REPUBLIC OF TURKIYE
CUKUROVA UNIVERSITY
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EVALUATION OF MACROECONOMIC PERFORMANCE OF SUB-SAHARAN AFRICAN COUNTRIES WITH MCDM METHODS

ALTAYEB ALHADI DAWAI YAHIA

DOCTORAL THESIS

ADANA / 2024

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Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Müdürlüğüne;

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ALTAYEB ALHADI DAWAI YAHIA

ABSTRACT

EVALUATION OF MACROECONOMIC PERFORMANCE OF SUB-SAHARAN AFRICAN COUNTRIES WITH MCDM METHODS

ALTAYEB ALHADI DAWAI YAHIA

Ph.D. Thesis, Department of Econometrics
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SSA countries were significantly affected by the COVID-19 pandemic that erupted in 2020, like many other countries. Although macroeconomic performance was severely weakened during the COVID-19 period, it was positively affected by the expansionary policies implemented in the period following COVID-19 pandemic. However, after a while, it was again disturbed and fluctuated. So, the research conducted to evaluate macroeconomic performance of SSA countries, considering the period pre- and during COVID-19. For this purpose, Multi Criteria Decision Making (MCDM) methods, including Entropy, CRITIC and MEREC as weighting methods, and MARCOS, MOORA, TOPSIS and CoCoSo, are used as ranking methods. The results of ranking orders of countries are different, so the BORDA method is used to unify the final ranking. Moreover, to compare the effect of each MCDM method to the final ranking, the Taylor diagram is utilised.

The results of this research revealed that South Africa, Nigeria achieved the most successful macroeconomic performance, while the worst-ranked country with the lowest macroeconomic performance was Zimbabwe and Gambia. The ranks of other countries are changing more or less with respect to the MCDM methods used. The BORDA method, which offers the unify ranking, has the capability to provide clear information to decision-makers. As with all MCDM methods, BORDA ranked the best and worst countries in similar positions. Therefore, it can be concluded that countries with strong macroeconomic performance have always maintained their top positions in the rankings of the MCDM methods used. Because of this, it is recommended that countries improve their performance so as to rank highly in terms of macroeconomic performance.

The differences obtained from MCDM methods are natural due to their own algorithms. Therefore, it will be beneficial for decision-makers to use more than one MCDM method. So, it is recommended to use the BORDA method. The Taylor diagram's findings demonstrated that the TOPSIS and CoCoSo approaches yield more accurate findings. So, TOPSIS and CoCoSo methods are also recommended to be used alongside other MCDM methods in future studies.

Keywords: Macroeconomic performance, Sub-Saharan Africa countries, MARCOS, TOPSIS, CoCoSo

ÖZET

SAHRA ALTI AFRİKA ÜLKELERİNİN MAKROEKONOMİK PERFORMANSININ ÇKKV YÖNTEMLERİYLE DEĞERLENDİRİLMESİ

ALTAYEB ALHADI DAWAI YAHIA

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2020 yılında ortaya çıkan COVID-19 salgınından birçok ülke gibi SSA ülkeleri de önemli ölçüde etkilenmiştir. Bu ülkelerin COVID-19 döneminde makroekonomik performansları ciddi bir şekilde zayıflamasına rağmenı, COVID-19 sonrası dönemde uygulanan genişletici politikalar ile kısmen toparlanmıştır. Ancak bir süre sonra tekrar bozulma ve dalgalanmalara maruz kalmıştır. Bu nedenle çalışma, Sahra Altı Afrika (SSA) ülkelerinin makroekonomik performansını, COVID-19 öncesi ve sırasındaki dönem dikkate alınarak değerlendirmek amacıyla yürütülmüştür. Bu amaç doğrultusunda, SSA ülkelerinin makroekonomik performansını değerlendirmek için Çok Kriterli Karar Verme (ÇKKV) yöntemlerinden olan MARCOS, MOORA, TOPSIS ve CoCoSo; kriter ağırlıklarının belirlenmesi için Entropi, CRITIC ve MEREC yöntemleri kullanılmıştır. Farklı ağırlıklandırma yöntemlerinde olduğu gibi, SSA ülkelerinin farklı ÇKKV yöntemleri ile elde edilen farklı sıralamalarını birleştirmek ve tek bir sıralama elde etmek için BORDA yöntemi kullanılmıştır. Ayrıca ÇKKV yöntemlerinin nihai sıralama sonucuna katkısını/etkisini belirlemek amacıyla Taylor diyagramı kullanılmıştır.

Yapılan bu araştırmanın sonuçları, Güney Afrika ve Nijerya'nın en başarılı makroekonomik performansa sahip olduğunu, en düşük makroekonomik performansa sahip ülkelerin ise Zimbabve ve Gambiya olduğunu ortaya koymaktadır. Diğer ülkelerin sıralamaları ise yönteme göre az ya da çok değişiklik göstermektedir. Tek bir sıralama sunan BORDA metodu, bu özelliği ile karar vericilere daha açık bilgi sağlamaktadır. Diğer ÇKKV metotları gibi BORDA yöntemi de en iyi ve en kötü performansa sahip ülkeleri benzer konuma yerleştirmektedir. Bu nedenle güçlü makroekonomik performansa sahip ülkelerin, üst sıralardaki konumlarını tüm ÇKKV yöntemlerinde korudukları sonucu ifade edilebilir. Bu sebeple, ülke sıralamalarında makroekonomik göstergeler açısından

üst sırlarda yer almak isteyen ülkelerin, bu göstergeler açısından performanslarını artırmaları önerilmektedir.

Esasında, ÇKKV yöntemleri ile elde edilen farklı sıralamalar, metotların kendilerine özel algoritmaları nedeniyle doğaldır. Bu sebeple karar vericilerin çalışmalarında birden fazla ÇKKV yöntemlerinin kullanılması faydalı olabilir. Bu durumda, BORDA metodunun kullanılması önerilmektedir. Taylor diyagramı sonuçları TOPSIS ve CoCoSo yöntemlerinin daha real sıralama verdiğini vurgulamaktadır. Bu nedenle, gelecekteki çalışmalarda da bu iki yöntemin diğer kullanılan ÇKKV yöntemleri ile birlikte kullanılması tavsiye edilmektedir.

Anahtar Kelimeler: Makroekonomik performans, Sahra-altı Afrika, MARCOS, TOPSIS, CoCoSo

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TABLE OF CONTENTS

Pages

CHAPTER IV
EMPIRICAL RESULTS

CHAPTER V
CONCLUSION

ABBREVIATIONS

AHP: Analytic Hierarchy Process

ANP: Analytical network process

ARAS: Additive Ratio Assessment

BWM: Best Worst Method

CRITIC: Criterion Importance Through Intercriteria Correlation

CoCoSo: Combined Compromise Solution

COPRAS: COmplex PRoportional Assessment

DEA: Data Envelopment Analysis

DEMATEL: Decision making trial and evaluation laboratory

DM: Decision Maker

EDAS: Evaluation based on Distance from Average Solution

FCM: Fuzzy Cognitive Map

FMEA: Failure Mode and Effect Analysis

FRA: Fuzzy Reasoning Approach,

FUCOM: Full Consistency Method

GRA: Gray relational analysis

IOCRA: Improved Operational Competitiveness Rating Analysis

ISM: Interpretative Structural Modeling

MABAC: Multi-Attributive Border Approximation Area Comparison

MADM: Multi-Attribute Decision Making

MARCOS: Measurement Alternatives and Ranking According to Compromise Solution

MCDM: Multi-Criteria Decision Making

MEREC: Based on the Removal Effects of Criteria

MOORA: The Multi Objective Optimization on the basis of Ratio Analysis

MP-MADM: The Multi-Period Multi-Attribute Decision-Making

OCRA: Operational Competitiveness Rating

PIPRECIA: PIvot Pair-wise RElative Criteria Importance Assessment method

PROMETHEE: Preference Ranking Organization Method for Enrichment Evaluation

PSI: Preference Selection Index

RN: Rough Number

SSA: Sub-Saharan Africa

SWOT: Strength-Weakness-Opportunity-Threat

TOPSIS: Technique for Order Performance by Similarity to Ideal Solution

VIKOR: Višekriterijumsko Kompromisno Rangiranje

LIST OF TABLES

Pages

LIST OF FIGURES

Pages

APPENDICES LIST

Pages

CHAPTER I

INTRODUCTION

1.1. Background of the Research

Basic indicators of improvement in an economy are macroeconomic data. Local investors can perceive economic process with macroeconomic data, foreign investors are concerned about the effective use of the resources of the country; acquire a lot of information as to the assessment of an assortment of investment opportunities. In this regard, the macroeconomic performance of the nation is the most crucial requirement for competing on a global scale (Eyupoglu, 2016). According to this approach, there are many indicators of macroeconomic performance of a country, such as unemployment rate (UEM), Foreign direct investment (FDI), Inflation rate (INF), and Gross Domestic Product (GDP) (Ayad et al., 2017). The growth in GDP could be considered as one of the essential criteria reflecting a society's high level of welfare and improvement of international competitiveness (Kotan, 2002). Unemployment rate is one of the most important issues for all societies regardless of the level of economic growth in a society. Poverty, which emerges from the unavailability of the right to work, which is a part of the right to live, is considered as a main indicator of unhappiness. One of the criterions that reflect the stability of the economy is named as inflation rates. Inflation, on one hand increases the cost of borrowing based on high interest rates, on the other hand, it has a negative impact on investment due to the accumulations' orientations towards unproductive fields (Buheji et al., 2020).

Despite significant progress in the past two decades, SSA economies have lagged behind other regions on almost any real measure of macroeconomic performance (Chuku & Onye, 2019)**.** SSA is a continent with significant problems on the one hand and great potential on the other. Its past has been difficult and formidable challenges to further development remain. Poverty is pervasive, human development is low, and growth has not been inclusive (Mlachila et al., 2013). The economic situation of SSA defies the prediction of the neoclassical theory that capital flows positively affect the economy. Despite increasing inflows of private capital, the region's GDP as a percentage of the world's has not risen above the 1980's level (Alley, 2015). The financial crisis of the late 2000s generated a global recession that brought declines in cross country private capital

flows, including those from developed to underdeveloped countries. As a result of the fiscal stress in developed countries, reductions in official development assistance accompanied the declines in private flows. These changes in the tempo and pattern of capital flows have significant implications for growth in the SSA region (Chapte, 2008).

For the first time since the 1970s, many countries in SSA have been enjoying an extended period of strong economic growth. The pick-up in growth began in the mid-1990s and has been maintained in good part during the extended global slowdown since 2008. The pace of growth recorded in SSA since the mid-1990s is not exceptional by developing country standards, but still represents a sharp break with the experience of falling living standards and macroeconomic instability in SSA during the previous two decades, a period when the region fell behind developing countries in other parts of the world (Mlachila et al., 2013).

Although economic performance deteriorated in many countries in SSA, unemployment rate stabilized at 7.3 percent. However, unemployment rates were uneven among countries. For example, due to the slowdown in the South African economy, the unemployment rate reached more than 25 percent in 2016 (Ela & Kurt, 2019). There was a significant increase in export growth rate between 1993 and 1996. However, there were considerable fluctuations in this growing tendency until a dramatic decrease shortly after the 2008 economic slump.

Compared to other developing and advanced economies, inflationary conditions in SSA tend to be relatively high with significant negative impact on regional financial system and macroeconomic conditions. IMF regional economic outlook data indicates on the average, inflationary rate for the sub-region hovered around 10% between 1980 and 1988. This relatively high inflation rate rose significantly between 1991 and 1996, with highest rate over the period reaching over 40% on average for the sub-region. Inflationary conditions in the sub-region after 2000 however, have been relatively low by regional standards except for the period leading to 2008 global financial crisis (Abaidoo, 2012). It is on record that the 2015 global economic recession heavily affected vulnerable economies including SSA, as many foreign investors withdrew their investment from the region. This action was presumed to be in connection with the fall in investment profit and global oil shock particularly for oil producing economies like Nigeria, Angola, Gabon, and Egypt. However, despite the continuous fall in global FDI inflows, the region recorded a positive increase in 2018 where FDI inflow to the region increased by 6%.

Inflows of FDI were $US38 billion in 2017 and $US40 billion in 2018, with a lopsided distribution around the region (Joshua & Babatunde, 2021).

The COVID-19 pandemic has affected all SSA economies through a multitude of impact channels (Nechifor et al., 2021). Despite a late arrival, the COVID-19 outbreak has spread rapidly across SSA (Djiofack et al., 2020). The economic shock of the pandemic in SSA countries resulted in a high cost of living. Many of the ordinary people could not afford the high cost of living brought about by the pandemic due to the high unemployment rate in many of these countries. The unemployment rate in South Africa was at 28.5% in 2019 compared to 16.9% in Zimbabwe, 12,1% in Zambia and 19.9% in Namibia (Munyeka & Munzhedzi, 2022). COVID-19 worsened the situation in most of these SSA countries. However, the impact varied from one country to another, particularly in the informal sector. Most of the jobs in the region (80%) were in the informal sector which were more vulnerable to the effect of the pandemic (Weber et al., 2020).

Africa undoubtedly faced a significant economic downturn because of the pandemic projections estimated Africa's GDP contracted by 3.4% in 2020, resulting in the region's first recession in over two decades (Morsy et al., 2021). Africa's exports are decreased by 8% in 2020, and imports about 6% (Banga et al., 2020). Although all sectors are expected to be hit by the pandemic, Africa's agricultural sector is among the most vulnerable. Border disruptions and anti-COVID-19 policy measures such as curfews, quarantines, and closures of non-essential businesses impact all stages of agricultural value chains, from input supply to production, distribution logistics, and consumption, elevating the risks of food insecurity, hunger, and malnutrition (Anthem, 2020). Disruptions in demand from these regions due to COVID-19 have resulted in a severe contraction of export earnings by countries highly dependent on exports of agricultural products including Côte d'Ivoire, Ethiopia, Ghana, Kenya, Tanzania, and Uganda (AfDB, 2016).

Recently, MCDM methods have increasingly been used to solve various problems and some new methods have been developed. All MCDM methods can be grouped as outranking methods, synthesis methods and interactive methods. Interactive methods are used to solve the problems of optimization and a non-dominant solution is sought. Outranking methods take decision maker's (DM's) preferences and allow the ranking of alternatives. Synthesis methods provide the ability to make decisions when it is necessary to evaluate multiple and often conflicting situations (Stevic et al., 2020). Economic

performance evaluation problem consists of many criteria and sub criteria. Therefore, it is a kind of MCDM. It is very important for a country to monitor performance parameters to ensure that appropriate and timely decisions and plans can be made. Suitable performance measures can ensure that governments adopt a long-term perspective and allocate the country's resources to the most effective activities (Onder et al. 2015). In this study, the weights of criteria to be used in the evaluation of countries include (GDP, INF, UEM, IMP, EXP and FDI) will be determined by Entropy, CRITIC and MEREC methods, the data sets span the period 2019 to 2021, and performance scores will be computed and ranked by MARCOS, MOORA, TOPSIS and CoCoSo methods. Then, the results will be compared with the performances SSA countries used in this research.

1.2. The Research Problem

Macroconomic performance evaluation problem consists of many criteria and sub criteria. Therefore, it is a kind of MCDM problem. Monitoring performance of parameters is critical for a country's ability to make suitable and timely decisions and plans. Appropriate performance measurements can help governments take a long-term view and focus their resources on the most productive activities (Önder et al., 2015) and help them achieve their growth potential (Kildiene, 2013).

1.3. Objectives of the Research

The goals of the research are as follows: First, evaluate the macroeconomic performance of SSA countries over the period 2019–2021 (pre- and during COVID-19) by using MCDM techniques. For this purpose, Entropy, CRITIC and MEREC are utilized as a weighteing methods. MARCOS, MOORA, TOPSIS, CoCoSo methods used as ranking methods. Second, to determine the impact of the criteria weights, Entropy, CRITIC and MEREC methods are used. It is well known that there is no method accepted as the best one in the literature to rank the alternatives, so the third object of this research is to unify the final rank by the BORDA method. Lastly, to compare the effects of MCDM methods, the Taylor diagram was utilized. In this research, the macroeconomic indicators that will be used are GDP, EXP, FDI, IMP, INF, and UEM.

1.4. Importance of the Research

Ranking and evaluating a country's macroeconomic performance is crucial in defining the economic policies that should be enacted. The importance of this research

stems from being the first study to assess macroeconomic performance in SSA countries by utilizing MARCOS, MOORA, TOPSIS CoCoSo, and BORDA methods. In addition, no studies have been seen that used those methods together in SSA countries. In this regard, this research has provided authentic results regarding both the used data set and the methods preferred and has filled a gap in the literature. Furthermore, to the best of our knowledge, Tayler dıyagram is not utilized in this fild. So, this research will use it to compare the effects of MCDM methods in the final ranking.

1.5. Organization of the Research

This study consists of five chapters, following the background, problem, importance, and objective of the research in the first chapter, the remainder of the research is arranged as follows:

Chapter Two represents the recent empirical literature reviews. Chapter Three shows the data and methodology, as follows:

Section 3.1 introduction. Section 3.2 points out the data. Section 3.3 represents the methodology that has been utilised in the application of research. Following MCDM techniques for determining the criteria weights in Section 3.4. In the last section, MCDM techniques for obtaining rank, five sub-sections are included. The first sub-section includes the MARCOS method; the second sub-section illustrates the procedure for using the MOORA method, followed by the TOPSIS method; and the fourth sub-section highlights the CoCoSo method.

Chapter Four presents the empirical results, following a brief introduction in Section 4.1, Section 4.2 calculates the weights for the criteria. Section 4.3 indicates the MARCOS method: Four sub-sections are included in this section. The first sub-section applies the MARCOS method for 2019 with entropy, the second sub-section shows the MARCOS method for 2019 with CRITIC, the third sub-section applies the MARCOS method for 2019 with MEREC and the last sub-section indicates the effect of different weighting methods on the results of MARCOS. Section 4.4 shows the MOORA method, this section also contains four sub-sections. The first sub-section indicates the MOORA method for 2019 with entropy, the second sub-section applies the MOORA method for 2019 with CRITIC, the third sub-section applies the MOORA method for 2019 with MEREC and the last sub-section presents the effect of different weighting methods on the results of MOORA.

Section 4.5 displays the TOPSIS method, this section comprises four sub-sections, the first sub-section, the TOPSIS method for 2019 with entropy; the second sub-section highlights the TOPSIS method for 2019 with CRITIC, the third sub-section illustrates the TOPSIS method for 2019 with MEREC and the last sub-section demonstrates the effect of different weighting methods on the results of TOPSIS. Section 4.6 applies the CoCoSo method and is divided into four subsections. The first one applies the CoCoSo method for 2019 with entropy, the second shows the CoCoSo method for 2019 with CRITIC, the third sub-section indicates the CoCoSo method for 2019 with MEREC and the final subsection demonstrates the effect of different weighting methods on the results of CoCoSo. Section 4.7 unifies the rankings of MCDM methods by BORDA method. Section 4.8 compares the effects of MCDM methods using a Taylor diagram. Finally, a conclusion, key findings, policy recommendations, limitations, and directions for future research are presented in the last chapter.

CHAPTER II

LITERATURE REVIEW

MCDM methods are widely used for performance evaluation or determination of the best choice for many sectors. Although there are many studies in the literature evaluating the performance using MCDM models, other studies in the literature using MCDM methods will be included. However, in this research, the following selected studies are considered as the literature:

For instances, Altin (2020) used nine macroeconomic variables and the Gray relational analysis (GRA) method to analyse the macroeconomic performance of forty-four European countries. According to the obtained findings, the ten countries with the most successful macroeconomic performance were Ireland, Russia, Germany, Azerbaijan, Malta, Luxembourg, Netherlands, United Kingdom, Armenia, and Poland, and the ten countries with the lowest macroeconomic performance were France, Serbia, Finland, Portugal, Italy, Bosnia and Herzegovina, Croatia, Belgium, Montenegro, Ukraine, and Greece. Turkiye ranked thirty-third among the forty-four countries.

Paksoy & Dawai (2021) evaluated the performance of Sudanese macroeconomic indicators such as inflation, gross domestic product, exchange rate, export, and economic growth during the period 2000-2019. The study employed the FTOPSIS method to evaluate the performance of Sudanese macroeconomic indicators. The TOPSIS method was also used in the study to compare the results obtained by the two methods. The most successful economic performance was observed in the year 2019, followed by the second rank in 2016. On the other hand, 2006 was identified as the year with the lowest macroeconomic performance in Sudan. Wang & Le (2018) aimed to measure and forecast the macroeconomic performance of developed countries and Asian developing countries using four macroeconomic indicators, namely government gross debt, real GDP growth, inflation rate, and unemployment rate. The paper utilized data envelopment analysis (DEA)-based models to construct a scalar-valued summary measure of macroeconomic performance. The empirical results highlight Switzerland, Singapore, and the United States as having achieved the most successful macroeconomic management.

Oskay (2018) evaluated the macroeconomic performance of the Turkish economy from 2008 to the present, using six main indicators: inflation rate, unemployment rate, growth rate, long-term interest rate, current account deficit, and budget deficit. The study

utilizes the Index of Economic Discontent, Misery Index, and Macroeconomic Performance Index (MPI) to evaluate Turkiye's macroeconomic performance. As a result, it appears that Turkiye's economic performance is weak. Being placed near the top in terms of vulnerability in Fragile Five, Turkiye comes in last in terms of macroeconomic performance. Turkiye during 2008-2018, has an economic outlook that can not lower inflation, growing unemployment and borrows at a high cost with an increasing current account deficit. In recent years, the Turkish economy is advancing rapidly towards recession. The study recommended that to strengthen the macroeconomic performance of Turkiye, primarily by reducing dependence on foreign sources, reforms generating solution to the structural problems are needed to put into practice.

Önder & Boz (2017) proposed model used a combined method of Analytical Network Process (ANP) based weights and Grey Relational Analysis for ranking economic performance of the countries. The study focuses on 11 selected macroeconomic indicators to assess the economic performance of the countries. The weight of each variable was determined for use in grey relational analysis. MCDM methods were used for sorting and selecting alternatives and classifying the results and alternatives used in the comparison of the organizations. The findings of the study provided insights into the economic performance of the Union for the Mediterranean (UfM) countries and can be used for decision-making and policy formulation. The results of the empirical analyses showed that Ireland ranked as first according to the weighted arithmetic mean among 36 UfM countries. Egypt and Tunisia have been found as the countries with the worst economic performance. Baležentis & Streimikiene (2017) applied advance optimization models and MCDM techniques for ranking energy policy scenarios in the EU. The energy development scenarios were assessed using three MCDM techniques: WASPAS, ARAS, and TOPSIS, under two settings: egalitarian approach and Monte Carlo simulation. Results of the analysis provided valuable insights in integrated application of both IAMs and MCDM models for developing energy policy scenarios and decision makingin energy sector.

Mohamad & Said (2011) used DEA to evaluate the macroeconomic performance of 54 member countries of the Organization of the Islamic Conference (OIC) based on selected macroeconomic indicators. The study found that three fuel-exporting countries and four least-developed countries were in the top of the performance list, Iran and Yemen at the bottom. Seçme et al. (2009) utilized the TOPSIS (Technique for Order Performance by Similarity to Ideal Solution) method, which is a classical MCDM method developed

by Hwang and Yoon in 1981. It compared the financial and non-financial performances of Turkish banks and ranks them based on their total performance. The results showed that not only financial performance, but also non-financial performance should be taken into account in a competitive environment. Arsu (2022) proposed the use of the CRITIC method to calculate the total information measurement (Hj) and criteria weights in decision-making processes. The COPRAS method is employed to evaluate the alternatives. As a result, the most successful countries are found in order as China, Russia and Indonesia, according to the scenario 1 and scenario 3. According to the scenario 2, the most successful countries are found in order as Russia, Türkiye and Mexico.

Dinçer et al. (2019) focused on linguistic evaluations and methods used to evaluate the dimensions and criteria of financial services. It discussed the construction of direct relation matrices, normalization of matrices, and the use of fuzzy numbers for evaluations. The paper used of the DEMATEL-ANP method for computing the weights of dimensions and criteria, as well as the MOORA, TOPSIS, and VIKOR methods for ranking alternatives. Kamali et al. (2022) designed to evaluate the progress of the EU's twenty-third member countries in achieving energy union goals. A SWARA-TOPSIS framework was suggested and utilized in the study to evaluate EU nations based on their progress in developing sustainable energy sources. According to the study's findings Luxembourg is the first-ranked country, followed by Denmark and Sweden, while Bulgaria achieved the worst rank among the EU considering its progress towards the energy union goals. Ploskas & Papathanasiou (2019) presented a web-based decision support system that incorporates TOPSIS and VIKOR methods for solving multicriteria decision making problems in both fuzzy and nonfuzzy environments. The study suggested that extensive comparisons in different application areas should be made in order to study the effect of using a different technique.

