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Knowledge Flows and Innovation Capacity: A Reproducible Multi-Criteria Decision Analysis of the G7 and Türkiye

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Abstract: The macroeconomic performance of nations provides valuable insights into the knowledge economy and the governance structures that sustain its development. This study formalizes a framework for evaluating knowledge flows and innovation capacity through multi-criteria decision analysis (MCDA) using open World Bank data. The analysis employs the Logarithmic Decomposition of Criteria Importance (LODECI) method in conjunction with the Preference Selection Index (PSI) to determine objective weights, while the Weighted Euclidean Distance-Based Approach (WEDBA) is applied to rank the G7 countries and Türkiye in 2023. Knowledge flows, as represented by exports and foreign direct investment (FDI), serve as proxies for cross-border knowledge exchange, while inflation, unemployment, and economic growth are assessed within a reproducible, policy-driven framework. The weighting procedure assigns the greatest aggregate importance to inflation and the least to unemployment. The resulting rankings place the United States first, followed by Japan in second place, Türkiye fourth, and the United Kingdom last. The analysis further highlights how factors such as price stability, external openness, and investment dynamics shape national knowledge creation, diffusion, and organizational learning processes. By focusing on the utilization of open data, explicit knowledge representation, and transparent multi-criteria methodologies, the proposed framework strengthens digital knowledge infrastructures and facilitates actionable cross-country benchmarking. The findings have important policy implications, particularly in understanding how national macroeconomic variables influence innovation capacity. The framework is designed to be extensible, allowing for future adaptation to evaluate additional indicators, such as R&D intensity, high-tech export shares, and patenting activity. Furthermore, the approach is structured to support replication across various regions and timeframes, ensuring its broad applicability and scalability.

Keywords: Macroeconomic performance; G7 countries; Türkiye; Logarithmic Decomposition of Criteria Importance (LODECI); Preference Selection Index (PSI); Weighted Euclidean Distance-Based Approach (WEDBA); Innovation capacity; Cross-border knowledge flows; External openness; Digital knowledge infrastructures

1 Introduction

Macroeconomic performance is a fundamental indicator for assessing the effectiveness, stability, and development capacity of a country's economic structure. Economic stability requires the convergence of many elements, including controlling prices, ensuring sustainable growth, increasing employment, and maintaining external economic balance. In this context, analyses based solely on single indicators such as growth rates or unemployment may be insufficient to fully reflect a country's macroeconomic success. Increasing global economic uncertainties, the post-pandemic recovery process, and geopolitical vulnerabilities require a much more sensitive and multidimensional assessment of countries' macro performance. For today's decision-makers, determining not only the level of performance but also the factors driving this performance and its position relative to other countries is crucial.

In this context, measuring macroeconomic performance is considered not only a statistical endeavor but also a strategic tool that enables the assessment of policy impacts and comparative analysis. Comparative analysis of the macroeconomic structures of advanced industrialized economies, such as the G7 countries, and developing countries, such as Türkiye, which have become important actors in global trade and regional production chains, is particularly important for analyzing the success levels of different development models. While the G7 countries, which account for approximately half of the world economy, have long assumed economic leadership roles, emerging economies like Türkiye are moving toward decisive positions in regional balances and supply chain shifts. Therefore, analyzing these countries with different structural characteristics within the same framework not only provides a ranking but also allows for a more accurate interpretation of structural similarities and differences.

The use of MCDA methods in macroeconomic performance assessments has increased significantly in recent years. These methods have the capacity to simultaneously evaluate multiple economic indicators, reflect their effects with different weightings, and combine multidimensional structures into a single performance score. Lovell [1] emphasized the importance of this multidimensionality by developing a performance index combining unemployment, inflation, growth, and external balance. Chattopadhyay and Bose [2] combined classical indicators with the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method to rank developed and developing countries in terms of relative success. These studies demonstrate that univariate analyses can often be misleading and may overlook issues such as high inflation or unemployment, as well as high growth.

The primary objective of this study is to obtain a relative performance ranking between the G7 countries and Türkiye by evaluating various macroeconomic indicators, such as imports, exports, foreign direct investment, inflation, unemployment, and growth, from a holistic perspective. This study provides fundamental information for policymakers not only by revealing the level of national performance but also by revealing the critical indicators that drive this performance. An innovative aspect of this study is that it relies on an MCDA model, which, for the first time, comprises the LODECI, PSI, and WEDBA methods for measuring macroeconomic performance. Furthermore, the method used for the performance ranking is unique in its nature: the criteria weights calculated using LODECI and PSI are converted into the final ranking using the WEDBA method. This increases the reliability of the criteria weights and ensures that the final ranking yields more objective results. Another contribution of this study to the literature is that macro performance indicators are often limited to classical variables. This study goes beyond classical indicators to include elements such as imports, exports, and foreign direct investment. Furthermore, while the literature typically examines total foreign trade under a single heading, this study separates imports and exports to provide a more in-depth analysis of the structure of the external balance. Consequently, this study makes a significant contribution to the literature in terms of both its methodology and set of indicators.

