}}{2} \quad (15)$$

$$WED_i^- = \frac{WED_i^{l-}+WED_i^{u-}}{2} \quad (16)$$

$$IS_i = \frac{WED_i^-}{WED_i^-+WED_i^+} \quad (17)$$

The alternative with the highest IS_i is determined as the best alternative.

4. Application

In this study, 5-year economic freedom indexes of the EU countries, which were released by Heritage Foundation, are analysed. The Economic Freedom Index performances of the EU countries are evaluated based on 12 criteria, as follows: Property Rights, Government Integrity, Judicial Effectiveness, Tax Burden, Government Spending, Fiscal Health, Business Freedom, Labour Freedom, Monetary Freedom, Trade Freedom, Investment Freedom and Financial Freedom. All of these criteria are beneficial criteria. Table 2 presents the grey decision matrix.

Table 2. The Grey Decision Matrix

Criteria / Countries	Property Rights	Government Integrity	Judicial Effectiveness	Tax Burden
Austria	[83.5, 98.4]	[73.5, 84.8]	[71.3, 94.6]	[45.5, 51.3]
Belgium	[81.2, 92.5]	[70.9, 83.6]	[61.6, 91.2]	[44, 48.2]
Bulgaria	[62.5, 77.3]	[35.1, 46.8]	[41.9, 61.1]	[90.2, 93.9]
Croatia	[65.9, 81.1]	[38.6, 51.4]	[39.6, 69.9]	[65.9, 82.8]
Cyprus	[71.2, 85.6]	[41.3, 65]	[48.1, 90.9]	[74.8, 80.3]
Czech Republic	[73, 88.8]	[51.1, 64.4]	[47.6, 81.8]	[78.9, 82.9]
Denmark	[84.8, 98.6]	[84.1, 99.5]	[77.8, 89.6]	[41.4, 43.7]
Estonia	[80.4, 91.5]	[73.1, 86.4]	[73.7, 92.3]	[79.9, 81.1]
Finland	[89, 100]	[89.8, 97.2]	[80.5, 97.8]	[66.5, 68.4]
France	[82.2, 93.8]	[65.1, 83.3]	[66.1, 85.5]	[47.3, 52.1]
Germany	[78.8, 95.7]	[75.3, 89.4]	[69.8, 95.3]	[59.9, 61.3]
Greece	[52.3, 76]	[37.7, 53.6]	[48.6, 69.9]	[59, 60.4]

Criteria Countries	Property Rights	Government Integrity	Judicial Effectiveness	Tax Burden
Hungary	[57.6, 75.8]	[35.3, 48.7]	[45.2, 62.2]	[78.6, 84.1]
Ireland	[85.8, 92.6]	[78, 82.8]	[64.4, 93]	[76.1, 76.6]
Italy	[71.2, 81.7]	[40.1, 63.7]	[49.8, 78.6]	[55.2, 58.1]
Latvia	[67.3, 88.5]	[35.5, 61.10]	[48.4, 75.1]	[76.4, 84]
Lithuania	[73.6, 88.6]	[47.8, 74.5]	[61.2, 74.6]	[84.54, 86.4]
Luxembourg	[82.7, 97.4]	[79, 92.5]	[72.4, 96.4]	[63.4, 65.4]
Malta	[68.1, 87.8]	[49.9, 55.79]	[49.6, 89.9]	[64.2, 69]
Netherlands	[87.9, 96.2]	[86, 92.28]	[72.8, 96.9]	[51.2, 52.5]
Poland	[61.8, 72.3]	[49.8, 65]	[42.8, 56.6]	[73.6, 75.9]
Portugal	[69.2, 89.9]	[56.8, 68.9]	[64.3, 92.1]	[59.6, 60.4]
Romania	[61, 81]	[39.8, 55.1]	[51.9, 64.8]	[87.3, 94.3]
Slovak Republic	[68.2, 83.2]	[37.7, 53.70]	[37.2, 71.9]	[77.3, 78.9]
Slovenia	[76.4, 89.7]	[52.1, 68.2]	[46.5, 91.6]	[57.2, 59.2]
Spain	[72.9, 87.7]	[51.5, 70.3]	[51.4, 74.3]	[59.7, 62.3]
Sweden	[86.6, 97.3]	[88, 95.70]	[79.1, 97.1]	[43.2, 44.9]
Criteria Countries	Government Spending	Fiscal Health	Business Freedom	Labour Freedom
Austria	[19.3, 29.1]	[71.7, 90]	[72.6, 82.3]	[66.7, 78.4]
Belgium	[10.1, 18.4]	[50.3, 78.7]	[75.2, 82.8]	[57.4, 61.1]
Bulgaria	[60.5, 66.1]	[94.3, 99.2]	[62.6, 72.1]	[64.4, 68.5]
Croatia	[26.3, 35.8]	[67.2, 89.6]	[53.6, 72.4]	[43, 58.7]
Cyprus	[44.3, 58.6]	[71.2, 82]	[74.9, 77]	[55.7, 66.4]
Czech Republic	[44.7, 52.7]	[93.2, 98.1]	[68.8, 80.6]	[56.5, 78.1]
Denmark	[10.6, 23.1]	[96.2, 98.2]	[88.7, 92.5]	[64.4, 86.4]
Estonia	[48.4, 54.4]	[93.3, 99.9]	[72.7, 86.9]	[54.8, 61.1]
Finland	[2.3, 14.3]	[81.1, 91.4]	[84.8, 89.9]	[50.3, 65.1]
France	[0.5, 6.3]	[39.1, 69]	[80.2, 82.5]	[44.8, 58.80]
Germany	[34.5, 42.3]	[90.4, 92.9]	[82.4, 87.2]	[52.3, 53.3]
Greece	[17.9, 34.2]	[67.6, 80]	[70.3, 75.8]	[49.8, 61.1]
Hungary	[29.4, 35]	[58.4, 85]	[59.9, 77.2]	[61.2, 68.7]
Ireland	[69.6, 81.1]	[80.8, 93.1]	[81.5, 87.2]	[60.94, 76.4]
Italy	[20.6, 28.9]	[49, 73]	[68.1, 73.8]	[50.3, 70.39]
Latvia	[53.2, 59]	[91.4, 96.9]	[76.5, 81.9]	[62.39, 73.8]
Lithuania	[59.9, 66.8]	[86.5, 97.4]	[71.9, 87.3]	[59.47, 76.5]
Luxembourg	[41.5, 48.5]	[98.7, 99]	[66.1, 89.3]	[45.3, 56.32]
Malta	[51, 60.9]	[86.2, 96.3]	[64, 75.5]	[61.1, 61.8]