Tomic (2021) for the purpose of analyzing the results and selecting the scenarios on which the draft of the Integrated National Energy and Climate Plan will be based, a multi-criteria analysis has been established. The results indicate that the best alternative is A3 (electricity consumption by sources for February 2022), followed by A2 (electricity consumption by sources for January 2022) and lastly alternative A1 (electricity consumption by sources for December 2021). Mishra (2021) developed to detect and prioritize the manufacturing flexibility enablers by assessing the level of environmental uncertainty and manufacturing flexibility in an uncertain environment. The study proposes a methodological approach based on fuzzy quality function deployment, fuzzy

analytical hierarchical process and fuzzy technique for order of preference by similarity to ideal solution. The results of the initial part of the study suggest that the ABC should prioritize volume flexibility in the face of several environmental variables.

Kizielewicz et al. (2020) provide a framework for tackling the challenge of wind farm deployment. Ten criteria were analyzed and ranked using TOPSIS, VIKOR, and Characteristic Objects Methods. Dabbagh et al. (2019) proposed a hybrid decision-making approach based on the Failure Mode and Effect Analysis (FMEA), Fuzzy Cognitive Map (FCM), and Multi-Objective Optimization based on Ratio Analysis (MOORA) for assessing and prioritizing. OHS risks. The application of the suggested technique by a manufacturing company yielded the following results the score in question can overcome some of the disadvantages of the standard Risk Priority Number in the traditional FMEA. Ela et al. (2019) compared the macroeconomic results of eight Sub-Saharan African nations using the TOPSIS approach. For this purpose, four macroeconomic indicators including GDP growth rate, inflation rate, unemployment rate and current account balance/GDP are used to evaluate the performances of the countries. As a result of this study's findings, Cote d'Ivoire and Tanzania show the best macroeconomic performances.

Dincer (2011) examining the economic activity of EU Members and candidates in 2008. In performance measurement five macroeconomic indicators (GDP, exports, imports, inflation rate, and unemployment rate) were considered TOPSIS methods were used for the ranking. The findings showed that while Luxembourg, Netherland, and Denmark were the first three countries, Macedonia, Latvia, and Bulgaria were the last. Stević et al. (2016) compared various providers using an integrated model that detects a combination of fuzzy AHP and TOPSIS approach. Based on six ecriteria, the expert team was formed to compare them, Therefore, the fuzzy AHP approach is used to determine their relevance. Önder et al. (2015) used macroeconomic data such as GDP, inflation, current account balance, investment, unemployment rate, average consumer prices amount of exports, and volume of imports, the Analytic Network Process and TOPSIS techniques were used to evaluate the performance of fragile 5 nations. In this study, the most important ratios are found. Gross domestic product, current account balance, inflation, average consumer prices, unemployment rate are determined as the four most important macroeconomic parameters for the economic performance of the F5 countries. Aydin et al. (2012) proposed a MCDM model for evaluation of E-Commerce web sites.

Their model contains five criteria and twenty sub-criteria, where the key criteria are: Ease of use, Products, Security, Customer relationship and Fulfilment.

Almulhim (2020) presents a multi-criteria evaluation framework for insurance performance of Organization for Economic Cooperation and Development (OECD) countries by investigating conflicting and incommensurate insurance indicators for the period of 2010–2017. For the basis of the evaluation, eight main insurance performance inductors were identified and then their weights were determined using the entropy method. To determine preferable rankings for the insurance industry, the resulting entropy weights were then used in the evaluation based on distance from average solution (EDAS) technique. The ranked insurance industries were classified of similar levels of performance. Sensitivity analysis was applied to the main criteria to examine the robustness of the prioritizing results. The results indicate insurance markets in United States, the United Kingdom, Germany, France, and Japan are ranked higher than the remaining 25 OECD countries.

Ketabi et al. (2012) utilized the TOPSIS method to rank the stock market development levels of forty countries between 2004 and 2008, comprising twenty developed and twenty developing countries. They used depth, width and sophistication and considered these three criteria as indices of stock exchange development using TOPSIS method. They found average ranks of the countries based on depth, width, and sophistication indices during the research time.

Hussain et al. (2020) performed TOPSIS method to generate a comprehensive assessment of China's foreign investment risk and natural resource potential in 63 “Belt & Road Initiative” (BRI) countries. Regarding the potential for natural resources in the host countries, this study intends to enable Chinese businesses to develop suitable foreign investment decision-making techniques. According to the results, most Central and Eastern European nations as well as other BRI nations like Singapore, Malaysia, Nepal, Bhutan, Russia, Armenia, and the United Arab Emirates were the best options for Chinese businesses looking to invest abroad. Based on these results; to reduce potential risks and maximize the rewards of their investments, Chinese businesses might manage and carry out BRI projects more efficiently.

The study of Assfaw (2017) examines whether there is significant difference on macroeconomic performance between SSA countries which have stock exchanges and countries which do not have after these countries are ranked based on their macroeconomic performance composite index, computed using a TOPSIS method and

Shannon entropy to calculate the objective weight for each criterion. According to the study, there are significant differences in the macroeconomic performance of the two groups of countries. However, a random effect regression result, that is found to be appropriate after Hausman test, indicates that, from 2003 to 2014, the growth of the stock market had a beneficial impact on the GDP growth rate of 17 African nations that are members of the African stock exchange association. African nations must be committed to develop their stock markets if they are to have a major impact on boosting economic growth, such that, after adjusting for other factors, a significant difference in GDP growth may be shown between countries with and without stock exchange.

Güran et al. (2005) analyzed the macro performance of Turkey's economy for the period 1951-2003. They used four indicators (economic growth, inflation rate, unemployment rate, and current balance of payments as a percentage of gross domestic products) which were described as magic diamonds by OECD. They discovered that while performance was stable prior to 1975, after 1975, an unstable structure evolved.

Lausberg et al. (2021) aimed to rank the most crucial market entry requirements before identifying which sub-Saharan African nations are best for wind IPPs. A combination of MCDA methods was used to rank seven countries. Nineteen criteria, identified in the literature reviewed, were included in the analyses. In the first phase of the study an industry expert survey was conducted, and the analytical hierarchy process (AHP) was used to rank the criteria in order of importance. In the second phase, a preference ranking organization method for enrichment evaluation (PROMETHEE) was employed to rank the countries from most to least favourable for IPP market entry. The expert survey and AHP showed that political and economic criteria are more important than technical and social criteria. The PROMETHEE model ranked South Africa followed by Ethiopia as the most favourable markets for wind IPPs to enter. These countries have strong natural wind resources but only South Africa offers incentives specifically for on-grid renewable energy. The techniques utilized in this study can be applied to other technologies and industries to aid in decision-making, not just the wind industry.

Alaghemand (2014) tried to assess the relative importance of nine developed countries (Australia, Canada, Germany, Ireland, Japan, Luxembourg, Netherland, Switzerland, and United Kingdom) as a home country for foreign direct investment (FDI) from the United States' vantage point over the three periods of the economic pre-crisis (2004-2006), crisis (2007-2009), and post-crisis (2010-2012). This study suggests a

methodology based on a combination of the analytic hierarchy process (AHP), the technique for order preference by similarity to ideal solution (TOPSIS), and the multi-period multi-attribute decision-making (MP-MADM) technique. The AHP method was applied to prioritize the set of FDI determinants. The TOPSIS method was employed to evaluate the attractiveness of nine alternative countries for FDI during three spans of time. Meanwhile, the MP-MADM method was used to aggregate the related data from each period. The results show that during the pre- crisis period, Japan has won the best destination for the U.S. to increase direct investment. Canada, Germany, Luxembourg, Australia, the United Kingdom, Ireland, Switzerland, and the Netherlands follow Japan sequentially during this period.

Gyamerah et al. (2021) taked the initiative to systematically define and rank the set of characteristics that facilitate the implementation of the BRI among SSA SMEsutilizing survey data from 178 stakeholders. In total, we identified twenty-two factors and categorized them into five broad headings. based on the fuzzy projection of the image The components and sub-factors were ranked using the TOPSIS approach. The utmost ranked factor in the five categories was the governmental factors, while transparency in BRI policy, subsidy for SMEs, flexible trade agreements and clarity in the BRI policy framework emerged as the top four factors respectively within the 22 sub- factors.

Previous evaluations of macroeconomic performance in SSA have been based on DEA and other MCDM technique. The study contributes to the field by selecting indicators that optimally represent the macroeconomic performance of the countries, taking into consideration expert views and literature. This research fills a gap in the literature by using MCDM approach including Entropy, CRITIC and MEREC as a criterion weighting methods. MARCOS, MOORA, TOPSIS and CoCoSo as a ranking methods, and BORDA as a combine method, to evaluate SSA macroeconomic performance. Moreover, the Taylor diagram utilized to compare the effect of the MCDM methods for ranking results, which is not commonly found in the literature.

CHAPTER III

DATA AND METHODOLOGY

3.1. Introduction

The MCDM technique is a very powerful tool for evaluating and ranking decision problems under multiple or conflicting criteria. Many MCDM approaches have been created and used in many research areas over the years (Kumar & Ramesh, 2020). Over the last few decades, multi-criteria analysis has been increasingly popular among scientists (Vanegas-Cantarero et al., 2022). This research utilizes MARCOS, MOORA, TOPSIS, CoCoSo and BORDA methods for evaluation the macroeconomic performance of SSA countries. The rest of this chapter is structured in the following manner: Section 3.2 shows the data that has been utilised in the evaluation. Section 3.3 represents the methodology that has been utilised in the application of research. Section 3.4 represents the MCDM techniques for determining the criteria weights. Section 3.5 implies MCDM techniques for obtaining rank. Lastly, Section 3.6 highlights the BORDA approach.

3.2.The Data

The purpose of the research is to evaluate the macroeconomic performances of SSA countries during the period 2019-2021 (pre- and during Covid 19). The macroeconomic indicators used in the research were obtained from the websites of the World Bank (World Development Indicators) and are indicated in Table 1. The sample consists of 30 SSA countries, which are Sudan, Angola, Cameroon, Burkina Faso, Burundi, Central African Republic, Chad, Eritrea, Ethiopia, Gambia, Ghana, Kenya, Liberia, Madagascar, Mali, Mauritania, Malawi, Libya, South Sudan, Mauritius, Namibia, Mozambique, Rwanda, Sierra Leone, Somalia, Senegal, South Africa, Tanzania, Togo, Zambia and Uganda. For the determination of criteria weights, Entropy, CRITIC and MEREC are utilised, and the MARCOS, MOORA, TOPSIS, CoCoSo and BORDA methods are used for ranking the macroeconomic performances. Moreover, the Taylor diagram was utilised to compare the effect of the MCDM methods for ranking results.

Endowment in natural resources in Africa have taken the attention across the world (Alpha and Ding, 2016; Ola & Onyejiuwa, 2023). There has been an intense change to

the assertion that natural resources endowment is a driver of economic growth and development, especially with the coinage of the "natural resource curse" which has been caught on in both policy and academic circles (Musibau et al., 2022). In this context, resource endowment has a positive effect on economic growth in SSA countries (Ola & Onyejiuwa, 2023). Therefore, the current research is focused on evaluating macroeconomic performance of SSA countries, for the perid pre and post COVID-19.

Table 1

Variable description

Variable	Acronym	Measurement
Gross Domestic Product	GDP	Current US$
Exports of goods and services	EXP	Current US$
Foreign direct investment	FDI	Net inflows (% of GDP)
Imports of goods and services	IMP	Current US$
Inflation rate	INF	Consumer prices (annual %)
Unemployment rate	UEM	Total (% of total labor force)

3.3. Methodology

In this section, the details of the MCDM methods considered in the analysis are explained.

3.3.1 Multi Criteria Decision Making (MCDM)

The MCDM technique is a very powerful tool for evaluating and ranking decision problems under multiple or conflicting criteria. Over the years, many MCDM methods have been developed and employed in the field of economic research (Kumar & Rumesh, 2020). Multi-criteria analysis has gained popularity among the scientific community in the last few decades (Vanegas-Cantarero, 2022). The process of selecting, or more precisely, determining the best option from the set of available options based on the impact of multiple, often conflicting, criteria is called Multiple Criteria Decision Making (MCDM). Over time, many MCDM methods have been developed, such as SAW, ELECTRE, PROMETHEE, AHP, TOPSIS, COPRAS, VIKOR, MOORA, etc. (Stanujkic & Jovanovic, 2012).

The MCDM methods is a powerful technique for decision making (Aruldoss, 2013). Managers take decisions by simultaneously considering all the criteria (including both quantitative and qualitative factors) and objectives by using MCDM methods (Vanegas-

Cantarero et al., 2022). To evaluate macroeconomic performance of SSA countries we will use MARCOS, MOORA, TOPSIS and CoCoSo techniques.

In the last few years, scientists have proposed new decision-making methods, one of these methods is MARCOS technique. The MARCOS method was first used in 2019 (Stević et al., 2020). This method has been applied in several studies such as: in the selection of intermediate modes of transport between countries in the Danube region (Trung, 2021; Kilibarda, 2021) , for evaluation of human resources in a transport company (Stević & Brković, 2020).

The multi objective optimization on the basis of ratio analysis (MOORA) method is MCDM methods with a high potential for comprehensive evaluation of alternatives confronting considerable diversity and multiplicity of effective factors. The MOORA method was put forth by Brauers & Zavadskas (2006). This approach aims to find the optimal option based on a set of frequently competing criteria. In other words, this method simultaneously examines favourable and unfavourable criteria (Chakraborty, 2011). Several advantages of the MOORA technique over other decision-making systems have been recognized, including less mathematical computations, less computational time, and greater simplicity, and more stability compared with some MCDM techniques such as TOPSIS, ELECTRE, VIKOR, and PROMETHEE (Akkaya et al., 2015). There have been several studies which applied this methods, For instance, (Danh et al., 2022; Brauers & Zavadskas, 2006; Tepeli & Özkoç, 2020).

Technique for Order Performance by Similarity to Ideal Solution (TOPSIS), one of the classical MCDM methods, was first developed by Yoon and Hwang (1981). The primary goal is for the chosen alternative to be the closest to the ideal solution and the furthest away from the negative-perfect solution (Eyupoglu, 2016). The positive ideal solution is a solution that tries to maximize the profit criteria and minimize the cost criteria, whereas the negative ideal solution is just opposite to previous one (Karim & Karmaker, 2016). The TOPSIS is the most used method for MCDM in many different fields (Trung, 2021; Aggarwal et al., 2018). TOPSIS approaches provide several advantages, including simplicity, rationality, comprehensibility, high computer efficiency, and the ability to assess relative performance for each choice in a simple mathematical form (Roszkowska, 2011).

CoCoSo was developed by Yazdani and Zarate (2019) as a new MCDM method that combines simple additive weighting and an exponentially weighted product model. It is one of the recent MCDM methods based on compromise solutions and a helpful technique

in ranking or selecting multiple alternatives (Ghoushchi et al., 2022). This method has been used for a number of studies such as: (Yazdani & Zarate, 2019; Popović, 2021; Peng, 2020).

When performing multi-criteria decisions, an important task is to determine the weights for the criteria. This has a great influence on the ranking order of the alternatives (Trung, 2021). If it is done by the decision maker, the accuracy achieved is not high because it depends on the knowledge as well as the subjective thoughts of that person. If it is determined by consulting the experts, its accuracy will depend on the experience of the experts as well as the way the questionnaires are presented, which is also very time consuming and high cost (Roszkowska, 2013). To overcome these limitations, it is necessary to determine the weights for the criteria based on mathematical models. In this way, the weight of the criteria is determined independent of the subjectivity of the decision maker. The Entropy is known as a method of determining weights with high accuracy, which has been used in many cases. When it is necessary to compare MCDM methods, the Entropy method is also recommended to use to determine the weights for the criteria (Trung, 2021).

For the decision-making issues, criteria can be regarded as a significant information source. The vital criteria weights could reveal plentiful information involving in each of them, which is called as “objective weight” (Peng, 2020). CRITIC (The Criterion Importance Through Intercriteria Correlation) is one of the objective methods used to determine criterion weights (Özdağoğlu et al., 2022). The objective weights derived by above approach combine both intensity contrast of each criterion and conflict among criteria. Intensity contrast of criteria is deemed to standard deviation and conflict between them is computed by the correlation coefficient (Peng, 2020).

Method based on the removal effects of criteria (MEREC) is a weighting method which introduced in 2021 by (Keshavarz-Ghorabaee et al., 2021), it is a completely new MCDM method that gives more precise and accurate results. This method has been used to determine the weights for criteria such as: decision-making to determine the location of logistics distribution centres, decision-making for documental classification etc. However, up to now this method has not been used to determine the weights for criteria in evaluating SSA countries. MEREC method used to determine weights for evaluating when determining the best solution of MCDM (Trung, 2021).

In this research to evaluate macroeconomic performance of SSA countries we will use MARCOS, MOORA, TOPSIS and CoCoSo techniques. The reason for using four different methods is to see the differences in the rankings and the consistency among the methods (Selcuk et al., 2023). For determining the weights of the criteria Entropy, CRITIC and MEREC methods will utilize.

3.4. MCDM Techniques for Determining the Criteria Weights

Weighting is usually related to the experience and knowledge of the decision-makers for the previous studies for a long time. Instead of subjective techniques, in present time, the objective techniques are preffered to be more realistic since the weigting method is expected to be effective in the ranking. Three methods for determining the weights of the criteria including Entropy, CRITIC and MEREC methods were applied in this research. This section explains how to use these methods.

3.4.1. The Entropy Method

Determining the weights of the indicators by the Entropy method can be found by the following steps (Duc Trung, 2022)

Step 1: Normalize an initial matrix by applying Eq. (1) (Miškić et al., 2022).

$$\mathrm{P}_{ij} = \frac{\mathrm{x}_{ij}}{\sum_{i=1}^{m} \mathrm{x}_{ij}} \quad (1)$$

Where $\mathrm{x}_{ij}$is the value of criterion j corresponding to test's run i (Duc Trung, 2022).

Step 2: Computation of the entropy measure is performed by applying Eq (2).

$$\mathrm{E}_j = -\mathrm{K} \sum_{i=1}^{m} \mathrm{P}_{ij} \ln \mathrm{P}_{ij} \quad (2)$$

In which $\mathrm{k} = \frac{1}{\ln(m)}$

Step 2: Calculating the weight for each indicator (Trung, 2021; Le et al., 2022).

$$\mathrm{W}_j = \frac{1-\mathrm{E}_j}{\sum_{k=1}^{n}(1-\mathrm{E}_j)} \quad (3)$$

3.4.2. The CRITIC Method

The CRITIC method process is as follows (Özdağoğlu et al., 2022):

Step 1: Establishment of the normalized decision matrix (Peng, 2020)

$$\mathrm{R}_{ij} = \frac{\mathrm{x}_{ij} - X_j^{worst}}{X_j^{best} - X_j^{worst}} \quad (4)$$

$$R_{ij} = \frac{X_j^{best} - x_{ij}}{X_j^{best} - X_j^{worst}} \quad (5)$$

While calculating the Eq. (4) and Equation (5), X_j^{worst} represents the minimum value at the related criteria and X_j^{best} represents the maximum value.

Step 2: Calculate the criteria standard deviations by Eq. (6):

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{m}(r_{ij}^{'} - \bar{r}_j)^2}{m}} \quad (6)$$

Step 3: Calculate the correlation between criteria pairs using Eq. (7):

$$\sigma_j = \frac{\sum_{i=1}^{m}\left(r_{ij}^{'} - \bar{r}_j\right)(r_{ik}^{'} - \overline{r_k})}{\sqrt{\sum_{i=1}^{m}(r_{ij}^{'} - \bar{r}_j)^2 \sum_{i=1}^{m}(r_{ik}^{'} - \overline{r_k})^2}} \quad (7)$$

Step 4: Calculate the quantity of information of each criterion as follows (Peng, 2020):

$$C_j = \sigma_j \sum_{k=1}^{n}\left(1 - t_{jk}\right) \quad (8)$$

The larger the C_j is, the more information a certain criterion contains, so the weight of this evaluation criterion is greater than that of other criteria.

Step 5: Determination of the criteria weights (W_j). To calculate the final criteria weights (W_j) the H_j values of the criteria are used. Increase in the H_j value increases the relative importance for the decision-making process. To calculate W_j value the Eq. (9) is used (Arsu, 2022).

$$W_j = \frac{H_j}{\sum_{k=1}^{m} H_k} \quad (9)$$

3.4.3. The MEREC Method

In this research, the MEREC method is used to determine the weights of the criteria. The MEREC method can be applied by following the steps below:

Step 1: Construct the decision matrix. A decision matrix is constructed in this step, which shows each alternative's ratings or values concerning each criterion. The elements of this matrix are denoted by x_{ij}, and these elements should be greater than zero ($x_{ij} > 0$). If we have negative values in the decision matrix, they should be transformed into positive values using an appropriate technique. Suppose that there are n alternatives and m criteria, and the form of the decision-matrix is as follows (Keshavarz-Ghorabaee et al., 2021).

$$X = \begin{vmatrix} x_{11} & x_{12} & \cdots & x_{1j} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2j} & \cdots & x_{2m} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{i1} & x_{i2} & \cdots & x_{ij} & \cdots & x_{im} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nj} & \cdots & x_{nm} \end{vmatrix} \quad (10)$$

Step 2. Normalize the decision matrix by using following Eq.:

$$N_{ij} = \begin{cases} \frac{\min_k x_{kj}}{x_{ij}} & if\ j \in B \\ \frac{x_{ij}}{\max_k x_{kj}} & if\ j \in B \end{cases} \quad (11)$$

Where N_{ij} represents elements of the normalized matrix N, B is the set of benefit criteria, and C.is the set of cost criteria (Gabrijela et al, 2022; Ozcalici, 2022).

Step 3: Alternative's overall performances (S_i) are calculated using Eq. (12)

$$S_i = In(1 + \left(\frac{1}{m}\sum_j |In(n_{ij}^x)\right) \quad (12)$$

where S_i is the overall performance of the alternatives (Özdağoğlu et al., 2022)

Step 4: Calculate the performance of the alternatives by removing each criterion. In this step, we use the logarithmic measure in a similar way to the previous step. The difference between this step and Step 3 is that the alternatives' performances are calculated based on removing each criterion separately. Therefore, we have m sets of performances associated with m criteria. Let us denote by $S_{ij}^{'}$ the overall performance of *i*th alternative concerning the removal of *j*th criterion. The following equation is used for the calculations of this step:

$$S_{ij}^{'} = In(1 + \left(\frac{1}{m}\sum_{k,k\neq j} |In(n_{ik}^x)\right) \quad (13)$$

Step 5: Compute the summation of absolute deviations. In this step, we calculate the removal effect of the *j*th criterion based on the values obtained from Step 3 and Step 4. Let V_j denote the effect of removing jth criterion. We can calculate the values of V_j using the following formula (Rani & Hezam, 2022)

$$V_j = \sum_i |S_{ij}^{'} - S_i| \quad (14)$$

Step 6: The weights of the criteria are determined using the following formula (Shanmugasundar et al., 2022; Nguyen et al., 2022)

$$w_j = \frac{E_j}{\sum_k E_k} \tag{15}$$

3.5 MCDM Techniques for Obtaining Rank

In the research, MARCOS, MOORA, TOPSIS and CoCoSo methods are used. Below, the application steps of these methods are explained and accompanied by equations:

3.5.1 The MARCOS Method

Measurement Alternatives and Ranking According to Compromise Solution (MARCOS) method was first used in 2019 (Stević et al., 2020). The algorithm of MARCOS method is presented. The MARCOS method is based on defining the relationship between alter- natives and reference values (ideal and anti-ideal alternatives). Based on the defined relationships, the utility functions of alternatives are determined, and compromise ranking is made in relation to ideal and anti-ideal solutions. The steps to implement MCDM according to the MARCOS method are as follows.

Step 1: Formation of an initial decision-making matrix. Multi-criteria models include the definition of a set of n criteria and m alternatives. In the case of group decision-making, a set of r experts should be formed to evaluate alternatives according to the criteria. In the case of group decision-making, expert evaluation matrices are aggregated into an initial group decision-making matrix.