This study analyzes the macroeconomic performance of the G7 countries and Türkiye in 2023 using a model that integrates MCDA methods such as LODECI, PSI, and WEDBA. Data used in the study were obtained from the World Bank. The primary objective of the study is to obtain a relative performance ranking among countries by evaluating various macroeconomic indicators such as imports, exports, foreign direct investment, inflation, unemployment, and growth from a holistic perspective. Because some of these indicators are benefit-oriented (growth, exports, and foreign direct investment), while others are cost-oriented (imports, inflation, and unemployment), the data were first converted to positive form using the Z-score standardization method. Then, criteria weights were determined using both the LODECI and PSI methods; more reliable and objective weights were obtained by integrating these methods. In the final stage, countries' weighted performance scores were calculated using the WEDBA method, and an overall ranking was established.

2 Literature Review

Effectively measuring macroeconomic performance is critical for assessing the economic health and policy success of countries. Strong macroeconomic stability is a prerequisite for competitiveness and sustainable growth. In an unstable economy, neither public services can be delivered efficiently nor firms can operate in a predictable environment. Therefore, numerous studies in the literature have attempted to reduce macroeconomic performance to a single measure by combining different indicators. The purpose of this review is to highlight current trends and the basis for our current study by examining macroeconomic assessments conducted using similar methods, particularly in the last decade.

In early studies, macroeconomic performance was generally measured with single or simple composite indicators. For example, Calmfors and Driffill [3] evaluated the impact of union bargaining structure on macro performance. The "magic diamond" proposed by the Organization for Economic Co-operation and Development (OECD) [4] was used as a primary tool for jointly monitoring growth, inflation, unemployment, and the external balance. However, the limited number of variables and equal weighting of their components have shown that these indicators are insufficient to reflect the diverse priorities of economies. In response to these limitations, composite performance indices developed using MCDM methods have gained prominence in literature in recent years. Chattopadhyay and Bose [2] developed a performance index based on six macroeconomic variables using the TOPSIS method. This index includes indicators such as real GDP growth, GDP per capita, unemployment, fiscal balance, inflation, and current account balance, and it ranks countries. Öztürk and Bayramoğlu [5] used the TOPSIS method to compare the macro performance of Türkiye and European Union (EU) countries between 2006 and 2016 and analyze periodic trends.

In their study on MENA countries, Oussama et al. [6] developed a TOPSIS-based index using four main indicators (GDP growth, unemployment, inflation, and foreign trade balance). This method allows for monitoring the countries' performances over time and for regional comparisons. Chattopadhyay and Bose [7] extended their earlier work by applying TOPSIS to Indian states, linking macroeconomic performance to bank credit flows. Coşkun [8] integrated Entropy and Weighted Aggregated Sum Product Assessment (WASPAS) methods to evaluate BRICS-T countries (BRICS-T countries (BRICS Transformed) refer to an expanded group of nations building on the original BRICS framework, which includes Brazil, Russia, India, China, and South Africa, with potential additional members or transformed cooperation), incorporating both classical indicators and external trade variables (exports, imports, FDI), and found China significantly outperforming other members. Arsu [9] applied Complex Proportional Assessment of Alternatives (COPRAS) to assess BRICS and Mexico, Indonesia, Nigeria, and Turkey (MINT) economies, revealing consistent superiority of China and Russia. Ju et al. [10] introduced a hybrid Entropy–Criteria Importance Through Intercriteria Correlation (CRITIC)–fuzzy Relative Operational Value (ROV) model to assess the logistics and trade performance of EU countries, linking logistics capacity with macroeconomic competitiveness.

Topçu and Oralhan [11] analyzed OECD countries using three different methods (ELECTRE, PROMETHEE, TOPSIS), compared the results of different MCDM techniques, and discussed the impact of method selection on the rankings. Tekman and Ordu [12] proposed a Stepwise Weight Assessment Ratio Analysis (SWARA)–Compromise Solution (CoCoSo) hybrid model for Turkish regional economies, capturing subjective expert weighting alongside objective rankings. Karaköy et al. [13] introduced a grey Proximity to Ideal Solution (PSI)–Weighted Euclidean Distance Based Approach (WEDBA) hybrid model to evaluate EU countries' economic freedom, demonstrating how novel techniques can handle uncertainty in data. Kara et al. [14] integrated Multi-criteria Evaluation of Renewable Energy Sources Competitiveness (MEREC) and Additive Ratio Assessment with Ideal Normalization (AROMAN) methods to measure Türkiye's sustainable competitiveness, emphasizing environmental and social dimensions alongside classical macro variables. Baydaş et al. [15] systematically evaluated normalization and aggregation methods (Combinative Distance-based Assessment, fuzzy approaches) on macroeconomic data, showing how methodological choices strongly affect ranking robustness. Więckowski [16] surveyed the most recent advances in MCDM methods, especially variants of TOPSIS and interval data handling, and highlighted their potential applications in macroeconomic contexts.