Criteria / Countries	Property Rights	Government Integrity	Judicial Effectiveness	Tax Burden
Netherlands	[39.1, 47.7]	[88.2, 95.3]	[80.4, 88.1]	[58.85, 61.5]
Poland	[41.9, 48.8]	[78.3, 94.6]	[61.6, 78.7]	[55.72, 66.1]
Portugal	[29.8, 42.4]	[46, 78.2]	[75.9, 83.2]	[44.1, 55.48]
Romania	[63.9, 70.4]	[42.8, 91.1]	[58.6, 71.4]	[63, 66.8]
Slovak Republic	[41.8, 50.2]	[76, 93.4]	[55.3, 75.9]	[52.2, 56.54]
Slovenia	[31.2, 42.9]	[66.3, 91.1]	[78.4, 79.7]	[61.2, 63.32]
Spain	[38.3, 48.3]	[29.7, 69.8]	[66.3, 75.2]	[57.7, 61.82]
Sweden	[23.2, 29.5]	[95.8, 97.6]	[83.2, 89.3]	[53.7, 65.44]

Criteria / Countries	Monetary Freedom	Trade Freedom	Investment Freedom	Financial Freedom
Austria	[81, 83.7]	[79.2, 86.9]	[80, 90]	[70, 70]
Belgium	[76.1, 84.3]	[79.2, 86.9]	[85, 85]	[70, 70]
Bulgaria	[81.9, 88]	[79.2, 86.9]	[60, 70]	[60, 60]
Croatia	[77.6, 80.5]	[79.2, 87.4]	[75, 75]	[60, 60]
Cyprus	[83, 85]	[79.2, 86.9]	[75, 75]	[60, 60]
Czech Republic	[79, 85.2]	[79.2, 86.9]	[70, 80]	[80, 80]
Denmark	[84.1, 86.4]	[79.2, 86.9]	[90, 90]	[80, 80]
Estonia	[78.6, 85.1]	[79.2, 86.9]	[90, 90]	[70, 80]
Finland	[83.3, 86]	[79.2, 86.9]	[85, 85]	[80, 80]
France	[76.7, 81.6]	[79.2, 84]	[75, 75]	[70, 70]
Germany	[76.7, 86.2]	[79.2, 86.9]	[80, 80]	[70, 70]
Greece	[78.6, 81]	[79.2, 84]	[55, 55]	[40, 50]
Hungary	[78.5, 91.6]	[79.2, 86.9]	[80, 80]	[70, 70]
Ireland	[84.4, 87.4]	[79.2, 86.9]	[90, 90]	[70, 70]
Italy	[83.2, 88.2]	[79.2, 86.9]	[80, 85]	[50, 50]
Latvia	[79.6, 87.3]	[79.2, 86.9]	[85, 85]	[60, 60]
Lithuania	[79.7, 89.9]	[79.2, 86.9]	[70, 80]	[70, 70]
Luxembourg	[76.4, 87.6]	[79.2, 86.9]	[95, 95]	[80, 80]
Malta	[77.1, 78.8]	[79.2, 86.9]	[70, 85]	[50, 60]
Netherlands	[80.4, 87.5]	[79.2, 86.9]	[90, 90]	[80, 80]
Poland	[79.1, 85]	[79.2, 86.9]	[75, 80]	[70, 70]
Portugal	[83, 86.8]	[79.2, 86.9]	[70, 70]	[60, 60]
Romania	[77.7, 82.8]	[79.2, 86.9]	[70, 75]	[50, 50]
Slovak Republic	[74.8, 81]	[79.2, 86.9]	[75, 75]	[70, 70]
Slovenia	[81.9, 87.3]	[79.2, 86.9]	[70, 70]	[50, 50]
Spain	[82, 87.5]	[84, 86.9]	[85, 85]	[70, 70]

