

A Multi-Criteria Assessment of Economic Performance in G20 Countries Using an Entropy-COPRAS Approach

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Abstract

This study evaluates the economic performance of G20 countries using a multi-criteria approach. The Entropy method is used to determine the weights of the criteria and the COPRAS method is applied to rank the countries. To evaluate the economic performance of countries, ten macroeconomic variables are obtained from the World Bank. The results show that countries such as Canada, Australia, and Korea perform better in terms of overall economic performance. In contrast, Argentina and South Africa remain at lower levels. The findings also show that having a good position in some indicators are not sufficient to have a higher rank. Countries must have a balanced performance across all indicators to have a stable position in an economic manner. Overall, the study highlights the importance of using a multidimensional framework when evaluating economic performance. The proposed approach provides a simple and transparent way to compare countries and can be applied to different datasets or time periods.

Keywords

Economic performance, Entropy method, COPRAS, Multi-criteria decision-making, World Bank indicators

1. Introduction

Economic performance is an important issue for both developed and developing countries. Governments aim to improve economic growth while maintaining economic stability. They also want to attract investments and increase employment. Traditionally, economic performance is often evaluated using a limited number of indicators such as gross domestic product (GDP), GDP per capita, and unemployment rate. However, relying on a small set of indicators may not fully reflect the overall economic situation of a country.

In recent years, researchers have emphasized that economic performance should be evaluated using multiple indicators. Different aspects such as growth, trade, labor market conditions, stability, and investment environment together provide a more complete picture (Stiglitz et al., 2009.) For this reason, composite indices and multi-criteria evaluation approaches have become more common in the literature. (OECD, 2008). Therefore, evaluating economic performance using multiple indicators has become increasingly important.

1.1 Objectives

In this study, the economic performance of G20 countries is evaluated using a set of indicators obtained from the World Bank database (World Bank, 2023). The evaluation is realized for the year 2024. Instead of focusing only on GDP, GDP per capita, or unemployment rate, a multidimensional framework is used. The Entropy method is applied to determine the weights of the indicators, and the Complex Proportional Assessment (COPRAS) method is used to rank the countries (Shannon, 1948; Zavadskas et al., 1994).

The main contribution of this study is to provide a simple and data-driven evaluation of economic performance based on multiple indicators. The results are expected to offer a clearer comparison of countries and help better understand

their economic positions. The remaining part of the study is organized as follows. Literature review is presented in the next section. Methods are explained in Section 3. Section 4 illustrates the data collection process. Results and discussion are presented in Section 5. Conclusions are provided in the last section.

2. Literature Review

Multi-criteria decision-making (MCDM) methods are widely used to analyze complex problems that involve multiple indicators. These methods allow researchers to consider different criteria at the same time and produce a ranking of alternatives. Recent studies have used multi-criteria approaches to evaluate economic and financial performance from different perspectives. Kete and Karasac (2022) examined the impact of the COVID-19 epidemic on the economic performances of 27 member states of the European Union and Turkey. Unvan and Ergenc (2022) performed a financial performance analysis of banks using different MCDM methods. Busu et al. (2020) analyzed the economic factors which are the basis of economic performances of the new companies from the retails sector of Romania. In the literature, the Entropy method is often used to determine objective weights based on the variability of the data (Shannon, 1948).

In addition to academic studies, several international indices have been developed to evaluate the economic competitiveness, innovation capacity, and overall economic structure of countries. Table 1 presents several widely used international economic and competitiveness indices together with their main focus areas and methodological approaches (Unal and Dursun, 2026).

Table 1. Overview of international economic evaluation indices

Index	Main Focus	Methodological Approach
IMD (IMD World Competitiveness Center, 2024)	Competitiveness, economic performance	Composite index, survey and statistical data
GCI (World Economic Forum, 2019)	Productivity, long-term competitiveness	Multi-pillar framework, weighted aggregation
IEF (The Heritage Foundation, 2024)	Economic freedom, market openness	Equal weighting, score-based evaluation
ECI (Harvard Growth Lab, 2024)	Economic dynamics, growth opportunities	Network-based model, export complexity analysis
BLI (OECD, 2024)	Economic well-being, quality of life	Composite indicators, dimension-based weighting
GII (World Intellectual Property Organization, 2024)	Innovation capacity, innovation performance	Multi-criteria framework, weighted scoring system

3. Methods

3.1 Entropy Weighting Method

The Entropy method is used to determine the objective weights of the criteria. The method consists of the following steps:

First, a decision matrix is constructed, where each row represents a country and each column represents a criterion. Then, the decision matrix is normalized to eliminate the effect of different measurement units. The normalized values are calculated as:

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^m x_{ij}}$$

where x_{ij} is the value of country i for criterion j , and p_{ij} is the normalized value. Next, the entropy value for each criterion is calculated as:

$$e_j = -k \sum_{i=1}^m p_{ij} \ln(p_{ij})$$

where $k = \frac{1}{\ln(m)}$ and m is the number of countries. After that, the degree of diversification is obtained:

$$d_j = 1 - e_j$$

Finally, the weights of the criteria are calculated as:

$$w_j = \frac{d_j}{\sum_{j=1}^n d_j}$$

where w_j represents the weight of criterion j .