In their study on efficiency-based approaches, Lovell [1] measured the macro performance of Asian economies using Data Envelopment Analysis (DEA) and evaluated outputs such as growth, employment growth, external balance, and price stability without specifying any inputs. Furthermore, Lovell et al. [17] applied the efficiency frontier approach to OECD countries in a similar manner. Cherchye [18] evaluated the macroeconomic performance of 20 OECD countries during the 1992–1996 period using the DEA method, which combines multiple criteria into a single index. Nordin and Said [19] examined the productivity of the member countries of the Organization of Islamic Cooperation (OIC), and calculated DEA scores based on four key outcomes (growth, low inflation, low unemployment, and foreign trade surplus). Ouertani et al. [20] analyzed the effectiveness of public expenditures on macroeconomic outcomes using the DEA-bootstrap method in the case of Saudi Arabia. Halásková et al. [21] evaluated the efficiency of public services such as education and healthcare in European Union countries.

Wang and Le [22] measured the performance of developed and developing Asian economies using DEA, integrating debt and inflation as inputs and outputs. Mihaylova-Borisova and Nenkova [23] compared EU and Balkan countries during crisis periods, highlighting efficiency losses. Afonso et al. [24] analyzed the efficiency of taxation and public spending through international comparisons and emphasized that higher expenditure does not always lead to higher performance. Sağlam [25] applied a slack-based DEA model to 37 OECD countries for pre-pandemic, pandemic, and post-pandemic sub-periods, showing divergent productivity dynamics after COVID-19. Starčević et al. [26] integrated DEA with Principal Component Analysis (PCA), SWARA, and Comprehensive Risk Assessment and Decision Impact System (CRADIS) to evaluate the impact of FDI on the sustainability of Balkan economies. Profiroiu et al. [27] combined fuzzy MCDM with panel regression for Romanian regions, thus not only ranking but also identifying causal factors of regional disparities. Pascoe [28] further demonstrated the usefulness of DEA as a tool within broader MCDM frameworks, confirming its adaptability to macroeconomic contexts.

Recent studies also expand the criteria beyond classical macro indicators. Akandere and Zerenler [29] combined environmental and economic indicators using CRITIC-TOPSIS for Eastern European countries, showing that environmental outcomes significantly improve economic performance rankings. Liu et al. [30] introduced a TOPSIS–LASSO hybrid for French-speaking African countries, identifying foreign reserves and high-tech exports as decisive competitiveness factors. Mathebula and Mbuli [31] provided a systematic review of TOPSIS applications, including their use in macroeconomic and policy contexts. These innovations illustrate that modern studies increasingly pursue multi-dimensionality, combining economic, social, environmental, and technological variables.

Despite these important studies in the literature, some gaps remain. For example, very few studies utilize new and integrated methods such as LODECI, PSI, and WEDBA. Karaköy et al. [13] represent an exception with PSI-WEDBA, but broader applications in macroeconomic performance measurement are lacking. Furthermore, macro performance indicators are generally limited to classical variables, while studies such as Coşkun [8], Starčević et al. [26], and Ju et al. [10] highlight the importance of including FDI, logistics, and disaggregated trade indicators. This study goes beyond classical indicators to include elements such as imports, exports, and foreign direct investment. Furthermore, while the literature typically examines total foreign trade under a single heading, this study separates imports and exports to examine the structure of the external balance in more depth. Moreover, the method used for the performance ranking is unique in its nature: the criteria weights calculated using LODECI and PSI are converted into the final ranking using the WEDBA method. Consequently, this study makes a significant contribution to the literature in terms of both the methodology and the indicator set.

3 Methodology

A model combining the LODECI, PSI, and WEDBA methods is proposed to assess the macroeconomic indicator performance of the G7 countries and Türkiye. First, the Z-score (standard score) method was applied to convert negative values in the decision matrix to positive values. The LODECI and PSI methods were then used to determine the criteria weights, and the WEDBA method was used to rank countries according to their macroeconomic performance based on the calculated criteria weights. This section will explain the Z-score, LODECI, PSI, and WEDBA methods. Figure 1 shows the flowchart of the research methodology.