Criteria Countries	Property Rights	Government Integrity	Judicial Effectiveness	Tax Burden
Sweden	[81.2, 83.8]	[79.2, 86.9]	[85, 85]	[80, 80]

The weights of the criteria are obtained by using Equations 2-7. The results of Grey PSI are shown in Table 3.

Table 3. The Results of Grey PSI

Results Criteria	$\otimes\rho_j$	$\otimes\beta_j$	$\otimes w_j$
Property Rights	[0.140, 0.279]	[0.721, 0.86]	[0.081, 0.141]
Government Integrity	[0.648, 0.995]	[0.004, 0.352]	[0.001, 0.058]
Judicial Effectiveness	[0.285, 0.649]	[0.351, 0.715]	[0.039, 0.117]
Tax Burden	[0.554, 0.706]	[0.294, 0.446]	[0.033, 0.073]
Government Spending	[1.164, 1.47]	[0.164, 0.47]	[0.018, 0.077]
Fiscal Health	[0.214, 1.057]	[0.057, 0.786]	[0.006, 0.129]
Business Freedom	[0.094, 0.288]	[0.712, 0.906]	[0.08, 0.149]
Labour Freedom	[0.093, 0.294]	[0.706, 0.907]	[0.079, 0.149]
Monetary Freedom	[0.01, 0.04]	[0.96, 0.99]	[0.108, 0.162]
Trade Freedom	[0, 0.005]	[0.995, 1]	[0.112, 0.164]
Investment Freedom	[0.166, 0.307]	[0.693, 0.834]	[0.078, 0.137]
Financial Freedom	[0.375, 0.558]	[0.442, 0.625]	[0.05, 0.102]

Using Equations 8-17, the performances of the EU countries are achieved. Table 4 presents the results of the WEDBA-G method.

Table 4. The Results of WEDBA-G

Results Countries	$\otimes WED_i^+$	$\otimes WED_i^-$	WED_i^+	WED_i^-	IS_i	Rankings
Austria	[0.226, 0.816]	[0.429, 1.354]	0.521	0.892	0.631	5
Belgium	[0.377, 0.934]	[0.347, 1.159]	0.656	0.753	0.534	15
Bulgaria	[0.496, 1.028]	[0.315, 1.150]	0.762	0.733	0.490	19
Croatia	[0.653, 1.134]	[0.183, 0.975]	0.894	0.579	0.393	26
Cyprus	[0.404, 0.877]	[0.277, 1.181]	0.641	0.729	0.532	16
Czech Republic	[0.359, 0.850]	[0.319, 1.245]	0.605	0.782	0.564	12
Denmark	[0.209, 0.751]	[0.553, 1.636]	0.480	1.095	0.695	2
Estonia	[0.354, 0.759]	[0.403, 1.353]	0.557	0.878	0.612	7
Finland	[0.292, 0.786]	[0.493, 1.441]	0.539	0.967	0.642	4
France	[0.565, 1.268]	[0.469, 1.023]	0.917	0.746	0.449	23
Germany	[0.393, 0.854]	[0.352, 1.268]	0.624	0.810	0.565	11
Greece	[0.686, 1.443]	[0.376, 0.781]	1.065	0.579	0.352	27