Step 2: Formation of an extended initial matrix. In this step, the extension of the initial matrix is performed by defining the ideal (AI) and anti-ideal (AAI) solution (Stević et al., 2020).

$$X = \begin{array}{c} \\ AAI \\ \mathrm{A}_1 \\ \mathrm{A}_2 \\ \dots \\ \mathrm{A}_m \\ AI \end{array} \begin{array}{c} \begin{array}{cccc} C1 & C2 & \dots & \mathrm{C}_n \end{array} \\ \begin{vmatrix} \mathrm{x}_{aa1} & \mathrm{x}_{aa2} & \dots & \mathrm{x}_{aan} \\ \mathrm{x}_{11} & \mathrm{x}_{12} & \dots & \mathrm{x}_{1n} \\ \mathrm{x}_{21} & \mathrm{x}_{22} & \dots & \mathrm{x}_{2n} \\ \dots & \dots & \dots & \dots \\ \mathrm{x}_{m1} & \mathrm{x}_{22} & \dots & \mathrm{x}_{mn} \\ \mathrm{x}_{ai1} & \mathrm{x}_{\mathrm{ai2}} & \dots & \mathrm{x}_{\mathrm{ain}} \end{vmatrix} \end{array} \tag{16}$$

The anti-ideal solution (AAI) is the worst alternative, while the ideal solution (AI) is an alternative with the best characteristic. Depending on the nature of the criteria, AAI and AI are defined by applying Equations (17) and (18):

$$\mathrm{AAI} = \min \mathrm{x_{ij}} \text{ if } \mathrm{j} \in \mathrm{B} \text{ and } \max \mathrm{x_{ij}} \text{ if } \mathrm{j} \in \mathrm{C} \tag{17}$$

$$\mathrm{AI} = \max \mathrm{x_{ij}} \text{ if } \mathrm{j} \in \mathrm{B} \text{ and } \min \mathrm{x_{ij}} \text{ if } \mathrm{j} \in \mathrm{C} \tag{18}$$

where B represents a benefit group of criteria, while C represents a group of cost criteria.

Step 3: Normalization of the extended initial matrix (X). The elements of the normalized matrix $N = \left[\mathrm{N_{ij}}\right]_{\mathrm{mxn}}$ are obtained by applying Eqs. (19) and (20):

$$\mathrm{N_{ij}} = \frac{\mathrm{x_{ai}}}{\mathrm{x_{ij}}} \; if \; j \in C \tag{19}$$

$$\mathrm{N_{ij}} = \frac{\mathrm{x_{ij}}}{\mathrm{x_{ai}}} \; if \; j \in B \tag{20}$$

Where elements $\mathrm{x_{ij}}$and $\mathrm{x_{ai}}$ represent the elements of the matrix X.

Step 4: Determination of the weighted matrix $V = \left[\mathrm{V_{ij}}\right]_{\mathrm{mxn}}$ The weighted matrix V is obtained by multiplying the normalized matrix N with the weight coefficients of the criterion $\mathrm{w_j}$ Eq. (21) (Stević & Brković, 2020).

$$\mathrm{V_{ij}} = \mathrm{N_{ij}} \times \mathrm{w_j} \tag{21}$$

Step 5: Calculation of the utility degree of alternatives Ki. By applying Equations (22) and (23), the utility degrees of an alternative in relation to the anti-ideal and ideal solution are calculated.

$$K_i^- = \frac{\mathrm{S_i}}{\mathrm{S_{aai}}} \tag{22}$$

$$K_i^+ = \frac{\mathrm{S_i}}{\mathrm{S_{ai}}} \tag{23}$$

Where $\mathrm{S_i}$ $(i = 1,2, \ldots \ldots m)$ represents the sum of the elements of the weighted matrix V, Equation (24).

$$\mathrm{S_i} = \sum_{i=1}^{n} \mathrm{V_{ij}} \tag{24}$$

Step 6: Calculating functions f (K_i^+) and f (K_i^-) by Trung (2021).

$$f(K_i^-) = \frac{K_i^+}{K_i^+ + K_i^i} \tag{25}$$

$$f(K_i^+) = \frac{K_i^-}{K_i^+ + K_i^i} \tag{26}$$

Step 7: Calculating function f(Ki) according to the following equation and rank the alternatives:

$$f(K_i) = \frac{K_i^+ + K_i^-}{\frac{1-\mathrm{f}(K_i^+)}{\mathrm{f}(K_i^+)} + \frac{1-\mathrm{f}(K_i^-)}{\mathrm{f}(K_i^-)}} \tag{27}$$

Ranking the solutions according to the best solution is the one with the largest value of the function f (K_i).

3.5.2 MOORA Method

The MOORA method consists of four main steps as follows:

Step 1: Create the decision matrix X with m alternatives and n criteria (Dabbagh et al., 2019).

$$X = \mathrm{x}_{ij} = \begin{vmatrix} \mathrm{x}_{11} & \mathrm{x}_{12} & \mathrm{x}_{1n} \\ \mathrm{x}_{21} & \mathrm{x}_{22} & \mathrm{x}_{2n} \\ \mathrm{x}_{m1} & \mathrm{x}_{m2} & \mathrm{x}_{mn} \end{vmatrix} \tag{28}$$

Step 2: Normalize the decision matrix X

$$\mathrm{x}_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{j} x_{ij}^2}} \tag{29}$$

Step 3: Calculate the normalized evaluation value for each alternative, taking into account all of the other options. In actuality, the ultimate score of each option is calculated using the equation below.

$$y_i^* = \sum_{j=1}^{j} x_{ij}^* - \sum_{j=t+1}^{n} x_{ij}^* \tag{30}$$

Step 4: the MOORA score for each alternative is measure by using this Eq.

$$y_i^* = \sum_{j=1}^{j} w_j x_{ij}^* - \sum_{j=t+1}^{n} w_j x_{ij}^* \tag{31}$$

In this equation, w_j refers to the jth objective (criterion) weight. It should be noted that depending on the number and the value of the beneficial and non-beneficial criteria, y_i^* can be either positive or negative.

3.5.3 TOPSIS Method

In this study, for the final ranking of performance indicators, are given in the following the steps of TOPSIS:

Step 1: Identification of the aims and the assessment attributes for the study (Jabbarzadeh, 2018).

Step 2: Establish a decision matrix for the ranking. TOPSIS uses all outcomes (a_{ij}) in a decision matrix to develop a compromise rank (Onder et al., 2015).

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \ldots & a_{2n} \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ a_{m1} & a_{m2} & \ldots & a_{mn} \end{bmatrix} \quad (32)$$

Step 3: Normalize the decision matrix using the following equation (Baccour, 2018).

$$n_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{m} a_{ij}^2}} \quad (33)$$

$$i = 1,2, \ldots \ldots m; \;\; j = 1,2, \ldots . . n$$

$$N = \begin{bmatrix} n_{11} & \cdots & n_{1n} \\ \vdots & \ddots & \vdots \\ n_{m1} & \cdots & n_{mn} \end{bmatrix} \quad (34)$$

Step 4: By multiplying the normalized matrix with the weights of the criterion, we get a weighted normalized decision matrix:

$$v_{ij} = w_{ij}^{*} \; j = 1,2, \ldots \ldots j : i = 1,2, . . n \quad (35)$$

Step 5: (maximum values) and (minimum values) are determined as (Ploskas et al, 2019):

$$A^{*} = \{v_1^{*}, v_2^{*}, \ldots . . v_n^{*}\} \quad (36)$$

$$A^{-} = \{v_1^{-}, v_2^{-}, \ldots . . v_n^{-}\} \quad (37)$$

Step 6: The distance of each alternative from PIS and NIS is calculated as (Ameri et al, 2018).

$$S_i^{*} = \sqrt{\sum (v_{ij} - v_j^{*})^2} \; j = 1,2, \ldots . \quad (38)$$

$$S_i^{-} = \sqrt{\sum (v_{ij} - v_j^{-})^2} \; j = 1,2, \ldots . j \quad (39)$$

Step 7: The closeness coefficient of each alternative (C_i) is calculated as (Olson, 2004):

$$C_i^{*} = \frac{S_i^{-}}{S_i^{-} + S_i^{*}} \;\; i = 1,2, \ldots . . m \quad (40)$$

Step 8: The ranking of alternatives is decided at the end of the analysis by comparing CC values (Seçme et al., 2009).

3.5.4 CoCoSo Method

The steps of the CoCoSo method are given as below.

Step 1. Form the initial decision matrix X for M alternatives with respect to n criteria (Lai et al., 2020).

$$X = \begin{vmatrix} \mathrm{x}_{12} & \mathrm{x}_{12} & \ldots & \mathrm{x}_{1n} \\ \mathrm{x}_{21} & \mathrm{x}_{22} & \ldots & \mathrm{x}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \mathrm{x}_{\mathrm{m1}} & \mathrm{x}_{\mathrm{m2}} & \ldots & \mathrm{x}_{\mathrm{mn}} \end{vmatrix} \quad i = 1,2, . m . j = 1,2, . n . \quad (41)$$

Step 2. The normalisation of criteria values is accomplished based on compromise normalisation equation.

$$r_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \text{ for benefit criterion;} \quad (42)$$

$$r_{ij} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \text{ for cost criterion} \quad (43)$$

Step 3. The total of the weighted comparability sequence and the whole of the power weight of comparability sequences for each alternative sum of the weighted comparability sequence and an amount of the power weight of comparability sequences for each alternative as S_i and P_i, respectively:

$$S_i = \sum_{j=1}^{n} (w_j r_{ij}) \quad (44)$$

this S_i value is achieved based on grey relational generation approach:

$$P_i = \sum_{j=1}^{n} (r_{ij})^{w_j} \quad (45)$$

This P_i value is also achieved according to the WASPAS multiplicative attitude (Yazdani & Zarate, 2019).

Step 4. compute the relative priorities of alternatives by the aggregation strategies shown as Eqs. (46)-(48).

$$\mathrm{k}_{ia} = \frac{P_i + S_i}{\sum_{i=1}^{m} (P_i + S_i)}, \quad for\ i = 1,2, \ldots . m. \quad (46)$$

$$\mathrm{k}_{ib} = \frac{S_i}{\min_i S_i} + \frac{P_i}{\min_i P_i}, \quad for\ i = 1,2, \ldots . m. \quad (47)$$

$$\mathrm{k}_{ic} = \frac{\lambda(S_i) + (1-\lambda)(P_i)}{\lambda \max_i S_i + (1-\lambda) \max_i P_i}, for\ i = 1,2, \ldots m \quad (48)$$

In Eq. (48), the value of λ (usually $\lambda = 0{,}5$) is determined by decision-makers and $0 \leq \lambda \leq 1$.

Step 5. The ranking of all alternatives is determined in descending order of the performance scores of the alternatives (Lai et al., 2020).

$$\mathrm{k}_i = (\mathrm{k}_{ia}, \mathrm{k}_{ib,} \mathrm{k}_{ic})^{\frac{1}{3}} + \frac{1}{3}(\mathrm{k}_{ia} + \mathrm{k}_{ib} + \mathrm{k}_{ic}) \quad (49)$$

3.6 BORDA Approach

The BORDA method is one of the group decision-making methods where the selection process is based on assessments that often arise from the alternatives chosen while making decisions (Bara et al., 2023). The alternatives can be ranked using BORDA based on their ranking sums (Wu, 2011). The privilege of this method can overcome the difficulties of other methods where people/things that are not in the first rank will be

automatically eliminated (Ahmadi & Herdiawan, 2021). By Jean-Charles de BORDA, the BORDA method was proposed and represents an important step in the development of modern electoral systems. Furthermore, the BORDA approach has been applied as a data fusion tool to merge ranked lists (Wu, 2011). The BORDA method's main idea is to rank the available alternatives. The alternative that has the highest rank is given the highest score, and so on. The BORDA approach requires voters to rank and value each contender. Another definition of BORDA is a voting technique utilized for group decision making for the selection of single winner or multiple winner (Sonatha et al., 2021). Calculation of the number of BORDA points (Bara et al., 2023)

$$b_i = \sum_k N - r_{ik} \tag{50}$$

Information:

b_i = number of points each alternative receives.

N = number of alternatives.

r_{ik} = alternative ranking

CHAPTER IV

EMPIRICAL RESULTS

4.1.Introduction

In this chapter, an application is made to rank macroeconomic performance in SSA countries. In practice, Entropy, CRITIC and MEREC were used to weigh the criteria; MARCOS, MOORA, TOPSIS, and CoCoSo were used to rank the countries; and BORDA was utilised to combine the ranking to evaluate macroeconomic performance in SSA countries. Six criteria were utilised within the scope of the application. GDP, EXP, FDI, IMP, INF, and UEM. 30 SSA countries were identified as alternatives. The rest of the chapter is structured as follows: Section 4.2 calculates the weights for the criteria. Section 4.3 evaluates the macroeconomic performance of SSA countries by employing the MARCOS method. Section 4.4 evaluates the macroeconomic performance of SSA countries by applying the MOORA method. Section 4.5 shows the TOPSIS method. Section 4.6 implements the CoCoSo method to evaluate the macroeconomic performance in SSA countries. Section 4.7 unifies the rankings of MCDM methods by BORDA. In the last section, compares the effects of MCDM methods using a Taylor diagram. The application was made sequentially based on the steps presented in the methodology section.

4.2. Calculating the Weights for the Criteria

4.2.1. Applying Entropy Method

The determination of the weights for the criteria according to the Entropy method is carried out according to the steps mentioned in Chapter 3. In the first step, it is necessary to normalize an initial matrix (P_{ij}) applying Eq. (1) The normalized initial matrix formed by the achieved normalized criteria is given on the Table 2.

Table 2

Normalize the initial matrix

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.042	0.077	0.045	0.028	0.038	0.045
Burundi	0.002	0.000	0.000	0.001	0.002	0.004
Congo, Rep.	0.008	0.026	0.085	0.016	0.005	0.098
Cote d'Ivoire	0.036	0.038	0.011	0.031	0.002	0.011
Gambia	0.001	0.001	0.030	0.001	0.016	0.020
Guinea	0.008	0.013	0.003	0.014	0.021	0.024
Kenya	0.061	0.031	0.004	0.049	0.012	0.024
Mauritania	0.005	0.009	0.083	0.011	0.005	0.049
Niger	0.008	0.004	0.042	0.008	0.006	0.003
Rwanda	0.006	0.006	0.019	0.009	0.007	0.059
Sierra Leone	0.002	0.002	0.064	0.004	0.033	0.015
Togo	0.004	0.005	0.038	0.005	0.002	0.018
Zimbabwe	0.013	0.016	0.009	0.013	0.572	0.035
Benin	0.009	0.012	0.012	0.012	0.002	0.007
Cameroon	0.024	0.022	0.020	0.022	0.005	0.017
Chad	0.007	0.011	0.038	0.010	0.002	0.005
Ethiopia	0.058	0.021	0.020	0.048	0.035	0.015
Ghana	0.041	0.070	0.043	0.064	0.016	0.016
Gabon	0.010	0.024	0.070	0.009	0.006	0.098
Madagascar	0.009	0.011	0.026	0.012	0.013	0.009
Mali	0.010	0.012	0.038	0.016	0.004	0.008
Mauritius	0.009	0.017	0.023	0.018	0.001	0.030
Mozambique	0.009	0.014	0.167	0.029	0.006	0.016
Namibia	0.008	0.012	0.011	0.014	0.008	0.095
Nigeria	0.288	0.184	0.004	0.225	0.026	0.025
Senegal	0.014	0.016	0.035	0.022	0.004	0.014
South Africa	0.236	0.290	0.010	0.249	0.009	0.121
Sudan	0.020	0.007	0.019	0.014	0.114	0.083
Tanzania	0.037	0.027	0.015	0.025	0.008	0.010
Zambia	0.014	0.022	0.018	0.019	0.020	0.026

In the next step, the computation of the entropy measure is performed by applying Eq. (2). To carry out this step, it was necessary to calculate the natural logarithm, then, the negative reciprocal of the natural logarithm was calculated. This was needed to calculate the entropy value (E_j), which was obtained by multiplying the sum of the criteria by the previously obtained value. Then, the divergence rate was calculated by the formula $d_j = 1 - E_j$ and the weight-value criterion is calculated (W_j) and indicated in Table 3. For 2020 and 2021, the criteria weights are calculated similarly, the steps are shown in

Appendix A, and the results are given in the same table. Table 3 indicates that the criterion INF is the most important, UEM has the lowest importance within the period of the study.

Table 3

Entropy weights for 2019-2021

	GDP	EXP	FDI	IMP	INF	UEM
2019	0.194	0.169	0.082	0.157	0.316	0.082
2020	0.179	0.154	0.114	0.116	0.369	0.069
2021	0.185	0.181	0.106	0.137	0.314	0.077

The criteria weights achieved by the Entropy method are used in the solution steps of the MARCOS, MOORA, TOPSIS and CoCoSo methods.

4.2.2 Applying CRITIC Method

The determination of the weights for the criteria according to the CRITIC method is carried out according to the steps mentioned in Chapter 3. First, the decision matrix is formed which is the most fundamental stage of all MCDM methods.

To realize the normalization of the benefit direction (maximization) criteria the Eq. (4) and for the normalization of the cost direction (minimization) criteria the Eq. (5) are utilized. The normalized decision matrix formed by the achieved normalized criteria is given on the Table 4.

Table 4

Normalize the decision matrix

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.143	0.266	0.268	0.108	0.065	0.357
Burundi	0.002	0.000	0.000	0.000	0.001	0.013
Congo, Rep.	0.023	0.088	0.509	0.060	0.007	0.803
Cote d'Ivoire	0.123	0.129	0.063	0.119	0.003	0.074
Gambia	0.000	0.002	0.177	0.000	0.026	0.145
Guinea	0.025	0.043	0.013	0.050	0.036	0.179
Kenya	0.209	0.107	0.020	0.192	0.019	0.178
Mauritania	0.013	0.030	0.498	0.037	0.007	0.394
Niger	0.023	0.013	0.251	0.027	0.008	0.000
Rwanda	0.018	0.020	0.114	0.030	0.012	0.475
Sierra Leone	0.005	0.006	0.381	0.009	0.056	0.106
Togo	0.011	0.015	0.224	0.016	0.001	0.126
Zimbabwe	0.042	0.055	0.050	0.048	1.000	0.273
Benin	0.027	0.039	0.067	0.041	0.001	0.037
Cameroon	0.080	0.073	0.116	0.084	0.008	0.123
Chad	0.020	0.038	0.227	0.035	0.002	0.023
Ethiopia	0.199	0.071	0.119	0.188	0.060	0.107
Ghana	0.141	0.240	0.257	0.254	0.026	0.116
Gabon	0.032	0.081	0.418	0.030	0.008	0.806
Madagascar	0.026	0.037	0.152	0.041	0.020	0.052
Mali	0.033	0.041	0.225	0.058	0.005	0.043
Mauritius	0.027	0.059	0.138	0.067	0.000	0.231
Mozambique	0.029	0.046	1.000	0.113	0.009	0.117
Namibia	0.023	0.042	0.062	0.050	0.013	0.778
Nigeria	1.000	0.636	0.020	0.903	0.043	0.186
Senegal	0.046	0.054	0.206	0.083	0.005	0.092
South Africa	0.818	1.000	0.058	1.000	0.015	1.000
Sudan	0.065	0.025	0.115	0.049	0.198	0.682
Tanzania	0.125	0.091	0.089	0.094	0.012	0.067
Zambia	0.045	0.075	0.105	0.071	0.034	0.200

To calculate the standard deviation values, the Eq. (6) is used. As the CRITIC method is a method beads on binary correlations between the criteria, in the next step the correlation coefficients between the criteria are calculated by using the Eq. (7) and shown on the Table 5.

Table 5

Matrix for correlation coefficient between criteria

Country Name	GDP	EXP	FDI	IMP	INF	UEM
GDP	1.000	0.918	-0.262	0.979	-0.037	0.246
EXP	0.918	1.000	-0.185	0.963	-0.048	0.410
FDI	-0.262	-0.185	1.000	-0.200	-0.156	0.081
IMP	0.979	0.963	-0.200	1.000	-0.055	0.306
INF	-0.037	-0.048	-0.156	-0.055	1.000	0.057
UEM	0.246	0.410	0.306	0.306	0.057	1.000

In the next stage, while calculating the C_j indicating the quantity of information measurement. Then C_j value is used to achieve final criteria weights by utilizing the Eq. (9). For years 2020 and 2021, the criteria weights are calculated similarly, the steps are shown in Appendix A, and the results are given in the Table 6. According to the results, indicated in Table 6, the criterion FDI is the most important for all years, followed by the criterion UEM.

Table 6

CRITIC weights for 2019-2021

Year	**GDP**	**EXP**	**FDI**	**IMP**	**INF**	**UEM**
2019	0.138	0.118	0.227	0.135	0.185	0.199
2020	0.143	0.106	0.252	0.109	0.182	0.207
2021	0.161	0.112	0.209	0.119	0.209	0.189

The criteria weights achieved by the CRITIC method are used in the solution steps of the MARCOS, MOORA, TOPSIS and CoCoSo methods.

4.2.3 Applying MEREC Method

Normalize the decision matrix (N). In this step, a simple linear normalization is used to scale the elements of the decision-matrix. The elements of the normalized matrix are denoted by N_{ij} . Table 7 represents this matrix.

Table 7

Normalized decision matrix

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.026	0.005	0.007	0.114	0.067	0.371
Burundi	0.704	1.000	1.000	0.006	0.003	0.034
Congo, Rep.	0.142	0.014	0.004	0.065	0.009	0.807
Cote d'Ivoire	0.030	0.010	0.029	0.124	0.004	0.094
Gambia	1.000	0.390	0.010	0.006	0.028	0.164
Guinea	0.135	0.028	0.123	0.056	0.037	0.197
Kenya	0.018	0.012	0.087	0.196	0.021	0.196
Mauritania	0.225	0.040	0.004	0.042	0.009	0.407
Niger	0.140	0.090	0.007	0.033	0.010	0.022
Rwanda	0.175	0.059	0.016	0.036	0.013	0.487
Sierra Leone	0.445	0.179	0.005	0.015	0.058	0.125
Togo	0.259	0.079	0.008	0.022	0.003	0.145
Zimbabwe	0.083	0.022	0.035	0.054	1.000	0.289
Benin	0.126	0.031	0.027	0.047	0.003	0.057
Cameroon	0.046	0.017	0.016	0.090	0.010	0.142
Chad	0.160	0.032	0.008	0.041	0.004	0.044
Ethiopia	0.019	0.017	0.015	0.193	0.062	0.126
Ghana	0.027	0.005	0.007	0.259	0.028	0.136
Gabon	0.107	0.015	0.004	0.036	0.010	0.810
Madagascar	0.129	0.033	0.012	0.046	0.022	0.072
Mali	0.105	0.030	0.008	0.063	0.006	0.063
Mauritius	0.126	0.021	0.013	0.073	0.002	0.248
Mozambique	0.118	0.027	0.002	0.118	0.011	0.136
Namibia	0.145	0.029	0.029	0.056	0.015	0.783
Nigeria	0.004	0.002	0.083	0.904	0.045	0.204
Senegal	0.077	0.023	0.009	0.088	0.007	0.112
South Africa	0.005	0.001	0.031	1.000	0.016	1.000
Sudan	0.056	0.049	0.016	0.055	0.200	0.689
Tanzania	0.030	0.014	0.020	0.100	0.014	0.087
Zambia	0.078	0.017	0.017	0.077	0.036	0.217

In this step, the overall performance of the alternatives (S_j) is calculated based on Eq. (12). Based on Eq. (13), the performance of the alternatives by removing each criterion $S_{ij}^{'}$ are calculated. In this step, we use the logarithmic measure in a similar way to the previous step. Based on the deviation-based formula of Eq. (14), the removal effect of each criterion on the overall performance of the alternatives are calculated. These values are determined as follows:

Table 8

The removal effect of each criterion

	GDP	**EXP**	**FDI**	**IMP**	**INF**	**UEM**
V_j	1.106	1.056	0.783	0.652	1.031	0.928

By using Eq. (15) and the values computed in the previous section, we calculate the weights for 2019, Table 9 shows these weights. For 2020 and 2021, the criteria weights are calculated similarly, the steps are shown in Appendix A, and the results are given in the same table. According to the Table 9 results, INF and EXP are higly important criteria for all periods; FDI has very low importance.

Table 9

MEREC weights for 2019-2021

	GDP	**EXP**	**FDI**	**IMP**	**INF**	**UEM**
2019	0.199	0.19	0.141	0.118	0.186	0.167
2020	0.167	0.219	0.078	0.14	0.281	0.115
2021	0.158	0.223	0.095	0.155	0.245	0.124

The criteria weights achieved by the MEREC method are used in the solution steps of the MARCOS, MOORA, TOPSIS and CoCoSo methods.