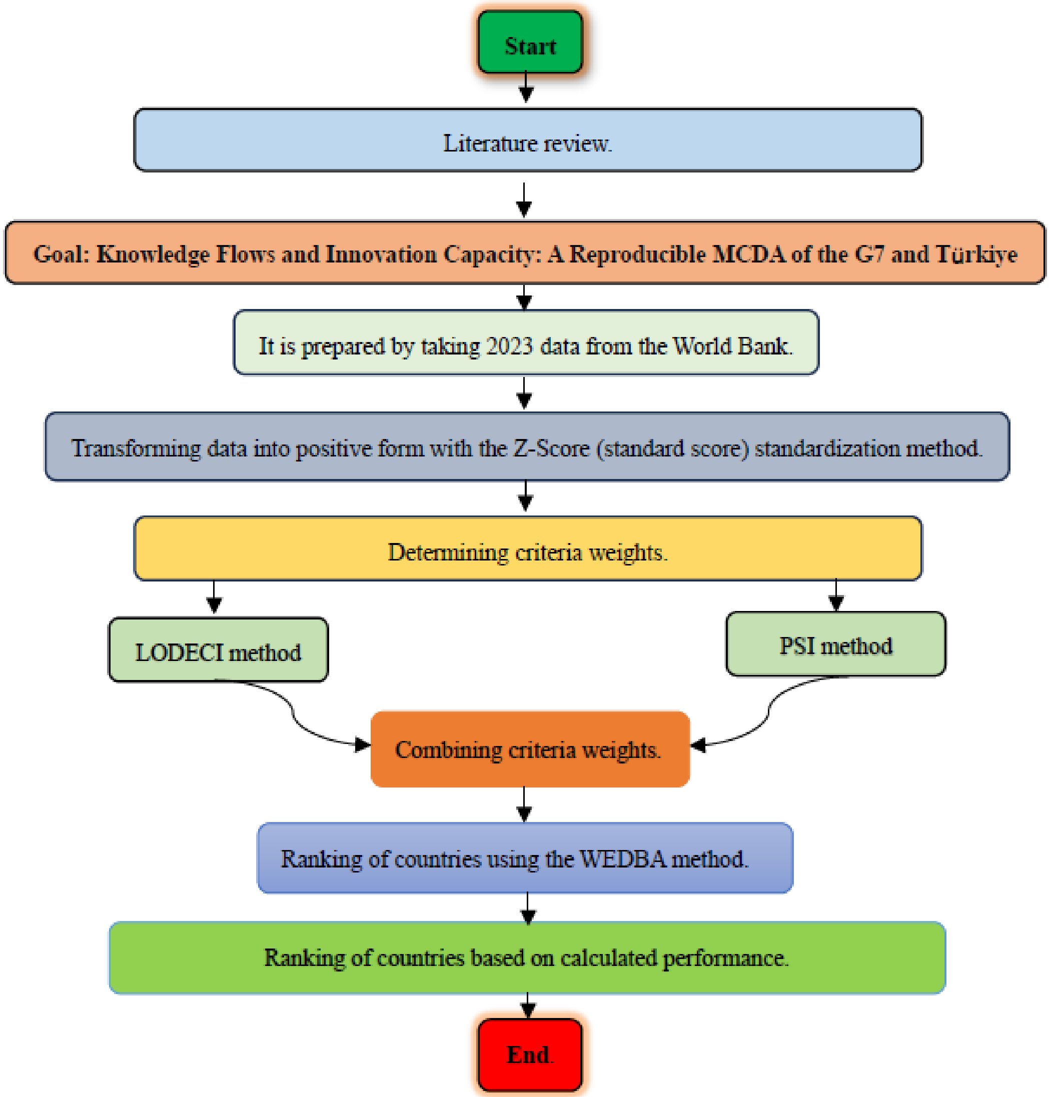

Figure 1. Flow diagram of research methodology

3.1 Z-Score (Standard Score) Standardization Method

It was developed by Zhang et al. [32] to convert negative values in the decision matrix into positive form in MCDA problems. The steps of the method are listed below [32, 33].

Step 1. The values in the decision matrix are transformed using Eq.(1).

$$B_{ij} = \frac{b_{ij} - \bar{b}_j}{\sigma_j} \tag{1}$$

where, B_{ij} is the Z-score and standardized value of the data belonging to region j corresponding to criteria i, b_{ij} defines the data, $\bar{b}_j$ defines the arithmetic mean value, and σ_j defines the standard deviation value.

Step 2. Negative values are converted to positive values using B_{ij} values.

$$B'_{ij} = B_{ij} + L; \quad L > |\min B_{ij}| \tag{2}$$

B'_{ij} prime represents the standardized data.

3.2 LODECI Method

Pala [34] developed the LODECI method as an approach combining the entropy and MEREC methods. This method works by taking into account the distances, or differences, between alternatives in each criterion. The mathematical description of the method shows that the distances between the criteria and alternative values are converted into numerical expressions using logarithmic discriminant functions, and the obtained values can then be used in related analyses. The maximum normalization used in the method yields more appropriate results, particularly in decision-making problems dominated by benefit criteria. Furthermore, the method is structured around intensive mathematical function calculations [34, 35]. Some studies using the LODECI method are as follows. Pala [34] used the LODECI method in evaluating the social progress of the members of the European Union. Pala et al. [36] used the LODECI method in financial performance analysis of cement strategies. Demirhan et al. [37] used the LODECI method in the performance analysis of banks. Çilek and Şeyranlıoğlu [38] used the LODECI method in the financial performance analysis of reinsurance companies. Tufan and Ulutaş [39] used the LODECI method in being a food supplier in the sector. Yalçın et al. [40] used the LODECI method in commercial insurance selection. Yalçın [41] used the LODECI method in sustainable tractor selection in a green port. Tatar [42] used the LODECI method in cybersecurity risk assessment in maritime transportation. The steps of the method are listed below [34, 36].