Results \ Countries	$\otimes WED_i^+$	$\otimes WED_i^-$	WED_i^+	WED_i^-	IS_i	Rankings
Hungary	[0.471, 1.020]	[0.287, 1.216]	0.746	0.752	0.502	18
Ireland	[0.179, 0.686]	[0.504, 1.505]	0.433	1.005	0.699	1
Italy	[0.424, 0.976]	[0.349, 1.132]	0.700	0.741	0.514	17
Latvia	[0.304, 0.810]	[0.381, 1.267]	0.557	0.824	0.597	10
Lithuania	[0.310, 0.784]	[0.342, 1.369]	0.547	0.856	0.610	8
Luxembourg	[0.354, 0.872]	[0.434, 1.439]	0.613	0.937	0.605	9
Malta	[0.499, 1.000]	[0.204, 1.127]	0.750	0.666	0.470	21
Netherlands	[0.219, 0.746]	[0.482, 1.427]	0.483	0.955	0.664	3
Poland	[0.522, 0.970]	[0.277, 1.044]	0.746	0.661	0.470	21
Portugal	[0.490, 0.987]	[0.308, 1.104]	0.739	0.706	0.489	20
Romania	[0.546, 1.066]	[0.222, 1.024]	0.806	0.623	0.436	24
Slovak Republic	[0.651, 1.052]	[0.214, 0.960]	0.852	0.587	0.408	25
Slovenia	[0.380, 0.895]	[0.320, 1.180]	0.638	0.75	0.540	14
Spain	[0.677, 1.114]	[0.385, 1.725]	0.896	1.055	0.541	13
Sweden	[0.295, 0.802]	[0.448, 1.397]	0.549	0.923	0.627	6

According to the results of the WEDBA-G method, the top 5 EU countries with the best performance are as follows: Ireland, Denmark, the Netherlands, Finland and Austria. Grey TOPSIS, COPRAS-G, and Grey PIV methods were applied to the grey decision matrix shown in Table 2 to check whether the developed WEDBA-G method reached accurate results. The results of grey MCDM methods are shown in Table 5.

Table 5. The Results of Grey MCDM Methods

Results \ Countries	Grey TOPSIS	COPRAS-G	Grey PIV	WEDBA-G
Austria	10	11	10	5
Belgium	21	18	17	15
Bulgaria	15	15	15	19
Croatia	26	26	26	26
Cyprus	13	13	13	16
Czech Republic	6	9	9	12
Denmark	7	2	2	2
Estonia	2	3	3	7
Finland	12	7	7	4
France	24	25	25	23
Germany	11	12	12	11
Greece	27	27	27	27
Hungary	23	22	22	18

Results Countries	Grey TOPSIS	COPRAS-G	Grey PIV	WEDBA-G
Ireland	1	1	1	1
Italy	25	24	24	17
Latvia	8	10	11	10
Lithuania	3	6	6	8
Luxembourg	5	5	5	9
Malta	14	14	14	21
Netherlands	4	4	4	3
Poland	19	20	20	21
Portugal	22	21	21	20
Romania	16	17	19	24
Slovak Republic	20	23	23	25
Slovenia	18	19	18	14
Spain	17	16	16	13
Sweden	9	8	8	6

The results of the grey MCDM methods and the results of the WEDBA-G method were evaluated with the help of Pearson correlation. The correlation coefficients between the results of the methods are as follows: COPRAS-G/WEDBA-G (0.897), Grey TOPSIS/WEDBA-G (0.829), and Grey PIV/WEDBA-G (0.911). There is a high correlation between the results of the WEDBA-G method developed according to these results and the results of other grey MCDM methods. Accordingly, one may say that the WEDBA-G method has reached accurate results.

5. Conclusion

Many studies have been written in the literature on the economic freedom index. However, no study that deals with the criteria of economic freedom index with grey MCDM methods has been found. While a 5-year period can be evaluated with grey MCDM methods, performances can only be evaluated in a single year with crisp MCDM methods. In this study, the 5-year (2018-2022) economic freedom sub-criteria of 27 countries that are members of the European Union are handled with Grey PSI and WEDBA-G methods. Therefore, we aimed to determine the importance levels of the criteria of economic freedom by using the Grey PSI method and to rank the EU countries with respect to their performance by the WEDBA-G method. According to the results of the WEDBA-G method, the top 5 EU countries with the best performance are as follows: Ireland, Denmark, Netherlands, Finland and Austria. The results of WEDBA-G were compared with Grey TOPSIS, COPRAS-G, and Grey PIV methods to confirm whether the developed WEDBA-G method achieved correct results. According to the results obtained, a high correlation was determined between the developed WEDBA-G method and other grey MCDM methods. Therefore, it was concluded that the WEDBA-G method achieved accurate results. This study has two contributions to the literature. First, a new grey MCDM method called the WEDBA-G method was developed. Second, a new grey hybrid model including grey PSI and grey WEDBA is presented. Future

studies can analyse the economic freedom indexes of different countries with other grey MCDM methods.

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