4.2.4 Evaluation of Different Weighting Methods

In MCDM methods, defining the criteria importance are very important since it is not easily obtained objectively. Sometimes subjective methods, depending on experts can be used. To be more realized, many different weighting methods are proposed to use in MCDM methods (Odu,2019). This research aimed to obtaine nonsubjective weights in selected MCDM methods. For this reason, three differen methods are utilised and results are evaluated.

With respect to obtained by Entropy weights, INF is the most important criterion out of all criteria within the period of the study, followed by UEM. Furthermore, according to CIRITC method, the criterion FDI is the most important for all years, followed by the criterion UEM. Moreover, the results of MEREC showed that INF and EXP respectivelly, are higly important criteria within the span of the research. So, we can expect that these results will affect the rankings obtained by different methods.

4.3 Applying MARCOS Method

4.3.1 MARCOS Method for 2019 with Entropy

The actions listed in section (3) are followed while applying the MARCOS technique. Eqs. (17) and (18) has been applied to determine the ideal solution (AI) and the opposite solution to the ideal solution (AAI).

Table 10

Calculation of the AI and the AAI

Country Name	GDP	EXP	FDI	IMP	INF	UEM
AAI	1.813.7	1.332.6	0.040	1.039	255.305	25.54
AI	4.746	1.060	21.958	614607193.6	0.406	0.552

Calculating the normalized values N_{ij} according to the Eqs. (19) and (20). In the next step the weighted normalized matrix is calculated by multiplying the previous normalized matrix by the values of the criteria obtained using the Entropy method. The coefficients K_i^+ and K_i^- were calculated according to Eqs. (23) and (22). The value of $f(K_i^+)$ that has been calculated by Eq. (26). Also, the value of $f(K_i^-)$ has been calculated by Eq. (25). Eq. (27) has been applied to calculate the values of $f(K_i)$. The results of calculating these quantities are presented in Table 11. The ranking results of the countries are also presented in Table 11. For 2020 and 2021, the alternatives are calculated similarly, the steps are shown in Appendix B, and the results are given in Table 12.

Table 11

The results of MARCOS method for 2019 with Entropy

	S_i	K_i^-	K_i^+	$f(K_i^-)$	$f(K_i^+)$	$f(K_i)$	Rank
AAI	0.004	1.000	0.004	0.004	0.996	0.004	
Angola	0.116	26.931	0.116	0.004	0.996	0.116	19
Burundi	0.397	92.124	0.397	0.004	0.996	0.397	1
Congo, Rep.	0.136	31.690	0.136	0.004	0.996	0.136	13
Cote d'Ivoire	0.194	45.003	0.194	0.004	0.996	0.194	9
Gambia	0.199	46.262	0.199	0.004	0.996	0.199	8
Guinea	0.053	12.383	0.053	0.004	0.996	0.053	28
Kenya	0.099	23.065	0.099	0.004	0.996	0.099	22
Mauritania	0.131	30.521	0.131	0.004	0.996	0.131	16
Niger	0.190	44.149	0.190	0.004	0.996	0.190	10
Rwanda	0.085	19.736	0.085	0.004	0.996	0.085	25
Sierra Leone	0.119	27.720	0.119	0.004	0.996	0.119	18
Togo	0.268	62.329	0.268	0.004	0.996	0.268	5
Zimbabwe	0.047	10.824	0.047	0.004	0.996	0.047	30
Benin	0.251	58.164	0.251	0.004	0.996	0.251	6
Cameroon	0.113	26.340	0.113	0.004	0.996	0.113	21
Chad	0.225	52.154	0.225	0.004	0.996	0.225	7
Ethiopia	0.088	20.498	0.088	0.004	0.996	0.088	24
Ghana	0.125	28.923	0.125	0.004	0.996	0.125	17
Gabon	0.135	31.399	0.135	0.004	0.996	0.135	14
Madagascar	0.092	21.391	0.092	0.004	0.996	0.092	23
Mali	0.153	35.426	0.153	0.004	0.996	0.153	12
Mauritius	0.363	84.311	0.363	0.004	0.996	0.363	3
Mozambique	0.163	37.792	0.163	0.004	0.996	0.163	11
Namibia	0.071	16.455	0.071	0.004	0.996	0.071	26
Nigeria	0.325	75.372	0.325	0.004	0.996	0.325	4
Senegal	0.135	31.336	0.135	0.004	0.996	0.135	15
South Africa	0.367	85.199	0.367	0.004	0.996	0.367	2
Sudan	0.049	11.398	0.049	0.004	0.996	0.049	29
Tanzania	0.115	26.640	0.115	0.004	0.996	0.115	20
Zambia	0.065	15.202	0.065	0.004	0.996	0.065	27
AI	1.000	232.172	1.000	0.004	0.996	1.000	0

Table 12 summarized the results of ranking countries when using the MARCOS method for 2019–2021 (pre- and during COVID-19). The results of Table 12 and Figure 1 shows that Burundi, South Africa, Mauritius and Nigeria have achieved the most successful macroeconomic performance in 2019, followed by Togo, while the worst-ranked country with the lowest macroeconomic performance was Sudan and Zimbabwe.

Table 12

The results of MARCOS method for 2019-2021

Country Name	Rank		
	MARCOS 2019	**MARCOS 2020**	**MARCOS 2021**
Angola	19	25	17
Burundi	1	8	5
Congo, Rep.	13	4	13
Cote d'Ivoire	9	12	14
Gambia	8	7	7
Guinea	28	29	29
Kenya	22	20	19
Mauritania	16	10	20
Niger	10	9	10
Rwanda	25	28	2
Sierra Leone	18	23	22
Togo	5	11	24
Zimbabwe	30	30	30
Benin	6	16	11
Cameroon	21	14	15
Chad	7	17	4
Ethiopia	24	24	21
Ghana	17	21	18
Gabon	14	5	6
Madagascar	23	22	25
Mali	12	1	23
Mauritius	3	19	27
Mozambique	11	6	9
Namibia	26	18	26
Nigeria	4	3	3
Senegal	15	13	12
South Africa	2	2	1
Sudan	29	26	8
Tanzania	20	15	16
Zambia	27	27	28

The rank of the countries using MARCOS method for 2019-2021 has been shown in Figure 1.

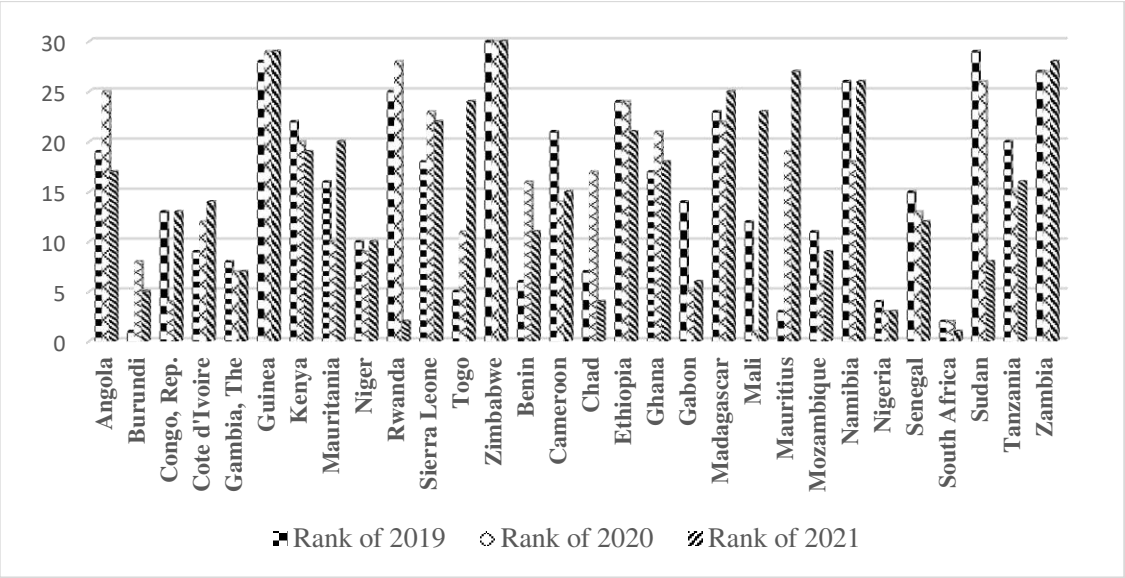

Figure 1. Results of MARCOS weighted with Entropy for 2019-2021

4.3.2 MARCOS Method for 2019 with CRITIC

The actions listed in section (3) are followed while applying the MARCOS technique. Eqs. (17) and (18) has been applied to determine the ideal solution (AI) and the opposite solution to the ideal solution (AAI).

Table 13

Calculation of the AI and the AAI

Country Name	GDP	EXP	FDI	IMP	INF	UEM
AAI	1.813.7	1.332.6	0.040	1.039	255.305	25.54
AI	4.746	1.060	21.958	614607193.6	0.406	0.552

Calculating the normalized values N_{ij}according to the Eqs. (19) and (20). In the next step the weighted normalized matrix is calculated by multiplying the previous normalized matrix by the values of the criteria obtained using the CRITIC method. The coefficients K_i^+ and K_i^- were calculated according to Eqs. (23) and (22). The value of $f(K_i^+)$ that has been calculated by Eq. (26). Also, the value of $f(K_i^-)$ has been calculated by Eq. (25). Eq. (27) has been applied to calculate the values of $f(K_i)$. The results of calculating these quantities are presented in Table 14. The ranking results of the countries for 2019 are also presented in this table. For 2020 and 2021, the alternatives are calculated similarly, the steps are shown in Appendix B, and the results are given in Table 15.

Table 14

Results of MARCOS method weighted with CRITIC for 2019

	S_i	K_i^-	K_i^+	$f(K_i^-)$	$f(K_i^+)$	$f(K_i)$	Rank
AAI	0.0065	1.0000	0.0065	0.0064	0.9936	0.0065	
Angola	0.1354	20.9327	0.1354	0.0064	0.9936	0.1354	19
Burundi	0.3711	57.3553	0.3711	0.0064	0.9936	0.3711	1
Congo, Rep.	0.1812	28.0088	0.1812	0.0064	0.9936	0.1812	13
Cote d'Ivoire	0.1671	25.8256	0.1671	0.0064	0.9936	0.1671	16
Gambia	0.2109	32.5924	0.2109	0.0064	0.9936	0.2109	10
Guinea	0.0565	8.7290	0.0565	0.0064	0.9936	0.0565	29
Kenya	0.0869	13.4333	0.0869	0.0064	0.9936	0.0869	24
Mauritania	0.1811	27.9835	0.1811	0.0064	0.9936	0.1811	14
Niger	0.3155	48.7674	0.3155	0.0064	0.9936	0.3155	2
Rwanda	0.0851	13.1566	0.0851	0.0064	0.9936	0.0851	25
Sierra Leone	0.1816	28.0740	0.1816	0.0064	0.9936	0.1816	12
Togo	0.2321	35.8707	0.2321	0.0064	0.9936	0.2321	8
Zimbabwe	0.0547	8.4590	0.0547	0.0064	0.9936	0.0547	30
Benin	0.2225	34.3898	0.2225	0.0064	0.9936	0.2225	9
Cameroon	0.1165	18.0093	0.1165	0.0064	0.9936	0.1165	22
Chad	0.2538	39.2326	0.2538	0.0064	0.9936	0.2538	6
Ethiopia	0.1066	16.4749	0.1066	0.0064	0.9936	0.1066	23
Ghana	0.1520	23.4899	0.1520	0.0064	0.9936	0.1520	17
Gabon	0.1676	25.8973	0.1676	0.0064	0.9936	0.1676	15
Madagascar	0.1333	20.5978	0.1333	0.0064	0.9936	0.1333	20
Mali	0.1867	28.8595	0.1867	0.0064	0.9936	0.1867	11
Mauritius	0.2561	39.5880	0.2561	0.0064	0.9936	0.2561	5
Mozambique	0.3017	46.6274	0.3017	0.0064	0.9936	0.3017	3
Namibia	0.0631	9.7460	0.0631	0.0064	0.9936	0.0631	27
Nigeria	0.2460	38.0244	0.2460	0.0064	0.9936	0.2460	7
Senegal	0.1502	23.2085	0.1502	0.0064	0.9936	0.1502	18
South Africa	0.2672	41.2971	0.2672	0.0064	0.9936	0.2672	4
Sudan	0.0610	9.4224	0.0610	0.0064	0.9936	0.0610	28
Tanzania	0.1282	19.8196	0.1282	0.0064	0.9936	0.1282	21
Zambia	0.0783	12.1088	0.0783	0.0064	0.9936	0.0783	26
AI	1.0000	154.5519	1.0000	0.0064	0.9936	1.0000	0

Table 15 summarized the results of ranking countries when using the MARCOS method for 2019–2021 (pre- and during COVID-19).

Table 15

Results of MARCOS method weighted with CRITIC for 2019–2021

	Rank		
Country Name	**MARCOS 2019**	**MARCOS 2020**	**MARCOS 2021**
Angola	19	22	18
Burundi	1	5	6
Congo, Rep.	13	2	23
Cote d'Ivoire	16	14	13
Gambia	10	7	8
Guinea	29	28	29
Kenya	24	24	25
Mauritania	14	10	14
Niger	2	3	3
Rwanda	25	29	4
Sierra Leone	12	15	16
Togo	8	18	24
Zimbabwe	30	30	30
Benin	9	13	10
Cameroon	22	20	20
Chad	6	11	5
Ethiopia	23	21	21
Ghana	17	19	17
Gabon	15	8	9
Madagascar	20	16	22
Mali	11	4	19
Mauritius	5	25	27
Mozambique	3	1	2
Namibia	27	26	26
Nigeria	7	9	7
Senegal	18	12	11
South Africa	4	6	1
Sudan	28	23	12
Tanzania	21	17	15
Zambia	26	27	28

The rank of the countries using MARCOS method for 2019-2020 has been shown in Figure 2. The results show that, Burundi is the best in terms of macroeconomic performance country in 2019. The highest GDP rate and the lowest rates of unemployment and inflation in Burundi are the reasons for this ranking, while Mauritania, Gabon and Cote d'Ivoire fall to the bottom of the ranking. The lowest macroeconomic performance country in 2019 is Zimbabwe according to techniques outlined above.

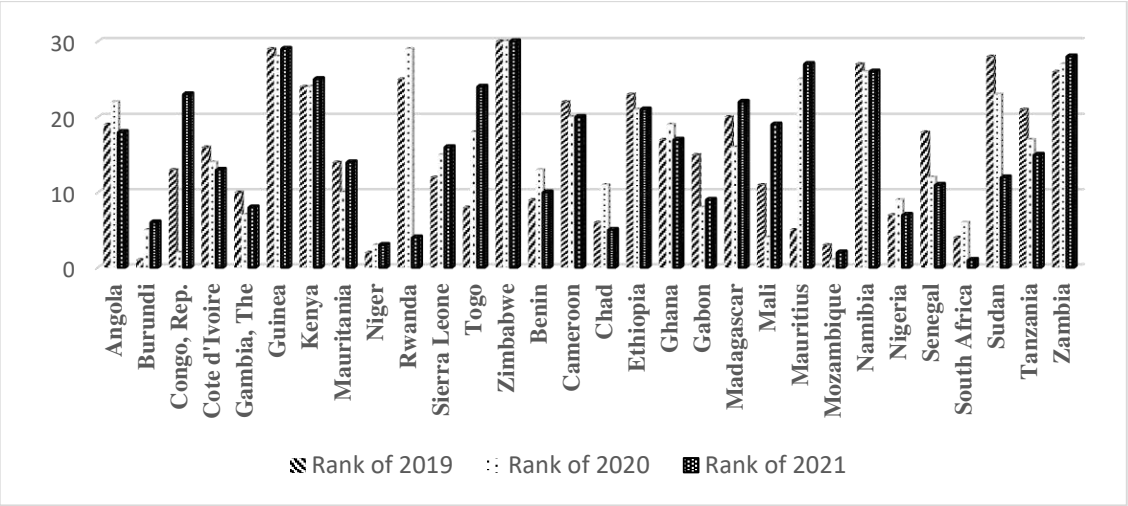

Figure 2. Results of MARCOS weighted with CRITIC for 2019-2021

4.3.3 MARCOS Method for 2019 With MEREC

The actions listed in section (3) are followed while applying the MARCOS technique. Eqs. (17) and (18) has been applied to determine the ideal solution (AI) and the opposite solution to the ideal solution (AAI).

Table 16

Calculation of the AI and the AAI

Country Name	GDP	EXP	FDI	IMP	INF	UEM
AAI	1.813.7	1.332.6	0.040	1.039	255.305	25.54
AI	4.746	1.0605911	21.958	614607193.6	0.406	0.552

Calculating the normalized values N_{ij} according to the Eqs. (19) and (20). Then the weighted normalized matrix is calculated by multiplying the previous normalized matrix by the values of the criteria obtained using the MEREC method. The coefficients K_i^+ and K_i^- were calculated according to Eqs. (23) and (22). The value of $f(K_i^+)$ that has been calculated by Eq. (26). Also, the value of $f(K_i^-)$ has been calculated by Eq. (25). Eq. (27) has been applied to calculate the values of $f(K_i)$. The results of calculating these quantities are presented in Table 17. The ranking results of the countries are also presented in Table 17. For 2020 and 2021, the alternatives are calculated similarly, the steps are shown in Appendix B, and the results are given in Table 18.

According to Table 17 South Africa appears at the top of the ranking. South Africa is a country that endowed with natural resources, and it is among the leading exporters of gold iron and platinum, followed by Nigeria, Burundi and Niger.

Table 17

Results of MARCOS method weighted with MEREC for 2019

Country Name	**Si**	K_i^-	K_i^+	$f(K_i^-)$	$f(K_i^+)$	$f(K_i)$	Rank
AAI	0.0059	1.0000	0.0059	0.0058	0.9942	0.0059	
Angola	0.1379	23.5468	0.1379	0.0058	0.9942	0.1379	15
Burundi	0.3344	57.0997	0.3344	0.0058	0.9942	0.3344	3
Congo, Rep.	0.1434	24.4752	0.1434	0.0058	0.9942	0.1434	14
Cote d'Ivoire	0.1710	29.1922	0.1710	0.0058	0.9942	0.1710	11
Gambia	0.1747	29.8249	0.1747	0.0058	0.9942	0.1747	10
Guinea	0.0549	9.3700	0.0549	0.0058	0.9942	0.0549	28
Kenya	0.1020	17.4085	0.1020	0.0058	0.9942	0.1020	24
Mauritania	0.1377	23.5115	0.1377	0.0058	0.9942	0.1377	16
Niger	0.2622	44.7607	0.2622	0.0058	0.9942	0.2622	4
Rwanda	0.0739	12.6190	0.0739	0.0058	0.9942	0.0739	25
Sierra Leone	0.1376	23.4846	0.1376	0.0058	0.9942	0.1376	17
Togo	0.2060	35.1647	0.2060	0.0058	0.9942	0.2060	9
Zimbabwe	0.0529	9.0249	0.0529	0.0058	0.9942	0.0529	30
Benin	0.2079	35.4861	0.2079	0.0058	0.9942	0.2078	8
Cameroon	0.1112	18.9794	0.1112	0.0058	0.9942	0.1112	22
Chad	0.2210	37.7310	0.2210	0.0058	0.9942	0.2210	6
Ethiopia	0.1079	18.4255	0.1079	0.0058	0.9942	0.1079	23
Ghana	0.1508	25.7456	0.1508	0.0058	0.9942	0.1508	13
Gabon	0.1362	23.2486	0.1362	0.0058	0.9942	0.1362	18
Madagascar	0.1131	19.3166	0.1131	0.0058	0.9942	0.1131	21
Mali	0.1605	27.3986	0.1605	0.0058	0.9942	0.1605	12
Mauritius	0.2470	42.1770	0.2470	0.0058	0.9942	0.2470	5
Mozambique	0.2157	36.8249	0.2157	0.0058	0.9942	0.2157	7
Namibia	0.0597	10.1901	0.0597	0.0058	0.9942	0.0597	27
Nigeria	0.3481	59.4247	0.3481	0.0058	0.9942	0.3481	2
Senegal	0.1324	22.6040	0.1324	0.0058	0.9942	0.1324	19
South Africa	0.3840	65.5538	0.3840	0.0058	0.9942	0.3840	1
Sudan	0.0542	9.2514	0.0542	0.0058	0.9942	0.0542	29
Tanzania	0.1263	21.5570	0.1263	0.0058	0.9942	0.1263	20
Zambia	0.0733	12.5078	0.0733	0.0058	0.9942	0.0733	26
AI	1.0000	170.7288	1.0000	0.0058	0.9942	1.0000	0

Table 18 summarized the results of ranking countries when using the MARCOS method for 2019–2021 (pre- and during COVID-19).

Table 18

Results of MARCOS method weighted with MEREC for 2019-2021

Country Name	Rank		
	MARCOS 2019	**MARCOS 2020**	**MARCOS 2021**
Angola	15	22	14
Burundi	3	4	4
Congo, Rep.	14	8	17
Cote d'Ivoire	11	10	13
Gambia	10	6	6
Guinea	28	28	29
Kenya	24	20	20
Mauritania	16	13	24
Niger	4	5	7
Rwanda	25	29	2
Sierra Leone	17	21	19
Togo	9	11	25
Zimbabwe	30	30	30
Benin	8	14	11
Cameroon	22	17	18
Chad	6	16	5
Ethiopia	23	23	21
Ghana	13	18	15
Gabon	18	7	9
Madagascar	21	19	23
Mali	12	2	22
Mauritius	5	25	27
Mozambique	7	9	10
Namibia	27	24	26
Nigeria	2	3	3
Senegal	19	12	12
South Africa	1	1	1
Sudan	29	26	8
Tanzania	20	15	16
Zambia	26	27	28

The rank of the countries using MARCOS method for 2019-2021 has been shown in Figure 3.

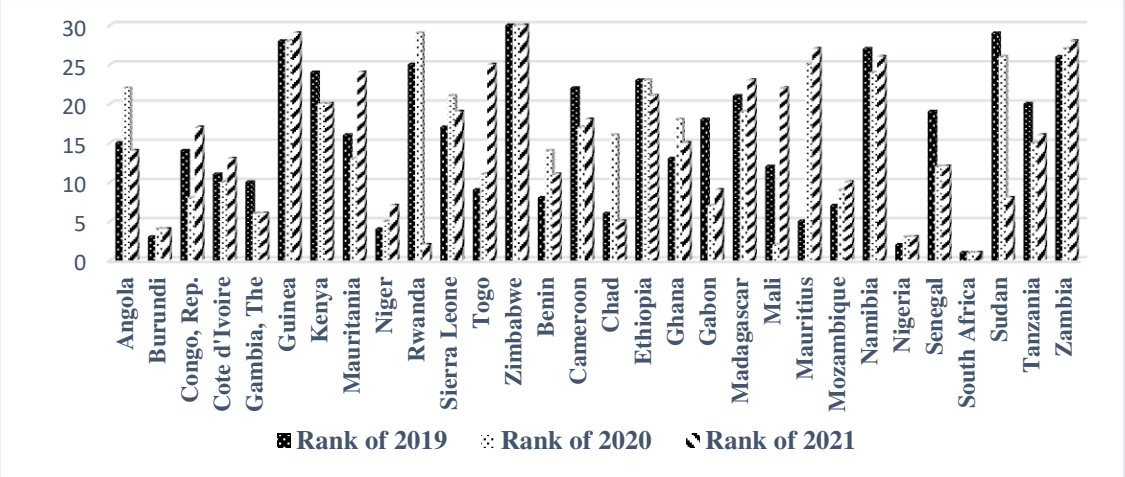

Figure 3. Results of MARCOS weighted with MEREC for 2019-2021

4.3.4 Effect of Different Weighting Methods on the Results of MARCOS

Table 19 shows a comparison of the results obtained using MARCOS method with the three weight calculation methods. From the Table 19, it is obvious that all three methods have different results. To determine the impact of the criteria weights obtained by Entropy, CRITIC and MEREC methods, the countries were ranked with the weights obtained using these methods. The procedure is the same, the only difference is in the weights of the criteria.

Based on the results obtained using Entropy weight, Burundi is best ranked country, followed by South Africa and Mauritius, which according to macroeconomic performance in 2019. Mali, South Africa and Nigeria have achieved the most successful macroeconomic performance in 2020, followed by Congo, Rep., while the worst-ranked country with the lowest macroeconomic performance was Zimbabwe, which according to macroeconomic performance in 2019, 2020 and 2021.