Step 1: The decision matrix is created.

$$B = [b_{ij}]_{m \times n} \tag{3}$$

Step 2: The matrix in Eq.(3) is normalized.

$$g_{ij} = \frac{b_{ij}}{\max(b_{ij})} \quad \text{if } j \in BN \tag{4}$$

$$g_{ij} = 1 - \frac{\min(b_{ij})}{b_{ij}} \quad \text{if } j \in CS \tag{5}$$

Step 3: Discrimination value (DV) is calculated using Eq.(6).

$$DV_{ij} = \text{maks}\{|g_{ij} - g_{rj}|\}\, r \neq i \tag{6}$$

Step 4: The logarithmic discrimination value of each criterion is calculated using Eq.(7).

$$LDV_j = In\left(1 + \frac{\sum_{i=1}^{n} DV_{ij}}{m}\right) \tag{7}$$

Step 5: The relative importance levels of the criteria are calculated within the scope of Eq.(8).

$$w_{jLODECI} = \frac{LDV_j}{\sum_{i=1}^{n} LDV_j} \tag{8}$$

3.3 PSI Method

The PSI method can be used in situations where there is a discrepancy in the relative importance of criteria, and this is one of its strengths. Its statistically based structure makes the PSI method more systematic, easily applicable, and understandable than methods such as Grey Target-Measurement Analysis (GTMA), VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR), and TOPSIS [43]. Some studies that use the PSI method are summarized as follows. Maniya and Bhatt [43] used the PSI method in material selection. Ulutaş et al. [44] used the PSI method in transportation company selection. Raj et al. [45] used the PSI method in evaluating the potential contributions of ChatGPT for improving the effectiveness and efficiency of business processes, and its possible application areas. Vahdani et al. [46] used the PSI method in the fuel type selection problem. Khorshidi and Hassani [47] used the PSI method in the material selection problem. Ulutaş et al. [48] used the PSI method in the selection of third-party logistics service providers of automobile manufacturing enterprises. Van Dua [49] used the PSI method in the selection of sustainable energy development technologies. Sutrisno and Kumar [50] used the PSI method in supply chain sustainability risk assessment. Ulutaş et al. [51] used the PSI method in material selection. Gligorić et al. [52] used the PSI method in selecting the support system. Attri and Grover [53] used the PSI method for decision-making during the design phase of the production system life cycle. Madić et al. [54] used the PSI method for the evaluation of the laser cutting process. The stages of the PSI method used in calculating the criteria weights are listed below [55].

Step 1. The decision matrix is created. The decision matrix is given in Eq.(3).

Step 2. The matrix in Eq.(3) is normalized.

$$b_{ij}^{*} = \frac{b_{ij}}{\max\left(b_{ij}\right)} \quad \text{if } j \in BN \tag{9}$$

$$b_{ij}^{*} = \frac{\min\left(b_{ij}\right)}{b_{ij}} \quad \text{if } j \in CS \tag{10}$$

Step 3. The average of the normalized values is calculated using Eq.(11).

$$\bar{b}_{ij}^{*} = \frac{\sum_{i=1}^{m} b_{ij}^{*}}{m} \tag{11}$$

Step 4. Preference variance (PV_j) is calculated using Eq.(12).

$$PV_j = \sum_{i=1}^{m} \left(b_{ij}^{*} - \bar{b}_{ij}^{*}\right)^2 \tag{12}$$

Step 5. The overall preference value ∇_j is calculated using Eq.(13) and the weight of each criterion (w_{jPSI}) is calculated using Eq.(14).

$$\nabla_j = \left|1 - PV_j\right| \tag{13}$$

$$w_{jPSI} = \frac{\nabla_j}{\sum_{j=1}^{n} \nabla_j} \tag{14}$$

Criteria weights calculated with LODECI and PSI methods are combined using Eq.(15).

$$w_j^{CM} = \frac{w_{jLODECI} + w_{jPSI}}{2} \tag{15}$$

3.4 WEDBA Method

The WEDBA approach allows alternatives to be evaluated according to their weighted distances from the best and worst cases. In this framework, the ideal point represents the most favorable case, and the anti-ideal point represents the least favorable case [56–58]. The method uses three types of weights: objective weights, subjective weights, and their combined weights [58, 59]. Some studies that use the PSI method are as follows. Kara et al. [60] used the WEDBA method in evaluating the academic performance of universities. Karaköy et al. [61] used the WEDBA method in evaluating the economic freedom index of the European Union. Hezam et al. [62] used the WEDBA method in examining the location, technology, and sustainability of wave energy converters. Gupta and Garg [63] used the WEDBA method in selecting the most appropriate software reliability growth models. The steps of the WEDBA method used in ranking the alternatives are listed below [58, 59, 64].

Step 1: The decision matrix is created. The decision matrix is given in Eq.(3).