3.2 COPRAS Method

The COPRAS method is used to rank the countries based on both beneficial and non-beneficial criteria. This method evaluates the performance of alternatives by considering positive and negative effects separately. The method consists of the following steps:

First, the normalized decision matrix obtained from the Entropy method is multiplied by the corresponding weights to obtain the weighted normalized matrix:

$$v_{ij} = w_j \cdot p_{ij}$$

where w_j is the weight of criterion j and p_{ij} is the normalized value. Then, the sums of beneficial and non-beneficial criteria are calculated for each country:

$$S_i^+ = \sum v_{ij}, j \in J^+ \\ S_i^- = \sum v_{ij}, j \in J^-$$

where J^+ and J^- represent the sets of beneficial and non-beneficial criteria, respectively. Next, the relative significance of each country is calculated as:

$$Q_i = S_i^+ + \frac{S_i^-}{S_i^-} \cdot \frac{1}{\sum \left(\frac{S_i^-}{S_i^-} \right)}$$

Finally, the performance index is obtained as:

$$P_i = \frac{Q_i}{\max Q_i} \times 100$$

where P_i represents the performance score of country i . Countries are ranked according to their P_i values, with higher values indicating better economic performance.

4. Data Collection

In this study, the economic performance of G20 countries is evaluated. To perform the evaluation, ten macroeconomic indicators (Criteria) are used and they are obtained from the World Bank database (World Bank, 2023). The analysis is conducted for the year 2024. The analysis includes 19 countries. Instead of relying on a single indicator such as GDP, multiple criteria are used to better reflect different dimensions of economic performance such as economic growth, stability, trade, investment, and labor market conditions. Ten indicators are; GDP growth, GDP per capita, gross capital formation, exports and imports of goods and services, total trade, unemployment rate, labor force participation rate, inflation and foreign direct investment. Definitions of criteria and their codes are given in Table 2.

The criteria are classified as benefit and cost type. ECO7 (Unemployment rate) and ECO9 (Inflation) are treated as cost criteria, where lower values are preferred. The remaining indicators are considered as benefit criteria, where higher values indicate better performance.

Table 2. Indicators and their codes

Codes	Indicators
ECO1	GDP growth (annual %)
ECO2	GDP per capita (PPP, current international \$)
ECO3	Gross capital formation (% of GDP)
ECO4	Exports of goods and services (% of GDP)
ECO5	Imports of goods and services (% of GDP)
ECO6	Total trade (% of GDP)

ECO7	Unemployment rate (% of total labor force)
ECO8	Labor force participation rate (% of population ages 15+)
ECO9	Inflation (consumer prices, annual %)
ECO10	Foreign direct investment, net inflows (% of GDP)

The analysis is based on the decision matrix presented in Table 3 which includes 19 G20 countries and ten economic indicators obtained from the World Bank database (World Bank, 2023).