According to CRITIC weight Burundi, Niger and Mozambique have the highest macroeconomic performance in 2019. In 2020 Mozambique, Congo, Rep. and Niger have achived the highest macroeconomic performance. Zimbabwe was rated as the least performing economy out of all countries in the research period. In 2021 the best ranked country is South Africa, followed by Mozambique, Niger, Rwanda and Chad. According to MEREC weight South Africa was determined to be the best country in 2019, 2020 and 2021. South Africa Ranking as a third most visited country in Africa. The tourism sector has also had a posted impact on the macroeconomic performance of South Africa. Nigeria ranked Second in 2019 and third in 2020 and 2021. Mauritius ranked Fifth, however,

occupies 25th and 27th during Covid- 19. Also, according to results outlined above the macroeconomic performance of Senegal came in 12th position during Covid- 19. Ghana is ranked 15th in 2021.

It is noticeable that the results obtained using the calculated weights of the CRITIC method deviated the most from the other results.

Table 19

Results of MARCOS method weighted with respect to all weighting methods

	Entropy	CRITIC	MEREC	Entropy	CRITIC	MEREC	Entropy	CRITIC	MEREC
Country Name	**2019**	**2019**	**2019**	**2020**	**2020**	**2020**	**2021**	**2021**	**2021**
Angola	19	19	15	25	22	22	17	18	14
Burundi	1	1	3	8	4	4	5	6	4
Congo, Rep.	13	13	14	4	8	8	13	23	17
Cote d'Ivoire	9	16	11	12	10	10	14	13	13
Gambia	8	10	10	7	6	6	7	8	6
Guinea	28	29	28	29	28	28	29	29	29
Kenya	22	24	24	20	20	20	19	25	20
Mauritania	16	14	16	10	13	13	20	14	24
Niger	10	2	4	9	5	5	10	3	7
Rwanda	25	25	25	28	29	29	2	4	2
Sierra Leone	18	12	17	23	21	21	22	16	19
Togo	5	8	9	11	11	11	24	24	25
Zimbabwe	30	30	30	30	30	30	30	30	30
Benin	6	9	8	16	14	14	11	10	11
Cameroon	21	22	22	14	17	17	15	20	18
Chad	7	6	6	17	16	16	4	5	5
Ethiopia	24	23	23	24	23	23	21	21	21
Ghana	17	17	13	21	18	18	18	17	15
Gabon	14	15	18	5	7	7	6	9	9
Madagascar	23	20	21	22	19	19	25	22	23
Mali	12	11	12	1	2	2	23	19	22
Mauritius	3	5	5	19	25	25	27	27	27
Mozambique	11	3	7	6	9	9	9	2	10
Namibia	26	27	27	18	24	24	26	26	26
Nigeria	4	7	2	3	3	3	3	7	3
Senegal	15	18	19	13	12	12	12	11	12
South Africa	2	4	1	2	1	1	1	1	1
Sudan	29	28	29	26	26	26	8	12	8
Tanzania	20	21	20	15	15	15	16	15	16
Zambia	27	26	26	27	27	27	28	28	28

4.4 Applying MOORA Method

4.4.1 MOORA Method for 2019 with Entropy

By using Eq. (29) the normalized matrix is calculated. Then Eq. (30) is used tocalculate the normalized matrix with weight. Where the weights of the criteria were determined using Entropy method in Table 3. The calculated results were presented in Table 20.

Table 20

Normalized matrix using MOORA Weighted with Entropy for 2019

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	7412.685	5593.777	0.030	2029.539	0.180	0.038
Burundi	275.562	26.366	0.000	105.625	0.007	0.003
Congo, Rep.	1363.663	1861.597	0.057	1164.937	0.023	0.082
Cote d'Ivoire	6406.208	2728.597	0.007	2213.627	0.012	0.010
Gambia	193.968	67.610	0.020	107.307	0.075	0.017
Guinea	1437.729	932.039	0.002	1002.034	0.100	0.020
Kenya	10735.583	2269.675	0.002	3507.339	0.055	0.020
Mauritania	862.680	663.591	0.055	756.943	0.024	0.041
Niger	1381.429	291.896	0.028	583.641	0.026	0.002
Rwanda	1106.588	446.917	0.013	642.970	0.035	0.050
Sierra Leone	435.995	147.177	0.042	265.830	0.156	0.013
Togo	747.872	335.167	0.025	390.630	0.007	0.015
Zimbabwe	2334.981	1173.374	0.006	957.673	2.697	0.029
Benin	1539.207	843.731	0.008	842.185	0.007	0.006
Cameroon	4242.854	1558.075	0.013	1604.111	0.026	0.014
Chad	1210.146	822.567	0.025	735.593	0.010	0.004
Ethiopia	10257.958	1506.774	0.013	3440.943	0.167	0.013
Ghana	7308.821	5063.634	0.029	4624.380	0.075	0.014
Gabon	1804.736	1717.146	0.047	637.912	0.026	0.083
Madagascar	1508.509	793.245	0.017	828.446	0.059	0.007
Mali	1848.142	878.872	0.025	1127.118	0.018	0.006
Mauritius	1543.983	1258.841	0.016	1295.504	0.004	0.025
Mozambique	1645.981	982.584	0.111	2108.788	0.030	0.014
Namibia	1341.373	903.294	0.007	1002.278	0.039	0.080
Nigeria	50750.162	13351.596	0.002	16149.189	0.120	0.021
Senegal	2503.083	1156.884	0.023	1578.820	0.019	0.011
South Africa	41553.839	20984.635	0.007	17866.387	0.044	0.102
Sudan	3458.593	540.851	0.013	981.831	0.539	0.070
Tanzania	6526.879	1936.376	0.010	1781.040	0.037	0.009
Zambia	2492.887	1597.352	0.012	1368.171	0.097	0.022

Eg. (31) was applied to measure the MOORA score for each alternative. The ranking results of the countries are also presented in Table 21. For 2020 and 2021, the alternatives are calculated similarly, the steps are shown in Appendix C, and the results are given in Table 22.

Table 21

Results of MOORA method weighted with Entropy for 2019

Country Name	**Assessment value**	**Rank**
Angola	10976.734	3
Burundi	196.292	29
Congo, Rep.	2060.274	15
Cote d'Ivoire	6921.164	7
Gambia	154.199	30
Guinea	1367.616	20
Kenya	9497.846	4
Mauritania	769.318	25
Niger	1089.683	23
Rwanda	910.464	24
Sierra Leone	317.214	28
Togo	692.412	26
Zimbabwe	2547.961	13
Benin	1540.747	17
Cameroon	4196.792	9
Chad	1297.131	21
Ethiopia	8323.622	5
Ghana	7748.015	6
Gabon	2883.908	11
Madagascar	1473.258	19
Mali	1599.897	16
Mauritius	1507.306	18
Mozambique	519.844	27
Namibia	1242.277	22
Nigeria	47952.430	1
Senegal	2081.140	14
South Africa	44671.948	2
Sudan	3017.017	10
Tanzania	6682.179	8
Zambia	2721.961	12

The ranking results of the countries when using MOORA pre-during Covid 19 have been summarized in Table 22.

Table 22

Results of MOORA method weighted with Entropy for 2019-2021

	Rank		
Country Name	**MOORA 2019**	**MOORA 2020**	**MOORA 2021**
Angola	3	6	3
Burundi	29	29	29
Congo, Rep.	15	17	15
Cote d'Ivoire	7	7	7
Gambia	30	30	30
Guinea	20	18	18
Kenya	4	4	4
Mauritania	25	26	26
Niger	23	21	22
Rwanda	24	25	24
Sierra Leone	28	28	28
Togo	26	27	27
Zimbabwe	13	13	13
Benin	17	16	17
Cameroon	9	9	9
Chad	21	23	20
Ethiopia	5	3	5
Ghana	6	5	6
Gabon	11	12	10
Madagascar	19	19	19
Mali	16	15	16
Mauritius	18	20	21
Mozambique	27	24	25
Namibia	22	22	23
Nigeria	1	1	2
Senegal	14	14	14
South Africa	2	2	1
Sudan	10	10	11
Tanzania	8	8	8
Zambia	12	11	12

The rank of the countries using MOORA method for 2019-2021 has been shown in Figure 4.

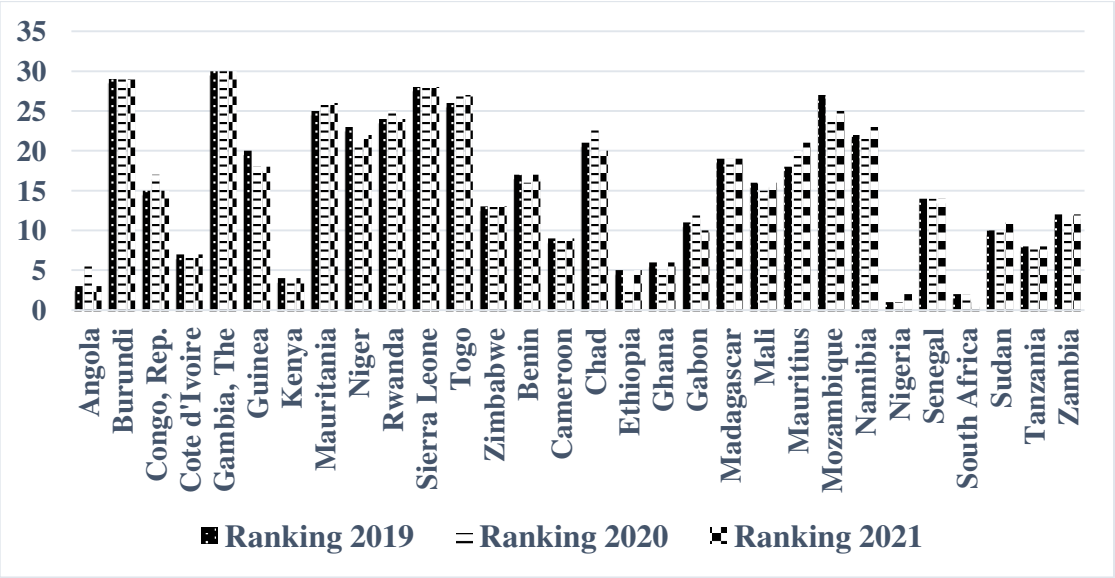

Figure 4. Results of MOORA weighted with Entropy for 2019-2021

4.4.2 MOORA Method for 2019 with CRITIC

Eq. (29) was applied to build normalize decision matrix. Then the normalized value considering the weights is calculated according to the Eq. (30), and provided in Table 23, which is obtained by using the CRITIC method to weight the normalized criteria.

Table 23

Normalized matrix using MOORA weighted with CRITIC for 2019

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	5258.279	3884.244	0.083	1744.186	0.106	0.092
Burundi	195.473	18.308	0.001	90.774	0.004	0.008
Congo, Rep.	967.331	1292.669	0.156	1001.147	0.014	0.199
Cote d'Ivoire	4544.322	1894.702	0.020	1902.390	0.007	0.023
Gambia	137.593	46.947	0.055	92.219	0.044	0.040
Guinea	1019.871	647.196	0.005	861.148	0.059	0.048
Kenya	7615.418	1576.032	0.007	3014.207	0.032	0.048
Mauritania	611.953	460.789	0.153	650.516	0.014	0.100
Niger	979.934	202.689	0.078	501.581	0.015	0.005
Rwanda	784.972	310.333	0.036	552.568	0.021	0.120
Sierra Leone	309.278	102.197	0.117	228.454	0.092	0.031
Togo	530.512	232.735	0.069	335.708	0.004	0.036
Zimbabwe	1656.348	814.775	0.016	823.024	1.579	0.071
Benin	1091.855	585.876	0.021	723.774	0.004	0.014
Cameroon	3009.721	1081.907	0.036	1378.572	0.015	0.035
Chad	858.432	571.180	0.070	632.169	0.006	0.011
Ethiopia	7276.609	1046.284	0.037	2957.146	0.098	0.031
Ghana	5184.602	3516.121	0.079	3974.191	0.044	0.033
Gabon	1280.212	1192.363	0.129	548.222	0.015	0.200
Madagascar	1070.080	550.819	0.047	711.966	0.035	0.018
Mali	1311.002	610.277	0.069	968.645	0.010	0.016
Mauritius	1095.243	874.122	0.043	1113.356	0.003	0.061
Mozambique	1167.597	682.293	0.307	1812.292	0.017	0.033
Namibia	951.519	627.236	0.020	861.358	0.023	0.193
Nigeria	36000.252	9271.171	0.007	13878.609	0.071	0.050
Senegal	1775.593	803.325	0.064	1356.838	0.011	0.028
South Africa	29476.728	14571.452	0.018	15354.368	0.025	0.247
Sudan	2453.395	375.559	0.036	843.785	0.315	0.170
Tanzania	4629.922	1344.594	0.028	1530.626	0.021	0.021
Zambia	1768.360	1109.180	0.033	1175.806	0.057	0.053

Eq. (31) was applied to measure the MOORA score for each alternative. The ranking results of the countries are also presented in Table 24. For 2020 and 2021, the alternatives are calculated similarly, the steps are shown in Appendix C, and the results are given in Table 25.

Table 24

Results of MOORA method weighted with CRITIC for 2019

Country Name	Assessment value	Rank
Angola	7398.224	3
Burundi	122.995	28
Congo, Rep.	1258.797	14
Cote d'Ivoire	4536.624	7
Gambia	92.292	29
Guinea	805.816	20
Kenya	6177.169	4
Mauritania	422.264	26
Niger	681.098	23
Rwanda	542.632	24
Sierra Leone	183.016	27
Togo	427.569	25
Zimbabwe	1646.464	13
Benin	953.960	16
Cameroon	2713.041	9
Chad	797.497	21
Ethiopia	5365.655	5
Ghana	4726.534	6
Gabon	1924.267	11
Madagascar	908.926	18
Mali	952.678	17
Mauritius	855.989	19
Mozambique	37.854	30
Namibia	717.201	22
Nigeria	31392.701	1
Senegal	1222.105	15
South Africa	28693.558	2
Sudan	1984.720	10
Tanzania	4443.875	8
Zambia	1701.657	12

The ranking results of the countries when using MOORA pre-during Covid-19 have been summarized in Table 25.

Table 25

Results of MOORA method weighted with CRITIC for 2019-2021

	Rank		
Country Name	**MOORA 2019**	**MOORA 2020**	**MOORA 2021**
Angola	3	6	5
Burundi	28	29	29
Congo, Rep.	14	17	15
Cote d'Ivoire	7	8	7
Gambia	29	30	30
Guinea	20	22	20
Kenya	4	4	4
Mauritania	26	25	26
Niger	23	19	19
Rwanda	24	24	24
Sierra Leone	27	28	28
Togo	25	26	25
Zimbabwe	13	13	13
Benin	16	16	16
Cameroon	9	9	9
Chad	21	23	21
Ethiopia	5	3	3
Ghana	6	5	6
Gabon	11	12	11
Madagascar	18	18	18
Mali	17	15	17
Mauritius	19	20	22
Mozambique	30	27	27
Namibia	22	21	23
Nigeria	1	1	2
Senegal	15	14	14
South Africa	2	2	1
Sudan	10	10	10
Tanzania	8	7	8
Zambia	12	11	12

The rank of the countries using MOORA method for 2019-2021 has been shown in Figure 5.

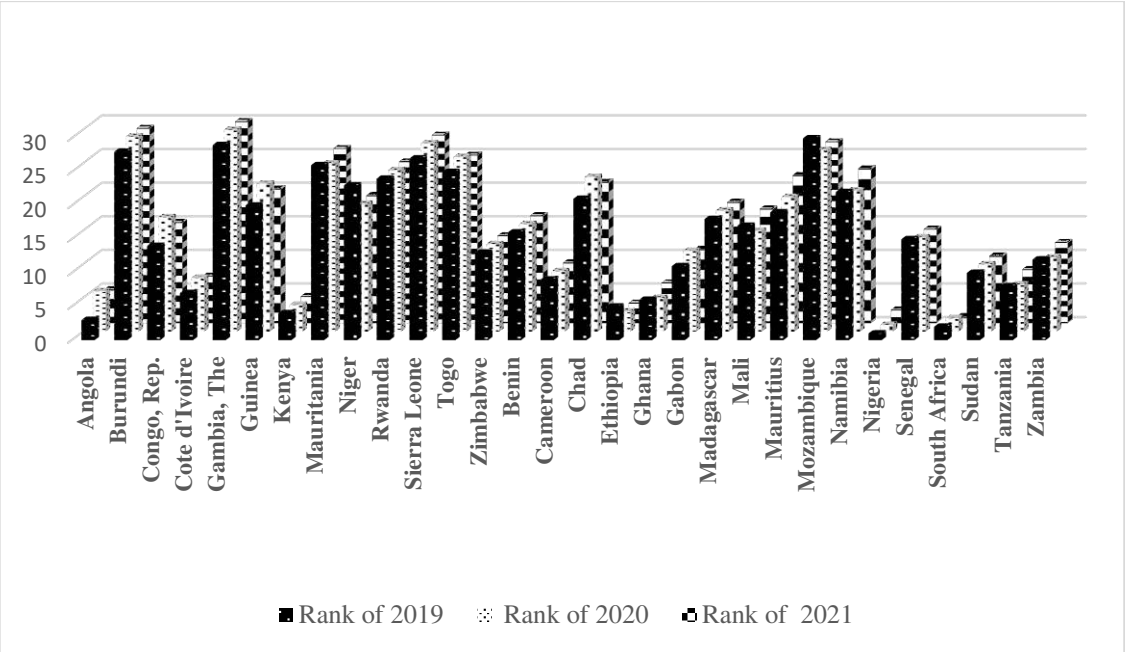

Figure 5. Results of MOORA weighted with CRITIC for 2019-2021

4.4.3 MOORA Method for 2019 with MEREC

By using Eq. (29) the normalized matrix is calculated. In the next step, the normalized value considering the weights is calculated according to the Eq. (30), and provided in Table 26, which is obtained by using the Entropy method to weight the normalized criteria.

Table 26

Normalized matrix using MOORA weighted with MEREC for 2019

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	7597.636	6277.623	0.051	1517.764	0.106	0.077
Burundi	282.437	29.590	0.000	78.990	0.004	0.007
Congo, Rep.	1397.687	2089.180	0.097	871.183	0.014	0.168
Cote d'Ivoire	6566.047	3062.171	0.012	1655.431	0.007	0.020
Gambia	198.807	75.875	0.034	80.248	0.044	0.034
Guinea	1473.601	1045.982	0.003	749.358	0.059	0.041
Kenya	11003.443	2547.145	0.004	2622.917	0.033	0.041
Mauritania	884.205	744.716	0.095	566.070	0.014	0.085
Niger	1415.897	327.581	0.048	436.468	0.015	0.004
Rwanda	1134.198	501.554	0.022	480.836	0.021	0.101
Sierra Leone	446.873	165.169	0.073	198.798	0.092	0.026
Togo	766.532	376.142	0.043	292.128	0.004	0.030
Zimbabwe	2393.241	1316.820	0.010	716.183	1.587	0.060
Benin	1577.611	946.878	0.013	629.817	0.004	0.012
Cameroon	4348.716	1748.552	0.022	1199.613	0.015	0.030
Chad	1240.340	923.127	0.044	550.104	0.006	0.009
Ethiopia	10513.901	1690.979	0.023	2573.264	0.098	0.026
Ghana	7491.181	5682.670	0.049	3458.281	0.044	0.028
Gabon	1849.765	1927.069	0.080	477.054	0.015	0.168
Madagascar	1546.148	890.220	0.029	619.543	0.035	0.015
Mali	1894.254	986.315	0.043	842.900	0.010	0.013
Mauritius	1582.507	1412.736	0.027	968.826	0.003	0.051
Mozambique	1687.049	1102.706	0.191	1577.029	0.017	0.028
Namibia	1374.841	1013.723	0.012	749.541	0.023	0.163
Nigeria	52016.412	14983.846	0.004	12076.957	0.071	0.042
Senegal	2565.537	1298.315	0.040	1180.700	0.011	0.023
South Africa	42590.635	23550.034	0.011	13361.141	0.026	0.208
Sudan	3544.887	606.970	0.022	734.249	0.317	0.143
Tanzania	6689.729	2173.100	0.017	1331.928	0.022	0.018
Zambia	2555.087	1792.631	0.020	1023.169	0.057	0.045

Eg. (31) was applied to measure the MOORA score for each alternative. The ranking results of the countries are also presented in Table 27. For 2020 and 2021, the alternatives are calculated similarly, the steps are shown in Appendix C, and the results are given in Table 28.

Table 27

Results of MOORA method weighted with MEREC for 2019

Country Name	Assessment value	Rank
Angola	12357.364	3
Burundi	233.025	29
Congo, Rep.	2615.600	15
Cote d'Ivoire	7972.773	7
Gambia	194.390	30
Guinea	1770.129	20
Kenya	10927.602	4
Mauritania	1062.847	26
Niger	1307.037	23
Rwanda	1154.816	25
Sierra Leone	413.200	28
Togo	850.555	27
Zimbabwe	2992.241	13
Benin	1894.669	18
Cameroon	4897.633	9
Chad	1613.392	22
Ethiopia	9631.514	6
Ghana	9715.547	5
Gabon	3299.677	12
Madagascar	1816.804	19
Mali	2037.689	16
Mauritius	2026.389	17
Mozambique	1212.871	24
Namibia	1638.850	21
Nigeria	54923.192	1
Senegal	2683.157	14
South Africa	52779.306	2
Sudan	3417.170	10
Tanzania	7530.880	8
Zambia	3324.467	11

The ranking results of the countries when using MOORA pre-during Covid 19 have been summarized in Table 28.

Table 28

Results of MOORA method weighted with MEREC for 2019-2021

	Rank		
Country Name	**MOORA 2019**	**MOORA 2020**	**MOORA 2021**
Angola	3	5	3
Burundi	29	29	29
Congo, Rep.	15	16	14
Cote d'Ivoire	7	7	7
Gambia	30	30	30
Guinea	20	18	20
Kenya	4	3	4
Mauritania	26	24	25
Niger	23	22	23
Rwanda	25	25	24
Sierra Leone	28	28	28
Togo	27	27	26
Zimbabwe	13	13	13
Benin	18	17	18
Cameroon	9	9	9
Chad	22	23	21
Ethiopia	6	4	6
Ghana	5	6	5
Gabon	12	11	10
Madagascar	19	20	19
Mali	16	14	17
Mauritius	17	19	16
Mozambique	24	26	27
Namibia	21	21	22
Nigeria	1	2	2
Senegal	14	15	15
South Africa	2	1	1
Sudan	10	12	12
Tanzania	8	8	8
Zambia	11	10	11

The rank of the countries using MOORA method for 2019-2021 has been shown in Figure 6.

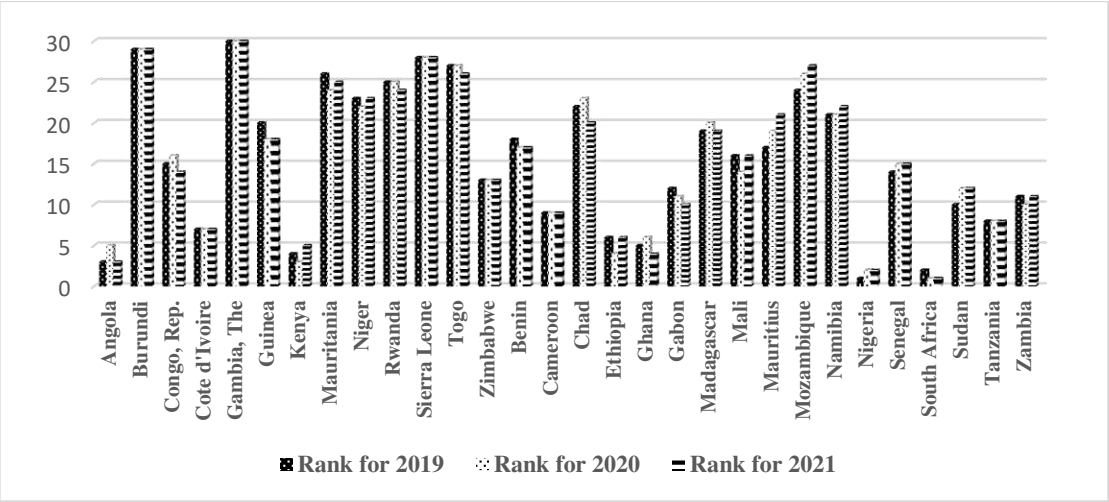

Figure 6. Results of MOORA weighted with MEREC for 2019-2021

4.4.4 Effect of Different Weighting Methods on the Results of MOORA

Table 29 shows the ranking of SSA countries. According to Entropy weight the best ranked country is Nigeria, followed by South Africa, and Angola, which according to macroeconomic performance in 2019. The worst-ranked country with the lowest macroeconomic performance was Gambia, which is pre and during Covid- 19. Based on CRITIC weight, the best ranked country is Nigeria, followed by South Africa and Angola, which according to macroeconomic performance in 2021, The worst-ranked country with the lowest macroeconomic performance was Gambia, which is pre and during Covid-19.