Step 2: The matrix in Eq.(3) is normalized.

$$p_{ij} = \frac{\min\left(b_{ij}\right)}{b_{ij}} \text{ if } j \in BN \tag{16}$$

$$p_{ij} = \frac{b_{ij}}{\max\left(b_{ij}\right)} \text{ if } j \in CS \tag{17}$$

Step 3: The values in the normalized decision matrix are standardized with the help of Eq.(18).

$$f_{ij} = \frac{p_{ij} - \mu_j}{\sigma_j} \tag{18}$$

Here, μ_j represents the mean value of the j criteria, while σ_j represents the standard deviation of the j criteria. The μ_j value is calculated using Eq.(19), and the σ_j value is calculated using Eq.(20).

$$\mu_j = \frac{\sum_{i=1}^{m} p_{ij}}{m} \tag{19}$$

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{m} (p_{ij} - \mu_j)^2}{m}} \tag{20}$$

Step 4: Ideal $\left(f_{ij}^{+}\right)$ values are calculated with the help of Eq.(21), and anti-ideal $\left(f_{ij}^{-}\right)$ values are calculated with the help of Eq.(22).

$$f_{ij}^{+} = \max\left(f_{ij}\right) \tag{21}$$

$$f_{ij}^{-} = \min\left(f_{ij}\right) \tag{22}$$

Step 5: Weighted Euclidean Distances $\left(WED_{\mathrm{i}}^{+}, WED_{\mathrm{i}}^{-}\right)$ and Index Score (IS_i) of each alternative are calculated.

$$WED_{\mathrm{i}}^{+} = \sqrt{\sum_{j=1}^{n} \left\{w_j \left(f_{ij} - f_{ij}^{+}\right)\right\}^2} \tag{23}$$

$$WED_{\mathrm{i}}^{-} = \sqrt{\sum_{j=1}^{n} \left\{w_j \left(f_{ij} - f_{ij}^{-}\right)\right\}^2} \tag{24}$$

$$IS_i = \frac{WED_{\mathrm{i}}^{-}}{WED_{\mathrm{i}}^{-} + WED_{\mathrm{i}}^{+}} \tag{25}$$

The alternative with the highest index score is preferred as the best alternative.

4 Application

In this study, the performance of the G7 countries (Canada, France, Germany, Italy, Japan, UK, and USA) and Türkiye in terms of their macroeconomic indicators for 2023 will be evaluated within the framework of a model that integrates the LODECI, PSI, and WEDBA methods. All data for the study are taken from the World Bank website [65]. The criteria used in the study are Import (C1), Inflation (C2), Unemployment (C3), GDP growth (C4), Export (C5), and FDI(C6). Of these criteria, Import (C1), Inflation (C2), and Unemployment (C3) are considered to be unprofitable, while GDP growth (C4), Export (C5), and FDI(C6) are considered to be beneficial. Due to negative values in the decision matrix created based on data from the World Bank, these values were converted to positive values using a Z-score. After converting the data in the decision matrix to positive values, the LODECI and PSI methods will be used to determine the criteria weights. Based on the calculated criteria weights, the WEDBA method will be applied to rank countries according to their macroeconomic indicators. Data from the World Bank website is presented in Table 1.

Table 1. Decision matrix

	C1	**C2**	**C3**	**C4**	**C5**	**C6**
Canada	723.340	3.8790	5.415	1.5287	724.806	42.076
France	1.107.189	4.8783	7.335	0.9365	1.046.168	8.803
Germany	1.782.980	5.9464	3.068	-0.2664	1.964.261	77.438
Italy	739.918	5.6221	7.627	0.7153	772.843	42.019
Japan	981.637	3.2681	2.6	1.4750	920.644	20.179
United Kingdom	1.113.837	6.7939	3.984	0.3971	1.077.661	13.789
United States	3.849.811	4.1163	3.638	2.8875	3.052.469	348.784
Türkiye	384.240	53.8594	9.388	5.1112	356.899	10.657

Source: World Bank [65].

The values in the decision matrix are rounded due to the large size of the main values. However, all operations were performed based on the main values.

4.1 Implementation Process of the Z-Score Standardization Method

In order to apply the methods in the model to be implemented in the study, the negative values in Table 1 must be converted to positive form by applying the Z-score standardization method. The decision matrix converted to positive form by applying Eqs.(1) and (2) to the values in Table 1 is shown in Table 2.

Table 2. Positive transformed decision matrix

	C1	C2	C3	C4	C5	C6
Canada	0.5707	0.7167	1.1434	1.0891	0.5351	0.8827
France	0.9215	0.7743	1.9181	0.7401	0.9066	0.5928
Germany	1.5390	0.8359	0.1963	0.0313	1.9678	1.1907
Italy	0.5859	0.8172	2.0359	0.6098	0.5906	0.8822
Japan	0.8068	0.6814	0.0075	1.0575	0.7615	0.6919
United Kingdom	0.9276	0.8848	0.5660	0.4223	0.9430	0.6363
United States	3.4277	0.7304	0.4263	1.8898	3.2257	3.5545
Türkiye	0.2609	3.5993	2.7465	3.2001	0.1098	0.6090

4.2 Obtaining Criteria Weights

The criteria weights required to be calculated for measuring macroeconomic performance of the G7 countries and Türkiye were obtained by applying the LODECI and PSI methods. In this section, the criteria weights will be calculated using the LODECI and PSI methods.

4.2.1 LODECI method

The normalized decision matrix is created by using Eqs.(4) and (5) for the values in the positively transformed decision matrix in Table 2. Table 3 shows the normalized decision matrix obtained with the LODECI method.