Table 3. Decision matrix of G20 countries based on selected economic indicators

Countries	ECO1	ECO2	ECO3	ECO4	ECO5	ECO6	ECO7	ECO8	ECO9	ECO10
United States	2,79	84534,04	21,84	11,11	14,27	25,38	4,02	73,71	2,95	1,03
Germany	-0,50	56103,73	21,50	41,43	37,66	79,09	3,40	79,94	2,26	1,02
Argentina	-1,34	13969,78	15,84	15,25	12,68	27,93	7,15	70,54	219,88	1,82
Australia	1,37	64603,99	24,32	24,62	22,52	47,15	3,94	80,56	3,16	3,04
Brazil	3,42	10310,55	16,98	17,94	17,65	35,58	6,80	70,97	4,37	3,39
China	4,98	13303,15	40,61	20,02	17,18	37,20	4,59	74,36	0,22	0,10
Indonesia	5,03	4925,43	31,40	22,18	20,39	42,57	3,30	70,05	2,18	1,74
France	1,19	46103,08	21,51	33,89	34,22	68,11	7,40	74,07	2,00	1,65
South Africa	0,53	6267,19	14,07	31,79	29,85	61,65	32,28	60,42	4,36	0,58
South Korea	2,00	36238,64	29,97	44,36	40,28	84,64	2,78	70,96	2,32	0,81
India	6,49	2694,74	32,91	21,16	23,49	44,65	4,17	58,99	4,95	0,69
United Kingdom	1,13	53246,37	19,12	30,98	31,86	62,84	4,36	76,78	3,27	-0,35
Italy	0,69	40385,34	22,58	32,51	30,32	62,82	6,50	66,62	0,98	1,13
Japan	0,10	32487,08	26,18	22,77	23,64	46,41	2,50	82,04	2,74	0,40
Canada	1,55	54340,35	23,20	32,44	32,71	65,15	6,35	79,87	2,38	2,81
Mexico	1,43	14185,78	24,12	36,70	37,89	74,59	2,68	66,14	4,72	2,45
Russian Federation	4,34	14889,02	26,30	21,92	17,59	39,51	2,43	76,44	8,43	-0,43
Saudi Arabia	2,00	35121,66	30,24	29,11	25,57	54,68	3,52	66,55	1,69	1,72
Turkiye	3,33	15892,72	30,73	27,57	27,03	54,60	8,80	60,40	58,51	0,86

The results obtained from the Entropy and COPRAS methods are presented in the next section.

5. Results and Discussion

5.1 Entropy and COPRAS Results

The Entropy method is applied to determine the objective weights of the criteria. The results are presented in Table 4.

Table 4. Criteria Weights

Criteria	Weight
ECO1	0,0992
ECO2	0,1855
ECO3	0,1083
ECO4	0,0895
ECO5	0,1178

ECO6	0,1126
ECO7	0,031
ECO8	0,1053
ECO9	0,0307
ECO10	0,1201

The results of Entropy method show that ECO2 is the most important criterion influencing economic performance of selected G20 countries. In contrast, the results also show that ECO7 and ECO9 are the least critical criteria

Using the weights obtained from the Entropy method, the COPRAS method is applied to rank the countries. The results are presented in Table 5.

Table 5. COPRAS results and ranking of G20 countries

Rank	Country	S+	S-	Q	Utility %
1	Canada	0,0652	0,0019	0,0678	100,0000
2	Australia	0,0635	0,0013	0,0672	99,1116
3	Korea, Rep.	0,0598	0,0010	0,0650	95,8875
4	Germany	0,0599	0,0011	0,0644	95,0223
5	United States	0,0566	0,0013	0,0603	88,9365
6	France	0,0579	0,0021	0,0602	88,8316
7	Japan	0,0534	0,0011	0,0577	85,1699
8	United Kingdom	0,0530	0,0011	0,0576	84,9819
9	Italy	0,0514	0,0018	0,0541	79,8688
10	Saudi Arabia	0,0507	0,0015	0,0541	79,7851
11	China	0,0451	0,0011	0,0497	73,3152
12	Russian Federation	0,0423	0,0009	0,0478	70,4466
13	Brazil	0,0450	0,0022	0,0473	69,7365
14	India	0,0423	0,0012	0,0463	68,2937
15	Türkiye	0,0456	0,0078	0,0463	68,2425
16	Indonesia	0,0430	0,0016	0,0462	68,1604
17	Mexico	0,0374	0,0014	0,0409	60,3655
18	South Africa	0,0358	0,0090	0,0364	53,6191
19	Argentina	0,0304	0,0223	0,0307	45,2414

Canada, Australia and Korea rank at the top with the highest utility scores. The reason is that they show balanced performance across all indicators. On the other hand, Argentina, South Africa, Mexico are positioned at the lower end of the ranking. In addition, Japan, United Kingdom and Italy rank in the middle group.

6. Conclusion

In this study, the economic performance of 19 G20 countries for the year 2024 are evaluated using an Entropy–COPRAS approach based on ten macroeconomic indicators. These indicators are retrieved from World Bank database. The results reveal that countries such as Canada, Australia, and Korea rank at the top. Because, they show higher performance in multiple criteria. However, Argentina and South Africa are positioned at the lower end of the ranking. Türkiye, for instance, ranks in the lower-middle group, where high inflation plays a significant role in reducing its overall

performance despite moderate results in other indicators. These findings suggest that it is unlikely to evaluate economic performance of countries considering a single factor and the evaluation process has to be done by considering multiple dimensions. As a limitation, the study is based on a selected set of indicators and available data. Future studies may include additional variables, consider time-series analysis, or compare different multi-criteria methods to enhance the robustness of the results. The study provides a simple and multidimensional framework for evaluating the economic performance of countries.

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