According to MEREC weight Nigeria appears at the top of the ranking. followed by South Africa. South Africa is a country that endowed with natural resources, and it is among the leading exporters of gold iron and platinum, followed by Angola, and Kenya. Kenya have been found as the countries with the same macroeconomic performance in the fourth position according to Entropy, CRITIC and MEREC. Kenya is a country located in east Africa. Kenya has the strongest economy in east Africa. The biggest contributor of Kenyan economy is it is people. Kenya is a country that is not endowed with natural resources like oil gold or diamond. However, Kenyan people are known to be very hard working and a such technology businesses and agricultural are the biggest contributor to Kenyan economy.

The ranking results of the countries in Table 29 show that, with Entropy, CRITIC and MEREC methods, the ranking results of the countries are different. The results of MOORA method by using mentioned weight methods is different, which proves that these three methods have given different results and can’t be used interchangeably.

Entropy method does not differ significantly from other methods and is the easiest to calculate, thus, it is recommended for use in similar studies.

Table 29

Results of MOORA for 2019-2021 with respect to all weighting methods

	Entropy	CRITIC	MEREC	Entropy	CRITIC	MEREC	Entropy	CRITIC	MEREC
Country Name	**2019**	**2019**	**2019**	**2020**	**2020**	**2020**	**2021**	**2021**	**2021**
Angola	3	3	3	6	6	5	3	5	3
Burundi	29	28	29	29	29	29	29	29	29
Congo, Rep.	15	14	15	17	17	16	15	15	14
Cote d'Ivoire	7	7	7	7	8	7	7	7	7
Gambia	30	29	30	30	30	30	30	30	30
Guinea	20	20	20	18	22	18	18	20	20
Kenya	4	4	4	4	4	3	4	4	4
Mauritania	25	26	26	26	25	24	26	26	25
Niger	23	23	23	21	19	22	22	19	23
Rwanda	24	24	25	25	24	25	24	24	24
Sierra Leone	28	27	28	28	28	28	28	28	28
Togo	26	25	27	27	26	27	27	25	26
Zimbabwe	13	13	13	13	13	13	13	13	13
Benin	17	16	18	16	16	17	17	16	18
Cameroon	9	9	9	9	9	9	9	9	9
Chad	21	21	22	23	23	23	20	21	21
Ethiopia	5	5	6	3	3	4	5	3	6
Ghana	6	6	5	5	5	6	6	6	5
Gabon	11	11	12	12	12	11	10	11	10
Madagascar	19	18	19	19	18	20	19	18	19
Mali	16	17	16	15	15	14	16	17	17
Mauritius	18	19	17	20	20	19	21	22	16
Mozambique	27	30	24	24	27	26	25	27	27
Namibia	22	22	21	22	21	21	23	23	22
Nigeria	1	1	1	1	1	2	2	2	2
Senegal	14	15	14	14	14	15	14	14	15
South Africa	2	2	2	2	2	1	1	1	1
Sudan	10	10	10	10	10	12	11	10	12
Tanzania	8	8	8	8	7	8	8	8	8
Zambia	12	12	11	11	11	10	12	12	11

4.5. Applying TOPSIS method

4.5.1 TOPSIS method for 2019 with Entropy

The application of TOPSIS method to MCDM is guided in Section 3 Accordingly. The normalized values of n_{ij} are calculated by Eq. (33), (See Table 30).

Table 30

Normalized matrix using TOPSIS weighted with Entropy for 2019

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.107	0.209	0.174	0.079	0.065	0.176
Burundi	0.004	0.001	0.001	0.004	0.003	0.016
Congo, Rep.	0.020	0.070	0.329	0.045	0.008	0.384
Cote d'Ivoire	0.093	0.102	0.042	0.086	0.004	0.045
Gambia	0.003	0.003	0.115	0.004	0.027	0.078
Guinea	0.021	0.035	0.010	0.039	0.036	0.093
Kenya	0.155	0.085	0.014	0.136	0.020	0.093
Mauritania	0.012	0.025	0.322	0.029	0.009	0.194
Niger	0.020	0.011	0.163	0.023	0.009	0.010
Rwanda	0.016	0.017	0.075	0.025	0.013	0.231
Sierra Leone	0.006	0.005	0.247	0.010	0.056	0.059
Togo	0.011	0.013	0.145	0.015	0.003	0.069
Zimbabwe	0.034	0.044	0.034	0.037	0.971	0.137
Benin	0.022	0.032	0.045	0.033	0.003	0.027
Cameroon	0.061	0.058	0.076	0.062	0.009	0.068
Chad	0.017	0.031	0.147	0.029	0.004	0.021
Ethiopia	0.148	0.056	0.078	0.134	0.060	0.060
Ghana	0.106	0.189	0.167	0.180	0.027	0.064
Gabon	0.026	0.064	0.270	0.025	0.009	0.385
Madagascar	0.022	0.030	0.099	0.032	0.021	0.034
Mali	0.027	0.033	0.146	0.044	0.006	0.030
Mauritius	0.022	0.047	0.090	0.050	0.002	0.118
Mozambique	0.024	0.037	0.645	0.082	0.011	0.064
Namibia	0.019	0.034	0.041	0.039	0.014	0.372
Nigeria	0.733	0.499	0.014	0.628	0.043	0.097
Senegal	0.036	0.043	0.134	0.061	0.007	0.053
South Africa	0.600	0.784	0.039	0.695	0.016	0.475
Sudan	0.050	0.020	0.075	0.038	0.194	0.327
Tanzania	0.094	0.072	0.059	0.069	0.013	0.041
Zambia	0.036	0.060	0.069	0.053	0.035	0.103

By multiplying the normalized matrix with the weights of the criterion, we get a weighted normalized decision matrix. The normalized values taking into account the weight v_{ij} are calculated according to the Eq. (35), the positive ideal solution (A^+) value has been determined by Eq. (36), is 1.930, 6.255, 2.128, 0.005, -0.08226 and 0.038 respectively. and the negative ideal solution (A^-) value has also been determined by Eq. (37), with values of 0.008, 0.008, -1.085, 0.695, .4.353.35 and 1.717 respectively. In the next step, the values S_i^+ and S_i^- have been calculated according to the Eqs. (38) and (39), respectively, and presented in Table 31.

Table 31

The values of S_i^+ and S_i^-

Country name	S_i^+	S_i^-
Angola	0.163	0.306
Burundi	0.201	0.327
Congo, Rep.	0.188	0.322
Cote d'Ivoire	0.177	0.323
Gambia	0.199	0.319
Guinea	0.195	0.314
Kenya	0.173	0.316
Mauritania	0.192	0.323
Niger	0.195	0.324
Rwanda	0.197	0.321
Sierra Leone	0.197	0.311
Togo	0.196	0.326
Zimbabwe	0.361	0.107
Benin	0.194	0.325
Cameroon	0.185	0.322
Chad	0.193	0.325
Ethiopia	0.176	0.304
Ghana	0.165	0.313
Gabon	0.189	0.322
Madagascar	0.194	0.320
Mali	0.192	0.324
Mauritius	0.192	0.324
Mozambique	0.187	0.324
Namibia	0.197	0.319
Nigeria	0.122	0.338
Senegal	0.189	0.322
South Africa	0.128	0.349
Sudan	0.202	0.267
Tanzania	0.180	0.321
Zambia	0.189	0.314

By applying Eq. (40), the value of C_i^* (TOPSIS Score) has been calculated, the results are obtained, and presented in Table 32. The ranking results of the countries are also presented in this Table 32. For 2020 and 2021, the alternatives are calculated similarly, the steps are shown in Appendix D, and the results are given in Table 33.

According to the Table 32, the best-performing country is Nigeria, with a score of 0.735, followed by South Africa with a score of 0.732 and Ghana with a score of 0.654, respectively. Zimbabwe is the worst-performing country with a score of 0.229.

Table 32

The results of TOPSIS method weighted with Entropy for 2019

Country name	TOPSIS Score	Rank
Angola	0.653	4
Burundi	0.619	24
Congo, Rep.	0.631	11
Cote d'Ivoire	0.645	6
Gambia	0.616	27
Guinea	0.617	26
Kenya	0.647	5
Mauritania	0.627	17
Niger	0.625	19
Rwanda	0.620	23
Sierra Leone	0.612	28
Togo	0.624	20
Zimbabwe	0.229	30
Benin	0.626	18
Cameroon	0.634	8
Chad	0.628	16
Ethiopia	0.633	10
Ghana	0.654	3
Gabon	0.631	12
Madagascar	0.623	22
Mali	0.628	14
Mauritius	0.628	15
Mozambique	0.634	9
Namibia	0.619	25
Nigeria	0.735	1
Senegal	0.630	13
South Africa	0.732	2
Sudan	0.569	29
Tanzania	0.641	7
Zambia	0.624	21

Table 33 illustrates the results of ranking countries when using the TOPSIS method for 2019–2021.

Table 33

Rank obtained by TOPSIS weighted with Entropy for 2019-2021

	Rank		
Country Name	**TOPSIS 2019**	**TOPSIS 2020**	**TOPSIS 2021**
Angola	4	6	3
Burundi	24	28	28
Congo, Rep.	11	12	15
Cote d'Ivoire	6	5	6
Gambia	27	23	17
Guinea	26	22	26
Kenya	5	4	7
Mauritania	17	15	12
Niger	19	21	19
Rwanda	23	26	23
Sierra Leone	28	27	27
Togo	20	24	24
Zimbabwe	30	30	29
Benin	18	17	18
Cameroon	8	9	11
Chad	16	18	13
Ethiopia	10	8	14
Ghana	3	3	4
Gabon	12	10	9
Madagascar	22	20	22
Mali	14	14	16
Mauritius	15	19	21
Mozambique	9	11	5
Namibia	25	25	20
Nigeria	1	1	2
Senegal	13	13	10
South Africa	2	2	1
Sudan	29	29	30
Tanzania	7	7	8
Zambia	21	16	25

The rank of the countries using TOPSIS method for 2019-2021 has been shown in Figure 7.

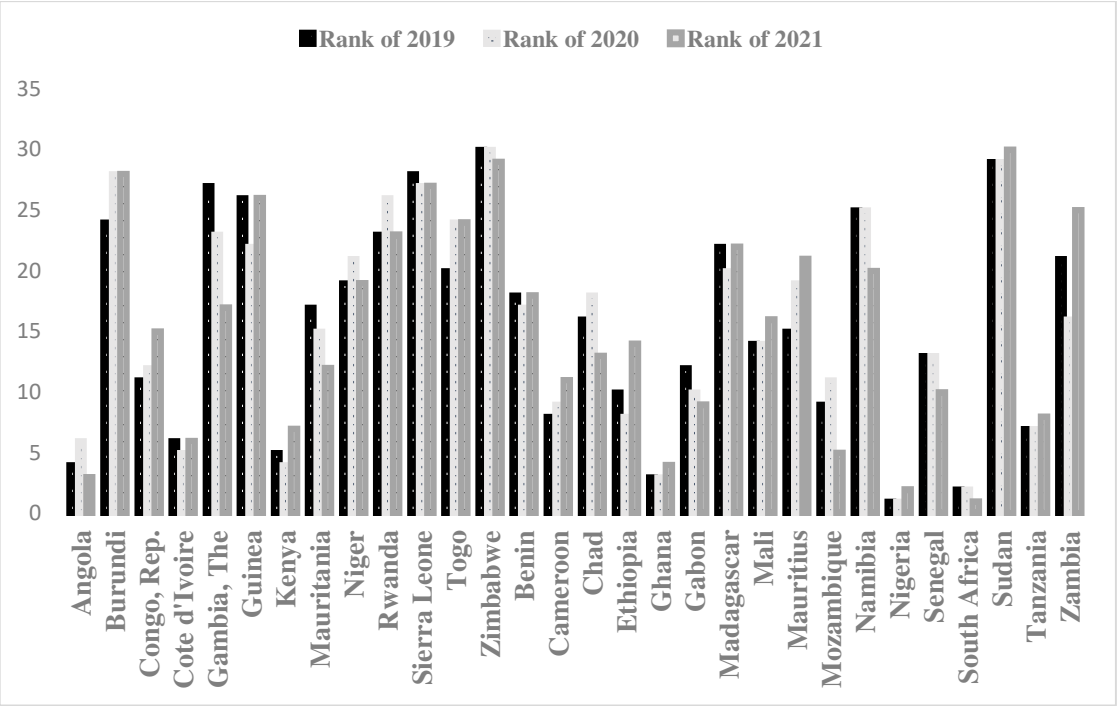

Figure 7. Results of TOPSIS weighted with Entropy for 2019-2021

4.5.2 TOPSIS Method for 2019 with CRITIC

The application of TOPSIS method to MCDM is guided in Section 3 Accordingly. The normalized values of n_{ij} are calculated by Eq. (33), (See Table 34).

Table 34

Normalized matrix using TOPSIS weighted with CRITIC for 2019

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.107	0.209	0.174	0.079	0.065	0.176
Burundi	0.004	0.001	0.001	0.004	0.003	0.016
Congo, Rep.	0.020	0.070	0.329	0.045	0.008	0.384
Cote d'Ivoire	0.093	0.102	0.042	0.086	0.004	0.045
Gambia	0.003	0.003	0.115	0.004	0.027	0.078
Guinea	0.021	0.035	0.010	0.039	0.036	0.093
Kenya	0.155	0.085	0.014	0.136	0.020	0.093
Mauritania	0.012	0.025	0.322	0.029	0.009	0.194
Niger	0.020	0.011	0.163	0.023	0.009	0.010
Rwanda	0.016	0.017	0.075	0.025	0.013	0.231
Sierra Leone	0.006	0.005	0.247	0.010	0.056	0.059
Togo	0.011	0.013	0.145	0.015	0.003	0.069
Zimbabwe	0.034	0.044	0.034	0.037	0.971	0.137
Benin	0.022	0.032	0.045	0.033	0.003	0.027
Cameroon	0.061	0.058	0.076	0.062	0.009	0.068
Chad	0.017	0.031	0.147	0.029	0.004	0.021
Ethiopia	0.148	0.056	0.078	0.134	0.060	0.060
Ghana	0.106	0.189	0.167	0.180	0.027	0.064
Gabon	0.026	0.064	0.270	0.025	0.009	0.385
Madagascar	0.022	0.030	0.099	0.032	0.021	0.034
Mali	0.027	0.033	0.146	0.044	0.006	0.030
Mauritius	0.022	0.047	0.090	0.050	0.002	0.118
Mozambique	0.024	0.037	0.645	0.082	0.011	0.064
Namibia	0.019	0.034	0.041	0.039	0.014	0.372
Nigeria	0.733	0.499	0.014	0.628	0.043	0.097
Senegal	0.036	0.043	0.134	0.061	0.007	0.053
South Africa	0.600	0.784	0.039	0.695	0.016	0.475
Sudan	0.050	0.020	0.075	0.038	0.194	0.327
Tanzania	0.094	0.072	0.059	0.069	0.013	0.041
Zambia	0.036	0.060	0.069	0.053	0.035	0.103

By multiplying the normalized matrix with the weights of the criterion, we get a weighted normalized decision matrix. The normalized values taking into account the weight v_{ij} are calculated according to the Eq. (35), the positive ideal solution (A^{+}) value has been determined by Eq. (36), is0.100981, 0.092166059, 0.146224961, 0.000554179, 0.000285267 and 0.002037035 respectively. and the negative ideal solution (A^{-}) value has also been determined by Eq. (37), with values of 0.000385952, 0.000115802, 0.000270082, 0.093739081, 0.1795369 and 0.094249754 respectively. Then the values

S_i^+ and S_i^- have been calculated according to the Eqs. (38) and (39), respectively, and presented in Table 35.

Table 35

The values of S_i^+ and S_i^-

Country Name	S_i^+	S_i^-
Angola	0.157	0.202
Burundi	0.200	0.221
Congo, Rep.	0.165	0.213
Cote d'Ivoire	0.182	0.215
Gambia	0.182	0.215
Guinea	0.196	0.209
Kenya	0.185	0.207
Mauritania	0.157	0.219
Niger	0.173	0.223
Rwanda	0.191	0.205
Sierra Leone	0.164	0.217
Togo	0.176	0.219
Zimbabwe	0.262	0.112
Benin	0.190	0.219
Cameroon	0.181	0.214
Chad	0.174	0.222
Ethiopia	0.176	0.204
Ghana	0.158	0.210
Gabon	0.171	0.210
Madagascar	0.181	0.217
Mali	0.174	0.220
Mauritius	0.183	0.213
Mozambique	0.132	0.258
Namibia	0.203	0.199
Nigeria	0.170	0.221
Senegal	0.174	0.217
South Africa	0.191	0.216
Sudan	0.197	0.172
Tanzania	0.180	0.215
Zambia	0.184	0.208

By applying Eq. (40), the value of C_i^* (TOPSIS Score) has been calculated, the results are obtained, and presented in Table 36. The ranking results of the countries are also presented in this table. For 2020 and 2021, the alternatives are calculated similarly, the steps are shown in Appendix D, and the results are given in Table 37.

According to the Table 36 the best-performing country is Mozambique, with a score of 0.661, followed by Mauritania with a score of 0.583 and Ghana with a score of 0.571, respectively. Zimbabwe is the worst-performing country with a score of 0.298.

Table 36

Results of TOPSIS method weighted with CRITIC for 2019

Country Name	TOPSIS Score	Rank
Angola	0.562	8
Burundi	0.526	25
Congo, Rep.	0.563	7
Cote d'Ivoire	0.542	17
Gambia	0.541	18
Guinea	0.515	27
Kenya	0.528	24
Mauritania	0.583	2
Niger	0.563	6
Rwanda	0.518	26
Sierra Leone	0.570	4
Togo	0.554	12
Zimbabwe	0.298	30
Benin	0.536	21
Cameroon	0.542	16
Chad	0.560	9
Ethiopia	0.537	20
Ghana	0.571	3
Gabon	0.550	13
Madagascar	0.545	14
Mali	0.559	10
Mauritius	0.538	19
Mozambique	0.661	1
Namibia	0.495	28
Nigeria	0.564	5
Senegal	0.555	11
South Africa	0.531	22
Sudan	0.466	29
Tanzania	0.544	15
Zambia	0.530	23

Table 37 illustrates the results of ranking countries when using the TOPSIS method for 2019–2021.

Table 37

Rank obtained by TOPSIS weighted with CRITIC for 2019-2021

	Rank		
Country Name	**TOPSIS 2019**	**TOPSIS 2020**	**TOPSIS 2021**
Angola	8	15	8
Burundi	25	22	23
Congo, Rep.	7	2	28
Cote d'Ivoire	17	17	11
Gambia	18	3	4
Guinea	27	26	25
Kenya	24	21	20
Mauritania	2	5	6
Niger	6	13	10
Rwanda	26	27	26
Sierra Leone	4	10	15
Togo	12	23	21
Zimbabwe	30	30	29
Benin	21	20	17
Cameroon	16	19	16
Chad	9	8	7
Ethiopia	20	16	14
Ghana	3	9	9
Gabon	13	7	18
Madagascar	14	14	19
Mali	10	11	13
Mauritius	19	24	22
Mozambique	1	1	1
Namibia	28	28	24
Nigeria	5	4	3
Senegal	11	6	5
South Africa	22	12	2
Sudan	29	29	30
Tanzania	15	18	12
Zambia	23	25	27

The rank of the countries using TOPSIS method for 2019-2021 has been shown in Figure 8.

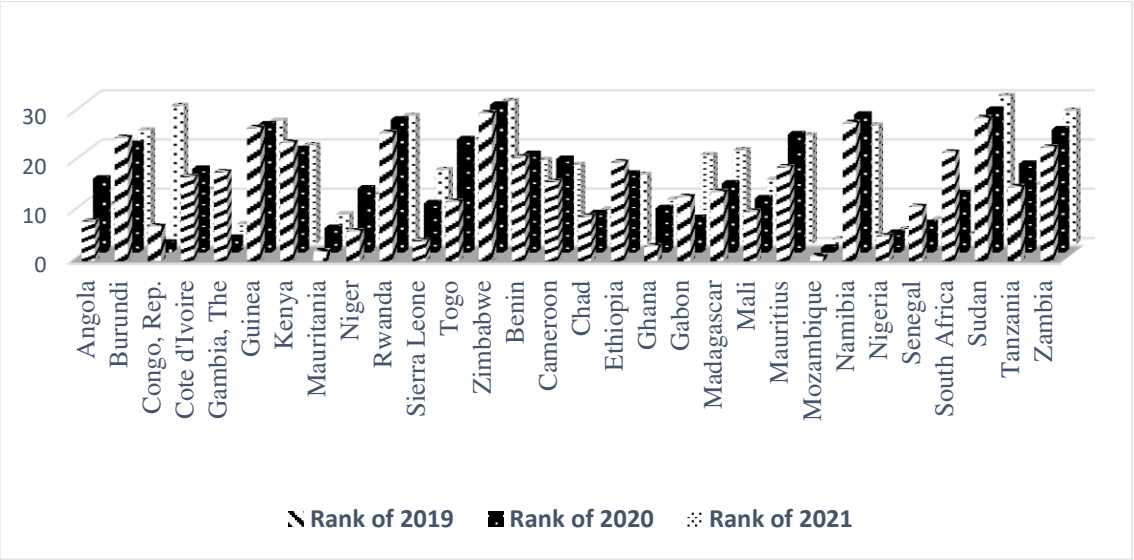

Figure 8. Results of TOPSIS weighted with CRITIC for 2019-2021

4.5.3 TOPSIS Method for 2019 with MEREC

The application of TOPSIS method to MCDM is guided in Section 3 accordingly. The normalized values of n_{ij} are calculated by Eq. (33), (See Table 38).

Table 38

Normalized matrix using TOPSIS weighted with MEREC for 2019

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.107	0.209	0.174	0.079	0.065	0.176
Burundi	0.004	0.001	0.001	0.004	0.003	0.016
Congo, Rep.	0.020	0.070	0.329	0.045	0.008	0.384
Cote d'Ivoire	0.093	0.102	0.042	0.086	0.004	0.045
Gambia	0.003	0.003	0.115	0.004	0.027	0.078
Guinea	0.021	0.035	0.010	0.039	0.036	0.093
Kenya	0.155	0.085	0.014	0.136	0.020	0.093
Mauritania	0.012	0.025	0.322	0.029	0.009	0.194
Niger	0.020	0.011	0.163	0.023	0.009	0.010
Rwanda	0.016	0.017	0.075	0.025	0.013	0.231
Sierra Leone	0.006	0.005	0.247	0.010	0.056	0.059
Togo	0.011	0.013	0.145	0.015	0.003	0.069
Zimbabwe	0.034	0.044	0.034	0.037	0.971	0.137
Benin	0.022	0.032	0.045	0.033	0.003	0.027
Cameroon	0.061	0.058	0.076	0.062	0.009	0.068
Chad	0.017	0.031	0.147	0.029	0.004	0.021
Ethiopia	0.148	0.056	0.078	0.134	0.060	0.060
Ghana	0.106	0.189	0.167	0.180	0.027	0.064
Gabon	0.026	0.064	0.270	0.025	0.009	0.385
Madagascar	0.022	0.030	0.099	0.032	0.021	0.034
Mali	0.027	0.033	0.146	0.044	0.006	0.030
Mauritius	0.022	0.047	0.090	0.050	0.002	0.118
Mozambique	0.024	0.037	0.645	0.082	0.011	0.064
Namibia	0.019	0.034	0.041	0.039	0.014	0.372
Nigeria	0.733	0.499	0.014	0.628	0.043	0.097
Senegal	0.036	0.043	0.134	0.061	0.007	0.053
South Africa	0.600	0.784	0.039	0.695	0.016	0.475
Sudan	0.050	0.020	0.075	0.038	0.194	0.327
Tanzania	0.094	0.072	0.059	0.069	0.013	0.041
Zambia	0.036	0.060	0.069	0.053	0.035	0.103

By multiplying the normalized matrix with the weights of the criterion, we get a weighted normalized decision matrix. The normalized values taking into account the weight v_{ij} are calculated according to the Eq. (35), the positive ideal solution (A^{+}) value has been determined by Eq. (36), is 0.145907098, 0.148956586, 0.090981459, 0.000482238, 0.000286558 and 0.001715334 respectively. and the negative ideal solution (A^{-}) value has also been determined by Eq. (37), with values of 0.000557658, 0.000187157, 0.000168046, 0.081570343, 0.180349255 and 0.079365254 respectively. Furthermore,

the values S_i^+ and S_i^- have been calculated according to the Eqs. (38) and (39), respectively, and presented in Table 39.