Table 3. LODECI method normalized decision matrix

	C1	C2	C3	C4	C5	C6
Canada	0.5428	0.0493	0.9934	0.3403	0.1659	0.2483
France	0.7169	0.1200	0.9961	0.2313	0.2811	0.1668
Germany	0.8305	0.1848	0.9618	0.0098	0.6100	0.3350
Italy	0.5547	0.1662	0.9963	0.1906	0.1831	0.2482
Japan	0.6766	0	0	0.3305	0.2361	0.1947
United Kingdom	0.7187	0.2299	0.9867	0.1320	0.2923	0.1790
United States	0.9239	0.0671	0.9824	0.5905	1	1
Türkiye	0	0.8107	0.9973	1	0.0340	0.1713

LODECI-based criteria weights were calculated by applying the operations of Eqs.(6) and (8) to the normalized decision matrix in Table 3, and the results are shown in Table 4.

Table 4. Criteria weights according to the LODECI method

	CR1	CR2	CR3	CR4	CR5	CR6
LDV_j	0.5516	0.5356	0.6876	0.5834	0.5843	0.5801
w_{jLODECI}	0.1566	0.1520	0.1952	0.1656	0.1659	0.1647

In Table 4, the criteria weight order based on the LODECI method results is as follows: Unemployment (C3) > Export (C5) > GDP growth (C4) > FDI(C6) > Import (C1) > Inflation (C2). The criteria weights obtained as a result of the LODECI method are transferred to Eq.(15) for merging purposes.

4.2.2 PSI method

The normalized decision matrix is created by using Eqs.(9) and (10) for the values in the positively transformed decision matrix in Table 2. Table 5 shows the normalized decision matrix obtained with the PSI method.

Table 5. PSI method normalized decision matrix

	C1	C2	C3	C4	C5	C6
Canada	0.4572	0.9507	0.0066	0.3403	0.1659	0.2483
France	0.2831	0.8800	0.0039	0.2313	0.2811	0.1668
Germany	0.1695	0.8152	0.0382	0.0098	0.6100	0.3350
Italy	0.4453	0.8338	0.0037	0.1906	0.1831	0.2482
Japan	0.3234	1	1	0.3305	0.2361	0.1947
United Kingdom	0.2813	0.7701	0.0133	0.1320	0.2923	0.1790
United States	0.0761	0.9329	0.0176	0.5905	1	1
Türkiye	1	0.1893	0.0027	1	0.0340	0.1713

PSI-based criteria weights were calculated by applying the operations between Eqs.(11) and (15) to the normalized decision matrix in Table 5, and the results are shown in Table 6.

Table 6. PSI method results

	C1	C2	C3	C4	C5	C6
PV_j	0.5534	0.4619	0.8546	0.6834	0.6728	0.5540
∇_j	0.4466	0.5381	0.1454	0.3166	0.3272	0.4460
w_{jPSI}	0.2012	0.2424	0.0655	0.1426	0.1474	0.2009

The criteria weight ordering based on the PSI method results in Table 6 is as follows: Inflation (C2) > Import (C1) > FDI(C6) > Export (C5) > GDP growth (C4) > Unemployment (C3). The criteria weights obtained as a result of the PSI method are transferred to Eq.(15) for the purpose of combining.

By applying Eq.(15), the criteria weights calculated according to the LODECI and PSI methods are combined. The combined criteria weights are listed in Table 7.

Table 7. Combined criteria weights

	C1	C2	C3	C4	C5	C6
$w_{jLODECI}$	0.1566	0.1520	0.1952	0.1656	0.1659	0.1647
w_{jPSI}	0.2012	0.2424	0.0655	0.1426	0.1474	0.2009
w_j^{CM}	0.1789	0.1972	0.1304	0.1541	0.1567	0.1828

Combined criteria weight ranking based on the results in Table 7: Inflation (C2) > FDI(C6) > Import (C1) > Export (C5) > GDP growth (C4) > Unemployment (C3). According to the combined criteria weights, the most important criterion was Inflation (C2), while the least important criterion was Unemployment (C3).

4.3 Ranking of Countries

The ranking of G7 countries and Türkiye according to macroeconomic performance was made by transferring the combined criteria weights to the WEDBA method. This section will rank the countries determined using the WEDBA method.

4.3.1 WEDBA method

The normalized decision matrix is created by using Eqs.(16) and (17) for the values in the positively transformed decision matrix in Table 2. Table 8 shows the normalized decision matrix obtained with the WEDBA method.

The values in the normalized decision matrix are standardized by applying Eqs.(18) and (20) to the normalized decision matrix in Table 8. The standardized decision matrix according to the WEDBA method is given in Table 9.

The WEDBA method results were calculated by applying the operations between Eqs.(21) and (25) to the standardized decision matrix in Table 9, and the results are shown in Table 10.

According to the WEDBA method results in Table 10, the country rankings in terms of macroeconomic indicators are: United States > Japan > Canada > Türkiye > Italy > Germany > France > United Kingdom. Based on the ranking, the country with the best macroeconomic performance was determined to be the United States, while the country with the worst macroeconomic performance was determined to be the United Kingdom.