Table 39

The values of S_i^+ and S_i^-

Country Name	S_i^+	S_i^-
Angola	0.181	0.197
Burundi	0.227	0.212
Congo, Rep.	0.211	0.201
Cote d'Ivoire	0.201	0.208
Gambia	0.221	0.205
Guinea	0.221	0.201
Kenya	0.198	0.202
Mauritania	0.211	0.206
Niger	0.215	0.211
Rwanda	0.222	0.199
Sierra Leone	0.215	0.203
Togo	0.217	0.209
Zimbabwe	0.282	0.096
Benin	0.218	0.210
Cameroon	0.209	0.206
Chad	0.214	0.211
Ethiopia	0.199	0.197
Ghana	0.183	0.203
Gabon	0.213	0.200
Madagascar	0.216	0.207
Mali	0.212	0.210
Mauritius	0.215	0.205
Mozambique	0.201	0.224
Namibia	0.227	0.195
Nigeria	0.128	0.253
Senegal	0.211	0.207
South Africa	0.144	0.260
Sudan	0.224	0.166
Tanzania	0.203	0.207
Zambia	0.212	0.200

By applying Eq. (40), the value of C_i^* (TOPSIS Score) has been calculated, the results are obtained, and presented in Table 40. The ranking results of the countries are also presented in this Table 40. For 2020 and 2021, the alternatives are calculated similarly, the steps are shown in Appendix D, and the results are given in Table 41.

According to the Table 40, the best-performing country is Nigeria, with a score of 0.663, followed by South Africa with a score of 0.644 and Mozambique with a score of 0.527, respectively. Zimbabwe is the worst-performing country with a score of 0.255.

Table 40

Results of TOPSIS method weighted with MEREC for 2019

Country Name	TOPSIS Score	Rank
Angola	0.520	5
Burundi	0.483	24
Congo, Rep.	0.488	20
Cote d'Ivoire	0.508	6
Gambia	0.481	25
Guinea	0.476	26
Kenya	0.505	7
Mauritania	0.494	15
Niger	0.495	14
Rwanda	0.472	27
Sierra Leone	0.486	21
Togo	0.490	16
Zimbabwe	0.255	30
Benin	0.490	17
Cameroon	0.497	11
Chad	0.497	10
Ethiopia	0.498	9
Ghana	0.526	4
Gabon	0.484	23
Madagascar	0.490	18
Mali	0.497	12
Mauritius	0.488	19
Mozambique	0.527	3
Namibia	0.462	28
Nigeria	0.663	1
Senegal	0.496	13
South Africa	0.644	2
Sudan	0.426	29
Tanzania	0.504	8
Zambia	0.485	22

Table 41 illustrates the results of ranking countries when using the TOPSIS method for 2019–2021.

Table 41

Ranks obtained by TOPSIS weighted with MEREC for 2019-2021

	Rank		
Country Name	**TOPSIS 2019**	**TOPSIS 2020**	**TOPSIS 2021**
Angola	5	3	3
Burundi	24	26	27
Congo, Rep.	20	14	21
Cote d'Ivoire	6	5	5
Gambia	25	24	16
Guinea	26	20	24
Kenya	7	6	8
Mauritania	15	16	15
Niger	14	22	17
Rwanda	27	28	25
Sierra Leone	21	27	26
Togo	16	23	23
Zimbabwe	30	30	29
Benin	17	17	14
Cameroon	11	9	11
Chad	10	18	12
Ethiopia	9	8	19
Ghana	4	4	4
Gabon	23	11	9
Madagascar	18	21	18
Mali	12	13	13
Mauritius	19	19	20
Mozambique	3	10	6
Namibia	28	25	28
Nigeria	1	2	2
Senegal	13	12	10
South Africa	2	1	1
Sudan	29	29	30
Tanzania	8	7	7
Zambia	22	15	22

The rank of the countries using TOPSIS method for 2019-2021 has been shown in Figure 9.

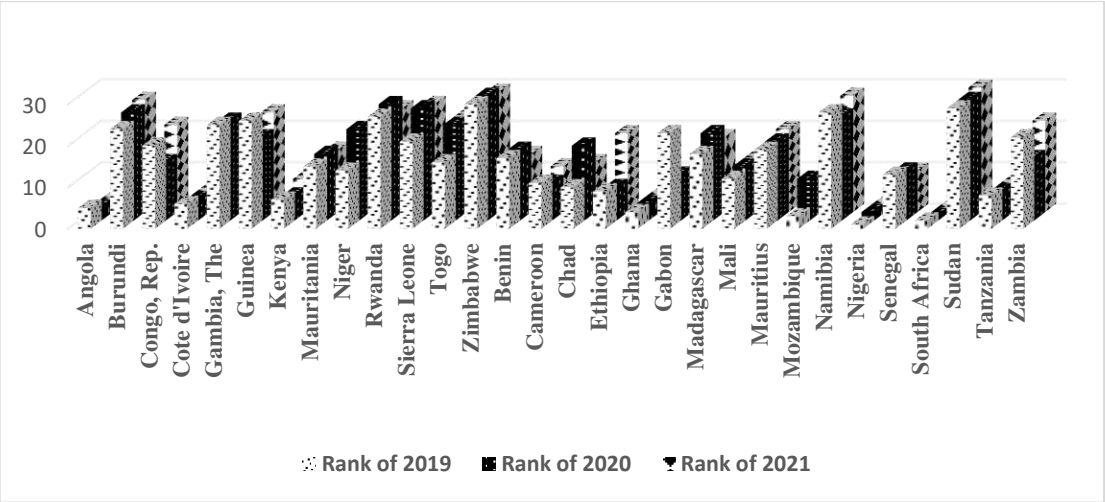

Figure 9. Results of TOPSIS weighted with MEREC for 2019-2021

4.5.4 Effect of Different Weighting Methods on the Results of TOPSIS

The use of the above methods and the weight determination for criteria according to the Entropy, CRITIC, and MEREC methods affect the results of choosing the best country. The ranking results of the countries in Table 42 show that, by TOPSIS method and with different weighting methods, the ranking results of the countries are different. As can be seen from the Table 42, based on Entropy weight Nigeria, South Africa, Ghana Angola and Kenya have the highest macroeconomic performance and Zimbabwe was rated as the least performing economy out of all countries in 2019. By utilizing CRITIC weight Nigeria, South Africa, Ghana Angola and Kenya have the highest macroeconomic performance and Zimbabwe was rated as the least performing economy out of all countries.

When applying MEREC weight Nigeria, South Africa, Mozambique, GhanaAngola, and Cote d'Ivoire have the highest macroeconomic performance and Zimbabwe was rated as the least performing country, the high rates of inflation and unemployment are barriers to the economic performance of Zimbabwe. Zimbabwe also, has been affected by covid-19 and political instability, which has hindered its economic performance.

Table 42

Results of TOPSIS method for 2019-2021 with respect to all weighting methods

	Entropy	CRITIC	MEREC	Entropy	CRITIC	MEREC	Entropy	CRITIC	MEREC
Country Name	**2019**	**2019**	**2019**	**2020**	**2020**	**2020**	**2021**	**2021**	**2021**
Angola	4	8	5	6	15	3	3	8	3
Burundi	24	25	24	28	22	26	28	23	27
Congo, Rep.	11	7	20	12	2	14	15	28	21
Cote d'Ivoire	6	17	6	5	17	5	6	11	5
Gambia	27	18	25	23	3	24	17	4	16
Guinea	26	27	26	22	26	20	26	25	24
Kenya	5	24	7	4	21	6	7	20	8
Mauritania	17	2	15	15	5	16	12	6	15
Niger	19	6	14	21	13	22	19	10	17
Rwanda	23	26	27	26	27	28	23	26	25
Sierra Leone	28	4	21	27	10	27	27	15	26
Togo	20	12	16	24	23	23	24	21	23
Zimbabwe	30	30	30	30	30	30	29	29	29
Benin	18	21	17	17	20	17	18	17	14
Cameroon	8	16	11	9	19	9	11	16	11
Chad	16	9	10	18	8	18	13	7	12
Ethiopia	10	20	9	8	16	8	14	14	19
Ghana	3	3	4	3	9	4	4	9	4
Gabon	12	13	23	10	7	11	9	18	9
Madagascar	22	14	18	20	14	21	22	19	18
Mali	14	10	12	14	11	13	16	13	13
Mauritius	15	19	19	19	24	19	21	22	20
Mozambique	9	1	3	11	1	10	5	1	6
Namibia	25	28	28	25	28	25	20	24	28
Nigeria	1	5	1	1	4	2	2	3	2
Senegal	13	11	13	13	6	12	10	5	10
South Africa	2	22	2	2	12	1	1	2	1
Sudan	29	29	29	29	29	29	30	30	30
Tanzania	7	15	8	7	18	7	8	12	7
Zambia	21	23	22	16	25	15	25	27	22

4.6 Applying CoCoSo method

4.6.1 CoCoSo Method for 2019 with Entropy

The first step demonstrates forming of the normalised decision-making matrix. In the second step normalization is performed using Eqs. (42)-(43) based on the type of criteria. The values of the sum of weighted comparability (S_i) and amount of the power weight of

comparability (p_i) are calculated using Eq. (44)-(45) respectively. in these steps, the weights obtained from the Entropy method are used, which is shown in Table 43.

Table 43

The values of the sum of weighted comparability S_i and P_i

Country name	$\mathbf{S_i}$	P_i
Angola	0.584	0.133
Burundi	0.554	0.131
Congo, Rep.	0.555	0.132
Cote d'Ivoire	0.582	0.137
Gambia	0.548	0.128
Guinea	0.534	0.127
Kenya	0.567	0.134
Mauritania	0.568	0.132
Niger	0.572	0.132
Rwanda	0.534	0.129
Sierra Leone	0.552	0.125
Togo	0.565	0.132
Zimbabwe	0.111	-0.007
Benin	0.562	0.132
Cameroon	0.568	0.133
Chad	0.574	0.133
Ethiopia	0.552	0.128
Ghana	0.586	0.135
Gabon	0.553	0.132
Madagascar	0.559	0.130
Mali	0.571	0.133
Mauritius	0.557	0.132
Mozambique	0.612	0.135
Namibia	0.514	0.127
Nigeria	0.694	0.159
Senegal	0.567	0.133
South Africa	0.680	0.162
Sudan	0.446	0.103
Tanzania	0.578	0.135
Zambia	0.547	0.128

Finally, k_{ia}, k_{ib} and k_{ic} are calculated using Eqs. (46)– (48), in the mentioned Eqs, the value of λ for equilibrium is considered equal to 0.5. And using these 3 values, the final score of each country, k_i based on Eq. (49) is obtained. And the ranking is based on the final score. For 2020 and 2021, the alternatives are calculated similarly, the steps are shown in Appendix E, and the results are given in Table 45.

According to the Table 44 we find that Nigeria with a score of 83.106 has a higher performance than other countries. South Africa and Mozambique with a score of 81.705

and 55.513 are in the second and third performance, and Zimbabwe with score -0.263 is in the last performance.

Table 44

Final aggregation and CoCoSo ranking of the countries with Entropy

Country Name	k_{ia}	k_{ib}	k_{ic}	k_i	Rank
Angola	0.035	93.747	0.837	50.527	6
Burundi	0.034	87.621	0.800	45.691	20
Congo, Rep.	0.034	88.249	0.802	46.106	19
Cote d'Ivoire	0.035	96.019	0.840	51.842	5
Gambia	0.033	84.685	0.789	43.778	24
Guinea	0.032	81.667	0.772	41.591	27
Kenya	0.034	92.039	0.820	48.833	11
Mauritania	0.034	90.413	0.817	47.870	14
Niger	0.035	91.244	0.822	48.519	9
Rwanda	0.032	82.947	0.774	42.298	26
Sierra Leone	0.033	83.438	0.791	43.187	23
Togo	0.034	90.341	0.815	47.741	15
Zimbabwe	0.005	-1.000	0.120	-0.263	30
Benin	0.034	89.986	0.812	47.418	16
Cameroon	0.034	91.520	0.819	48.545	12
Chad	0.035	92.302	0.826	49.240	8
Ethiopia	0.033	85.413	0.795	44.358	22
Ghana	0.035	95.476	0.842	51.660	4
Gabon	0.034	88.017	0.800	45.893	21
Madagascar	0.034	87.816	0.805	45.996	18
Mali	0.035	91.511	0.822	48.650	10
Mauritius	0.034	88.902	0.805	46.572	17
Mozambique	0.037	99.820	0.873	55.513	3
Namibia	0.031	78.971	0.749	39.438	28
Nigeria	0.042	133.678	0.997	83.106	1
Senegal	0.034	90.886	0.818	48.145	13
South Africa	0.041	133.046	0.984	81.705	2
Sudan	0.027	55.544	0.642	25.440	29
Tanzania	0.035	94.201	0.833	50.555	7
Zambia	0.033	84.843	0.789	43.842	25

Table 45 illustrates the results of ranking countries when using the CoCoSo method for 2019–2021.

Table 45

Ranks obtained by CoCoSo weighted with with Entropy for 2019-2021

	Rank		
Country Name	**CoCoSo 2019**	**CoCoSo 2020**	**CoCoSo 2021**
Angola	6	12	4
Burundi	20	25	25
Congo, Rep.	19	4	23
Cote d'Ivoire	5	6	6
Gambia	24	9	9
Guinea	27	26	28
Kenya	11	13	10
Mauritania	14	7	13
Niger	9	18	16
Rwanda	26	27	26
Sierra Leone	23	21	20
Togo	15	23	21
Zimbabwe	30	30	29
Benin	16	20	18
Cameroon	12	16	12
Chad	8	15	11
Ethiopia	22	14	15
Ghana	4	5	5
Gabon	21	8	14
Madagascar	18	19	19
Mali	10	17	17
Mauritius	17	22	22
Mozambique	3	3	3
Namibia	28	28	27
Nigeria	1	1	2
Senegal	13	10	7
South Africa	2	2	1
Sudan	29	29	30
Tanzania	7	11	8
Zambia	25	24	24

The rank of the countries using CoCoSo method for 2019- 2021 has been shown in Figure 10.

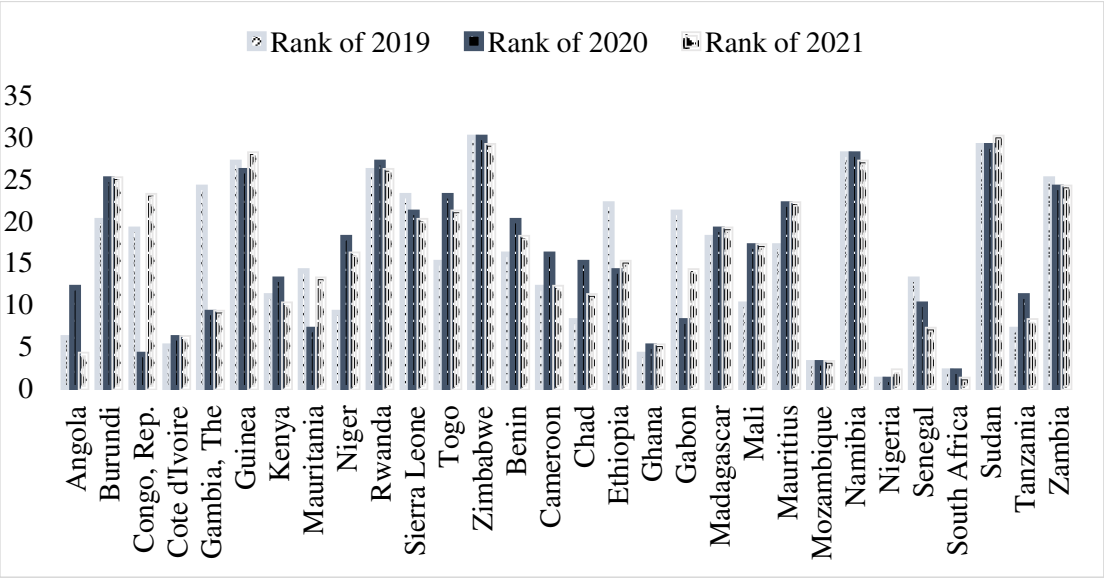

Figure 10. Results of CoCoSo weighted with Entropy for 2019-2021

4.6.2 CoCoSo Method for 2019 with CRITIC

The first step demonstrates forming of the normalised decision-making matrix. In the second step normalization is performed using Eqs. (42) and (43) based on the type of criteria. The values of the sum of weighted comparability (S_i) and amount of the power weight of comparability (p_i) are calculated using Eq. (44) and (45) respectively. in these steps, the weights obtained from the Entropy method are used, which is shown in Table 46.

Table 46

The values of the sum of weighted comparability S_i and P_i

Country Name	$\mathbf{S_i}$	P_i
Angola	0.544	0.096
Burundi	0.514	0.091
Congo, Rep.	0.515	0.093
Cote d'Ivoire	0.535	0.094
Gambia	0.526	0.094
Guinea	0.488	0.086
Kenya	0.508	0.089
Mauritania	0.562	0.103
Niger	0.566	0.102
Rwanda	0.474	0.083
Sierra Leone	0.564	0.103
Togo	0.545	0.098
Zimbabwe	0.237	0.039
Benin	0.527	0.094
Cameroon	0.530	0.094
Chad	0.561	0.101
Ethiopia	0.521	0.092
Ghana	0.561	0.100
Gabon	0.501	0.090
Madagascar	0.537	0.096
Mali	0.556	0.100
Mauritius	0.515	0.092
Mozambique	0.693	0.132
Namibia	0.423	0.073
Nigeria	0.580	0.097
Senegal	0.546	0.098
South Africa	0.494	0.079
Sudan	0.402	0.070
Tanzania	0.538	0.095
Zambia	0.508	0.090

Finally, k_{ia}, k_{ib} and k_{ic} are calculated using Eqs. (46)– (48), in the mentioned Eqs, the value of λ for equilibrium is considered equal to 0.5. And using these 3 values, the final score of each country, k_i based on Eq. (49) is obtained. And the ranking is based on the final score. For 2020 and 2021, the alternatives are calculated similarly, the steps are shown in Appendix E, and the results are given in Table 48.

According to the Table 47, we find that Mozambique with a score of 6.623 has a higher performance than other countries. Nigeria and Niger with a score of 3.658 and

3.707 are in the second and third performance, and Zimbabwe with score 0.567 is in the last performance.

Table 47

Final aggregation and CoCoSo ranking of the countries with CRITIC

Country Name	k_{ia}	k_{ib}	k_{ic}	k_i	Rank
Angola	0.035	5.607	0.775	3.266	11
Burundi	0.033	5.053	0.734	2.879	21
Congo, Rep.	0.033	5.196	0.738	2.959	19
Cote d'Ivoire	0.034	5.443	0.763	3.150	14
Gambia	0.034	5.349	0.752	3.071	17
Guinea	0.031	4.512	0.695	2.527	25
Kenya	0.033	4.859	0.723	2.758	23
Mauritania	0.036	6.255	0.806	3.694	5
Niger	0.036	6.257	0.810	3.707	3
Rwanda	0.030	4.266	0.675	2.368	27
Sierra Leone	0.036	6.276	0.809	3.712	4
Togo	0.035	5.778	0.780	3.366	10
Zimbabwe	0.015	1.000	0.334	0.567	30
Benin	0.034	5.335	0.753	3.068	16
Cameroon	0.034	5.376	0.756	3.097	15
Chad	0.036	6.125	0.802	3.614	6
Ethiopia	0.033	5.200	0.744	2.977	18
Ghana	0.036	6.065	0.801	3.579	7
Gabon	0.032	4.852	0.716	2.736	24
Madagascar	0.035	5.574	0.768	3.228	12
Mali	0.036	6.023	0.796	3.541	8
Mauritius	0.033	5.096	0.736	2.904	20
Mozambique	0.045	9.888	1.000	6.623	1
Namibia	0.027	3.336	0.601	1.810	28
Nigeria	0.037	6.089	0.821	3.658	2
Senegal	0.035	5.778	0.780	3.368	9
South Africa	0.031	4.212	0.695	2.386	26
Sudan	0.026	3.022	0.572	1.627	29
Tanzania	0.035	5.521	0.768	3.202	13
Zambia	0.033	4.927	0.725	2.794	22

Table 48 illustrates the results of ranking countries when using the CoCoSo method for 2019–2021.

Table 48

Ranks obtained using CoCoSo weighted with CRITIC for 2019-2021

	Rank		
Country Name	**CoCoSo 2019**	**CoCoSo 2020**	**CoCoSo 2021**
Angola	11	18	7
Burundi	21	22	21
Congo, Rep.	19	3	28
Cote d'Ivoire	14	13	11
Gambia	17	4	4
Guinea	25	26	25
Kenya	23	21	19
Mauritania	5	6	8
Niger	3	9	10
Rwanda	27	27	26
Sierra Leone	4	11	15
Togo	10	23	20
Zimbabwe	30	30	29
Benin	16	20	17
Cameroon	15	19	16
Chad	6	7	6
Ethiopia	18	17	12
Ghana	7	8	9
Gabon	24	12	23
Madagascar	12	15	18
Mali	8	14	14
Mauritius	20	25	22
Mozambique	1	1	1
Namibia	28	28	27
Nigeria	2	2	3
Senegal	9	5	5
South Africa	26	10	2
Sudan	29	29	30
Tanzania	13	16	13
Zambia	22	24	24

The rank of the countries using CoCoSo method for 2019- 2021 has been shown in Figure 11.

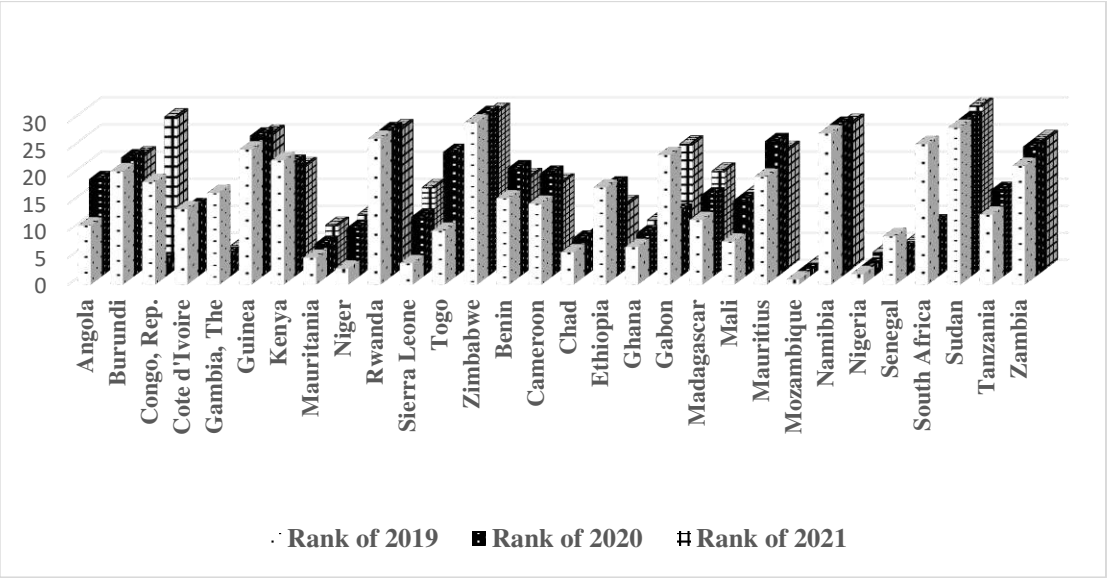

Figure 11. Results of CoCoSo weighted with CRITIC for 2019-2021

4.6.3 CoCoSo Method for 2019 with MEREC

The first step demonstrates forming of the normalised decision-making matrix. In the second step normalization is performed using Eqs. (42) and (43) based on the type of criteria. The values of the sum of weighted comparability (S_i) and amount of the power weight of comparability (p_i) are calculated using Eq. (44) and (45) respectively. in these steps, the weights obtained from the Entropy method are used, which is shown in Table 49.