Table 8. WEDBA method normalized decision matrix

	C1	C2	C3	C4	C5	C6
Canada	0.4572	0.9507	0.0066	0.3403	0.1659	0.2483
France	0.2831	0.8800	0.0039	0.2313	0.2811	0.1668
Germany	0.1695	0.8152	0.0382	0.0098	0.6100	0.3350
Italy	0.4453	0.8338	0.0037	0.1906	0.1831	0.2482
Japan	0.3234	1	1	0.3305	0.2361	0.1947
United Kingdom	0.2813	0.7701	0.0133	0.1320	0.2923	0.1790
United States	0.0761	0.9329	0.0176	0.5905	1	1
Türkiye	1	0.1893	0.0027	1	0.0340	0.1713

Table 9. WEDBA method standardized decision matrix

	C1	C2	C3	C4	C5	C6
Canada	0.2763	0.6003	-0.3696	-0.0410	-0.5949	-0.2474
France	-0.3427	0.3251	-0.3774	-0.3899	-0.2233	-0.5371
Germany	-0.7467	0.0728	-0.2792	-1.0987	0.8377	0.0607
Italy	0.2340	0.1452	-0.3779	-0.5201	-0.5394	-0.2478
Japan	-0.1994	0.7922	2.4735	-0.0724	-0.3684	-0.4380
United Kingdom	-0.3491	-0.1028	-0.3505	-0.7077	-0.1871	-0.4938
United States	-1.0788	0.5310	-0.3381	0.7597	2.0957	2.4245
Türkiye	2.2064	-2.3638	-0.3808	2.0702	-1.0203	-0.5211

Table 10. WEDBA method results

	WED_i^+	WED_i^-	IS_i	Rank
Canada	0.8833	0.6590	0.4273	3
France	0.9610	0.5710	0.3727	7
Germany	0.9445	0.5756	0.3787	6
Italy	0.9206	0.5625	0.3793	5
Japan	0.8468	0.7657	0.4749	2
United Kingdom	0.9857	0.4863	0.3304	8
United States	0.7234	0.9692	0.5726	1
Türkiye	1.0267	0.7641	0.4267	4

5 Conclusion

This study set out to measure and compare the macroeconomic performance of the G7 countries and Türkiye for the year 2023 using an integrated MCDA framework that combines the LODECI, PSI, and WEDBA methods. By jointly applying these approaches, the analysis produced reliable criteria weights and a robust ranking system that goes beyond traditional single-indicator evaluations. The findings revealed that inflation (C2) was the most decisive factor in determining performance, while unemployment (C3) had the least weight. This result emphasizes the priority attached to price stability in contemporary macroeconomic evaluations. In terms of country rankings, the United States achieved the highest performance, followed by Japan and Canada, whereas the United Kingdom ranked last. Türkiye occupied the fourth position, reflecting both its strong growth dynamics and ongoing structural challenges.

The contributions of this study are twofold. Methodologically, it demonstrates the originality and value of integrating LODECI, PSI, and WEDBA within the same framework—an approach not previously applied in the literature. This integration ensures that the weaknesses of a single weighting method are offset by the strengths of another, ultimately producing more balanced results. Substantively, the study enriches the macroeconomic performance literature by incorporating trade- and investment-oriented indicators such as imports, exports, and foreign direct investment. Unlike many prior works that treat foreign trade as a single aggregate, this research separates imports and exports, offering a more detailed picture of external balance structures. By doing so, it provides deeper insights into how external sector dynamics influence overall performance.

Despite these contributions, certain limitations must be acknowledged. The analysis was restricted to World Bank data for a single year (2023), which prevents capturing the long-term evolution of macroeconomic performance. Only six indicators were included, meaning that other relevant variables such as fiscal balance, debt sustainability, technological innovation, or environmental factors were excluded. Another limitation concerns the absence of subjective expert assessments, which might have enriched the analysis by combining quantitative data with qualitative perspectives. Finally, the cross-sectional design limits the generalizability of the findings, as they may change when additional years or alternative datasets are considered.

Looking ahead, future studies could address these limitations in several ways. First, expanding the set of indicators to include fiscal, social, and environmental dimensions would allow for a more holistic assessment. Second, integrating expert-based subjective weighting methods or hybrid fuzzy and grey system approaches could strengthen the robustness of results under conditions of uncertainty. Third, longitudinal analyses covering multiple years would shed light on performance dynamics and resilience to shocks such as financial crises or geopolitical tensions. Moreover, the integrated model developed in this research can be adapted to different contexts, such as assessing regional economic competitiveness, evaluating logistics performance, or analyzing sustainable development indicators. In this sense, the study not only contributes to the macroeconomic performance literature but also opens new avenues for the application of advanced MCDA methods in diverse fields.

In conclusion, the findings demonstrate that an integrated MCDA model provides a richer and more nuanced evaluation of macroeconomic performance than conventional approaches. The United States' leading position, Türkiye's intermediate but dynamic standing, and the United Kingdom's weaker performance highlight the differentiated outcomes of structural and policy choices among advanced and emerging economies. By combining methodological innovation with substantive insights, this study offers valuable guidance for policymakers and researchers seeking to understand and improve macroeconomic performance in an increasingly complex global environment.

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Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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