Table 49

The values of the sum of weighted comparability S_i and P_i

Country Name	$\mathbf{S_i}$	P_i
Angola	0.514	0.085
Burundi	0.467	0.076
Congo, Rep.	0.455	0.073
Cote d'Ivoire	0.504	0.084
Gambia	0.468	0.075
Guinea	0.449	0.073
Kenya	0.487	0.082
Mauritania	0.489	0.078
Niger	0.502	0.081
Rwanda	0.430	0.069
Sierra Leone	0.490	0.078
Togo	0.485	0.078
Zimbabwe	0.197	0.026
Benin	0.481	0.078
Cameroon	0.488	0.080
Chad	0.501	0.081
Ethiopia	0.488	0.081
Ghana	0.528	0.088
Gabon	0.447	0.072
Madagascar	0.484	0.078
Mali	0.498	0.081
Mauritius	0.469	0.076
Mozambique	0.579	0.092
Namibia	0.392	0.064
Nigeria	0.661	0.122
Senegal	0.493	0.080
South Africa	0.609	0.115
Sudan	0.366	0.058
Tanzania	0.501	0.083
Zambia	0.466	0.076

Finally, k_{ia}, k_{ib} and k_{ic} are calculated using Eqs. (46)–(48), in the mentioned Eqs, the value of λ for equilibrium is considered equal to 0.5. And using these 3 values, the final score of each country, k_i based on Eq. (49) is obtained. And the ranking is based on the final score. For 2020 and 2021, the alternatives are calculated similarly, the steps are shown in Appendix E, and the results are given in Table 51.

According to the Table 50 we find that Nigeria with a score of 9.841 has a higher performance than other countries. South Africa and Mozambique with a score of 8.006

and 5.888 are in the second and third performance, and Zimbabwe with score 0.524 is in the last performance.

Table 50

Final aggregation and CoCoSo ranking of the countries with MEREC

Country Name	k_{ia}	k_{ib}	k_{ic}	k_i	Rank
Angola	0.036	8.414	0.765	4.546	5
Burundi	0.032	6.789	0.693	3.526	22
Congo, Rep.	0.032	6.372	0.674	3.280	24
Cote d'Ivoire	0.035	8.104	0.750	4.338	6
Gambia	0.032	6.745	0.693	3.505	21
Guinea	0.031	6.290	0.665	3.220	25
Kenya	0.034	7.642	0.725	4.029	14
Mauritania	0.034	7.327	0.723	3.873	16
Niger	0.035	7.802	0.743	4.170	8
Rwanda	0.030	5.745	0.638	2.905	27
Sierra Leone	0.034	7.361	0.725	3.897	13
Togo	0.034	7.286	0.719	3.839	17
Zimbabwe	0.013	1.000	0.285	0.524	30
Benin	0.033	7.234	0.713	3.798	19
Cameroon	0.034	7.504	0.725	3.962	15
Chad	0.035	7.808	0.743	4.170	9
Ethiopia	0.034	7.594	0.726	4.007	12
Ghana	0.037	8.949	0.786	4.894	4
Gabon	0.031	6.154	0.662	3.149	26
Madagascar	0.034	7.298	0.718	3.842	18
Mali	0.035	7.743	0.739	4.126	10
Mauritius	0.033	6.884	0.696	3.580	20
Mozambique	0.040	10.247	0.856	5.888	3
Namibia	0.027	4.792	0.582	2.367	28
Nigeria	0.047	15.551	1.000	9.841	1
Senegal	0.034	7.596	0.731	4.027	11
South Africa	0.043	13.415	0.923	8.006	2
Sudan	0.025	4.106	0.542	2.006	29
Tanzania	0.035	7.976	0.745	4.260	7
Zambia	0.032	6.811	0.692	3.534	23

Table 51 illustrates the results of ranking countries when using the CoCoSo method for 2019–2021.

Table 51

Rank obtained using CoCoSo weighted with MEREC for 2019-2021

	Rank		
Country Name	**CoCoSo 2019**	**CoCoSo 2020**	**CoCoSo 2021**
Angola	5	6	4
Burundi	22	24	23
Congo, Rep.	24	15	27
Cote d'Ivoire	6	5	6
Gambia	21	12	10
Guinea	25	26	25
Kenya	14	8	11
Mauritania	16	17	17
Niger	8	16	14
Rwanda	27	27	26
Sierra Leone	13	23	19
Togo	17	22	21
Zimbabwe	30	30	29
Benin	19	18	16
Cameroon	15	11	12
Chad	9	13	9
Ethiopia	12	10	13
Ghana	4	4	5
Gabon	26	21	20
Madagascar	18	19	18
Mali	10	14	15
Mauritius	20	25	24
Mozambique	3	3	3
Namibia	28	28	28
Nigeria	1	2	2
Senegal	11	9	8
South Africa	2	1	1
Sudan	29	29	30
Tanzania	7	7	7
Zambia	23	20	22

The rank of the countries using CoCoSo method for 2019-2021 has been shown in Figure 12.

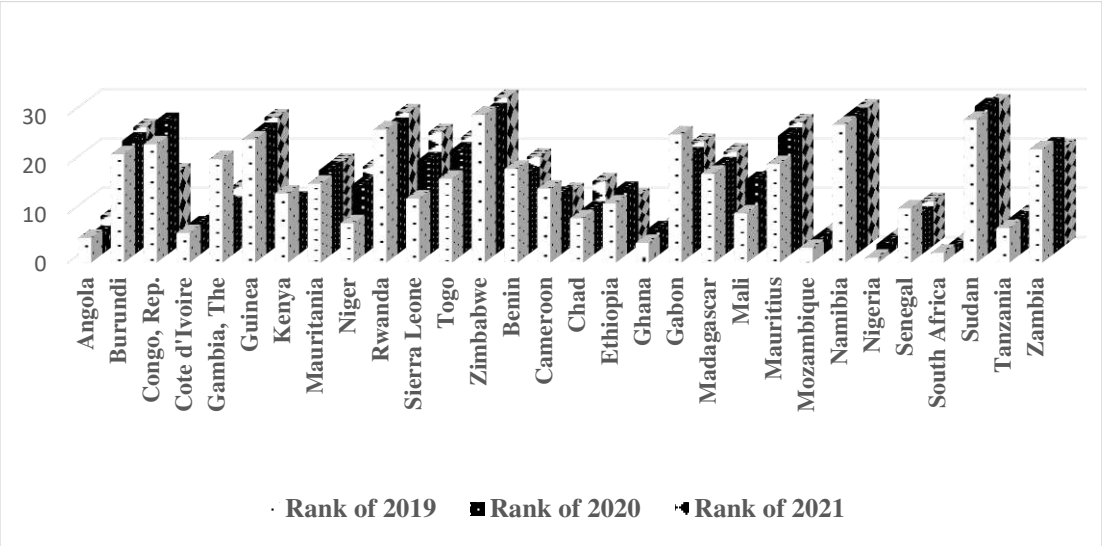

Figure 12. Results of CoCoSo weighted with MEREC for 2019-2021

4.6.4 Effect of Different Weighting Methods on the Results of CoCoSo

The ranking order of countries is different when using Entropy, CRITIC and MEREC methods. Based on the results obtained using the CoCoSo method with weights calculated by mentioned methods, the best ranked countries are Nigeria and South Africa except ranking obtained by CRITIC method. Followed by Mozambique also, except ranking obtained by CRITIC method, the worst ranked countries are Namibia, Sudan, and Zimbabwe.

Entropy method does not differ significantly from other methods and is the easiest to calculate, thus, it is recommended for use in similar studies. It should be emphasized that the CRITIC method differs from most of the other methods, and it is not recommended to be used primarily in similar decision-making problems particularly African macroeconomic indicators, only as a method for weight comparison.

Table 52

The results of CoCoSo for 2019-2021 with respect to all weighting methods

	Entropy	CRITIC	MEREC	Entropy	CRITIC	MEREC	Entropy	CRITIC	MEREC
Country Name	**2019**	**2019**	**2019**	**2020**	**2020**	**2020**	**2021**	**2021**	**2021**
Angola	6	11	5	12	18	6	4	7	4
Burundi	20	21	22	25	22	24	25	21	23
Congo, Rep.	19	19	24	4	3	15	23	28	27
Cote d'Ivoire	5	14	6	6	13	5	6	11	6
Gambia	24	17	21	9	4	12	9	4	10
Guinea	27	25	25	26	26	26	28	25	25
Kenya	11	23	14	13	21	8	10	19	11
Mauritania	14	5	16	7	6	17	13	8	17
Niger	9	3	8	18	9	16	16	10	14
Rwanda	26	27	27	27	27	27	26	26	26
Sierra Leone	23	4	13	21	11	23	20	15	19
Togo	15	10	17	23	23	22	21	20	21
Zimbabwe	30	30	30	30	30	30	29	29	29
Benin	16	16	19	20	20	18	18	17	16
Cameroon	12	15	15	16	19	11	12	16	12
Chad	8	6	9	15	7	13	11	6	9
Ethiopia	22	18	12	14	17	10	15	12	13
Ghana	4	7	4	5	8	4	5	9	5
Gabon	21	24	26	8	12	21	14	23	20
Madagascar	18	12	18	19	15	19	19	18	18
Mali	10	8	10	17	14	14	17	14	15
Mauritius	17	20	20	22	25	25	22	22	24
Mozambique	3	1	3	3	1	3	3	1	3
Namibia	28	28	28	28	28	28	27	27	28
Nigeria	1	2	1	1	2	2	2	3	2
Senegal	13	9	11	10	5	9	7	5	8
South Africa	2	26	2	2	10	1	1	2	1
Sudan	29	29	29	29	29	29	30	30	30
Tanzania	7	13	7	11	16	7	8	13	7
Zambia	25	22	23	24	24	20	24	24	22

4.7 Unifying Ranks Obtained by MCDM Methods with BORDA

After obtaining the ranking for countries through MARCOS, MOORA, TOPSIS and CoCoSo, the next step is to calculate the BORDA method to combine the ranking. The purpose for using BORDA method is to unify the final ranking.

Table 53 show the ranking of SSA countries according to BORDA method. The best ranked country is Nigeria, which is according to macroeconomic performance in 2019. The highest GDP rate and the lowest rates of unemployment and inflation in Nigeria are

the reasons for this ranking. The second ranks country is South Africa. Followed by Cote d'Ivoire, which is pre- COVID-19. Rwanda ranks 21th, due to climate shocks on domestic food production; high energy, food, and fertilizer prices; and weak external demand on exports. The unemployment rate worsened to 17.9% in 2020 from 15% in 2019.

Inflation is one of the indicators of macroeconomic stability. A low inflation rate is associated with a stable economy. The highest recorded was (255.304) by Zimbabwe Guinea, followed by Sudan (50.994). Zimbabwe was rated as the least performing economy out of all countries. Zimbabwe is one economy that has undergone economic crisis for a long period. The factors that impede Zimbabwe's investment are the lack of good legislation and quality institutions, the absence of quality infrastructure and the shortage of well qualified and highly productive labor force are the main obstacles to investment (local and foreign). Similar comments can be made for Guinea and Namibia.

Table 53

Ranking results of countries by BORDA method for 2019

Country Name	Points of MARCOS	Points of MOORA	Points of TOPSIS	Points of CoCoSo	Total points of BORDA	Rank
Angola	11	27	26	24	88	5
Burundi	29	1	6	10	46	16
Congo, Rep.	17	15	19	11	62	12
Cote d'Ivoire	21	23	24	25	93	3
Gambia	22	0	3	6	31	19
Guinea	2	10	4	3	19	22
Kenya	8	26	25	19	78	6
Mauritania	14	5	13	16	48	15
Niger	20	7	11	21	59	13
Rwanda	5	6	7	4	22	21
Sierra Leone	12	2	2	7	23	20
Togo	25	4	10	15	54	14
Zimbabwe	0	17	0	0	17	23
Benin	24	13	12	14	63	11
Cameroon	9	21	22	18	70	7
Chad	23	9	14	22	68	8
Ethiopia	6	25	20	8	59	13
Ghana	13	24	27	26	90	4
Gabon	16	19	18	9	62	12
Madagascar	7	11	8	12	38	17
Mali	18	14	16	20	68	8
Mauritius	27	12	15	13	67	9
Mozambique	19	3	21	27	70	7
Namibia	4	8	5	2	19	22
Nigeria	26	29	29	29	113	1
Senegal	15	16	17	17	65	10
South Africa	28	28	28	28	112	2
Sudan	1	20	1	1	23	20
Tanzania	10	22	23	23	78	6
Zambia	3	18	9	5	35	16

From Table 54 the obtained results showed that the best macroeconomic performances are achieved by Nigeria and South Africa in 2020, which is during-COVID-19. Although, the COVID-19 pandemic has affected all Sub-Saharan economies through a multitude of impact channels (Nechifor et al. 2021), however, South Africa and Nigeria still maintained their macroeconomic performance.

Cote d'Ivoire was determined to be the third country using the approach outlined above. Ghana ranks fourth in both pre- and during COVID- 19 periods. Despite the high unemployment rate, Congo, Rep's macroeconomic performance has improved during

COVID-19, due to the inflation being kept under control. Kenya has the most negative macroeconomic performance during COVID-19, this indicates its effect of COVID-19 on macroeconomic performance in Kenya. Followed by Tanzania, and Mozambique respectively. Furthermore, Gambia ranks 15th, after muted 0.6% growth in 2020 due the COVID-19 pandemic, GDP growth remained subdued at 4.3% in 2021 and 4.4% in 2022, as the effects of Russia's invasion of Ukraine disrupted agriculture, tourism, construction activities, and private investment. Increased COVID-19 spending (0.5% of GDP) and food support (0.7% of GDP) protected livelihoods and businesses, bolstering real GDP per capita growth from –2.0% in 2020 to 1.9% in 2022.

The COVID-19 pandemic generated one of the deepest economic recessions in decades with the SSA economy potentially taking a few years to recover back to its pre-COVID-19 levels. In this context, the five lowest scores are obtained by -in decreasing order- Sudan, Guinea, Sierra Leone, Zimbabwe, and Rwanda, which occupies the last position in 2020. The continued internal conflicts in Sudan, have undoubtedly serious negative impact on all aspects of life. It has impeded any efforts towards furthering the potential for economic development.

Table 54

Ranking results of countries by BORDA method for 2020

Country Name	Points of MARCOS	Points of MOORA	Points of TOPSIS	Points of CoCoSo	Total points of BORDA	Rank
Angola	5	24	24	18	71	11
Burundi	22	1	2	5	30	20
Congo, Rep.	26	13	18	26	83	6
Cote d'Ivoire	18	23	25	24	90	3
Gambia	23	0	7	21	51	15
Guinea	1	12	8	4	25	23
Kenya	10	4	26	17	57	14
Mauritania	20	4	15	23	62	13
Niger	21	9	9	12	51	15
Rwanda	2	5	4	3	14	26
Sierra Leone	7	2	3	9	21	24
Togo	19	3	6	7	35	19
Zimbabwe	0	17	0	0	17	25
Benin	14	14	13	10	51	15
Cameroon	16	21	21	14	72	10
Chad	13	7	12	15	47	16
Ethiopia	6	27	22	16	71	11
Ghana	9	25	27	25	86	4
Gabon	25	18	20	22	85	5
Madagascar	8	11	10	11	40	18
Mali	29	15	16	13	73	9
Mauritius	11	10	11	8	40	18
Mozambique	24	6	19	27	76	8
Namibia	12	8	5	2	27	21
Nigeria	27	29	29	29	114	1
Senegal	17	16	17	20	70	12
South Africa	28	28	28	28	112	2
Sudan	4	20	1	1	26	22
Tanzania	15	22	23	19	79	7
Zambia	3	19	14	6	42	17

According to Table 55, the best macroeconomic performances are achieved by South Africa. South Africa has maintained remarkable political stability and a relatively strong economy. Followed by Nigeria and Angola in that order. These findings probably map with the general intuition, at least for and in that period. The cases of South Africa and Nigeria indicate to the stability of the policy used to maintain economic performance. In this context. Ghana's macroeconomic performances tend to be stable during COVID-19. However, the outlook is tilted negative due to possible shocks from a prolongment of

Russia's invasion of Ukraine and a tighter global financial market (Hess, 2023). GDP growth is projected to fall to 1.7% in 2023 and to recover to 3.0% in 2024, in line with global demand trends. Inflation is projected to remain elevated at 44.7% in 2023 and to decline to 20.4% in 2024, driven by the base effect and food and energy inflation.

Mozambique is ranked fourth. Cote d'Ivoire ranks third in 2019 and fifth in 2021. In response to these negative effects, Real GDP growth rose to an estimated 8.7% in 2022, up from 3.4% in 2021, spurred by sustained policy support and the lifting of travel restrictions and buoyed by recovery in the tourism sector. Monetary policy remained accommodative to support economic activity, taking advantage of low inflation. Cameroon, Chad, Ethiopia, Gambia, and Benin fall to the bottom of the ranking.

Rwanda ranks 20th in 2021, Rwanda has recorded an impressive economic growth averaging 7.4% during the period 2015-2019, higher than the East Africa's average of 5.5% and the sub-Saharan Africa's average of 2.3% over the same period. Despite this impressive performance, growth has been factor driven and characterized by a declining total factor productivity (TFP). This did not allow the country to enjoy productivity gains and led to a slowdown in structural transformation. In 2020, the country entered recession with GDP growth rate of -3.4% caused by contraction in trade, travel, and tourism because of the impact of COVID-19. Rwanda's economy bouncing back from adverse effects of the COVID-19 pandemic despite the second and third waves of this pandemic. This rebound mainly resulted from fiscal and monetary policy measures, as well as the ease of COVID-19 containment measures (Tabe-Ojong et al., 2022)

Sudan shows the lowest macroeconomic performance. The countries with the lowest performance are Togo, Sierra Leone, Guinea, and Zimbabwe. COVID-19 has ambushed the world, and the ensuing economic crisis will likely be one of the deepest in modern history (Parrott, 2020). The impact of COVID-19 pandemics is undoubtedly quite excessive in this downfall in those countries. These weak macroeconomic performers countries are also considered as politically unstable.

Table 55

Ranking results of countries by BORDA method for 2021

Country Name	Points of MARCOS	Points of MOORA	Points of TOPSIS	Points of CoCoSo	Total points of BORDA	Rank
Angola	13	27	27	26	93	3
Burundi	25	1	2	5	33	23
Congo, Rep.	17	15	15	7	54	16
Cote d'Ivoire	16	23	24	24	87	5
Gambia	23	0	13	21	57	14
Guinea	1	12	4	2	19	28
Kenya	11	26	23	20	80	8
Mauritania	10	4	18	17	49	18
Niger	20	8	11	14	53	17
Rwanda	28	6	7	4	45	20
Sierra Leone	8	2	3	10	23	27
Togo	6	3	6	9	24	26
Zimbabwe	0	17	1	1	19	28
Benin	19	13	12	12	56	15
Cameroon	15	21	19	18	73	11
Chad	26	10	17	19	72	12
Ethiopia	9	25	16	15	65	13
Ghana	12	24	26	25	87	5
Gabon	24	20	21	16	81	7
Madagascar	5	11	8	11	35	22
Mali	7	14	14	13	48	19
Mauritius	3	9	9	8	29	25
Mozambique	21	5	25	27	78	4
Namibia	4	7	10	3	24	9
Nigeria	27	28	28	28	111	2
Senegal	18	16	20	23	77	10
South Africa	29	29	29	29	116	1
Sudan	22	19	0	0	41	21
Tanzania	14	22	22	28	86	5
Zambia	2	18	5	6	31	24

4.8 Comparing the Effect of MCDM Methods by Taylor Diagram

This sub-section utilized Taylor diagram to quantify the degree of correspondence between the MCDM methods and ranking results in terms of correlation coefficient, the root-mean-square error (RMSE) error and standard deviation.

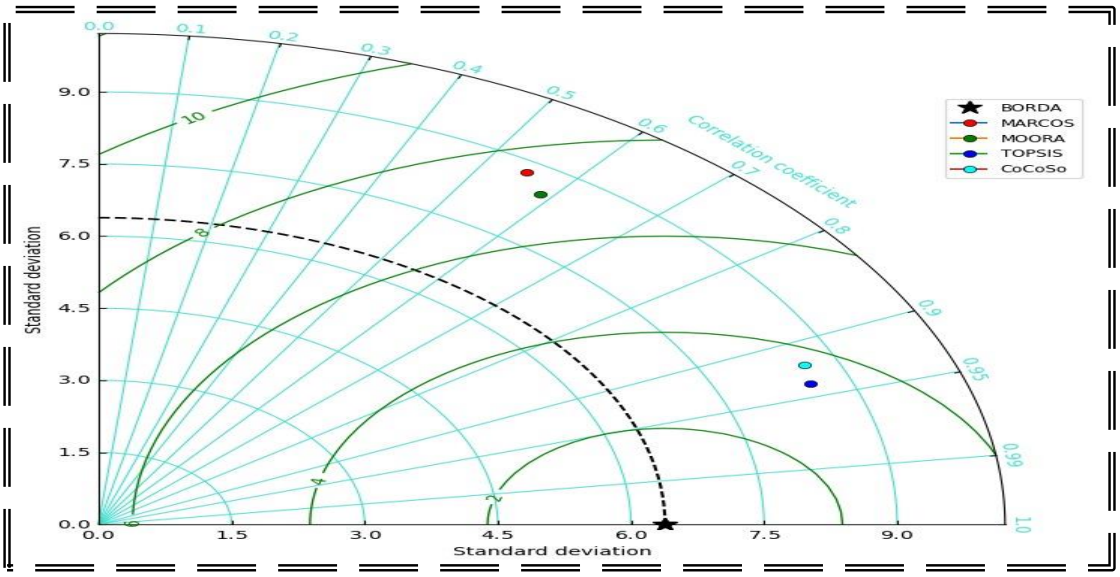

Figure 13. Taylor diagram for comparison of MCDM methods for 2019

Normalized pattern statistics showing differences between four methods for ranking SSA countries. From Figure 13 the TOPSIS method has relatively high correlation coefficient and low RMS errors. So, the TOPSIS method was the best method across all BORDA ranks. Followed by CoCoSo method. The contribution of MARCOS and MOORA was low in the BORDA calculations.

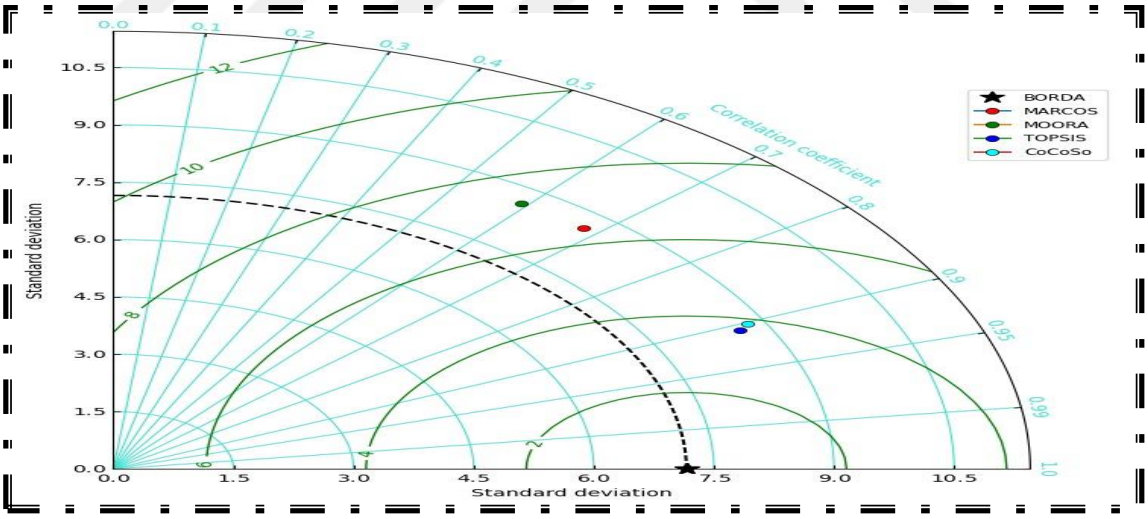

Figure 14. Taylor diagram for comparison of MCDM methods for 2020

In Figure 14 TOPSIS and CoCoSo method generally agree best with ranking results, the correlation coefficient of TOPSIS method is clearly greater than the other methods and standard deviation and RMSE error is less than from the other methods.

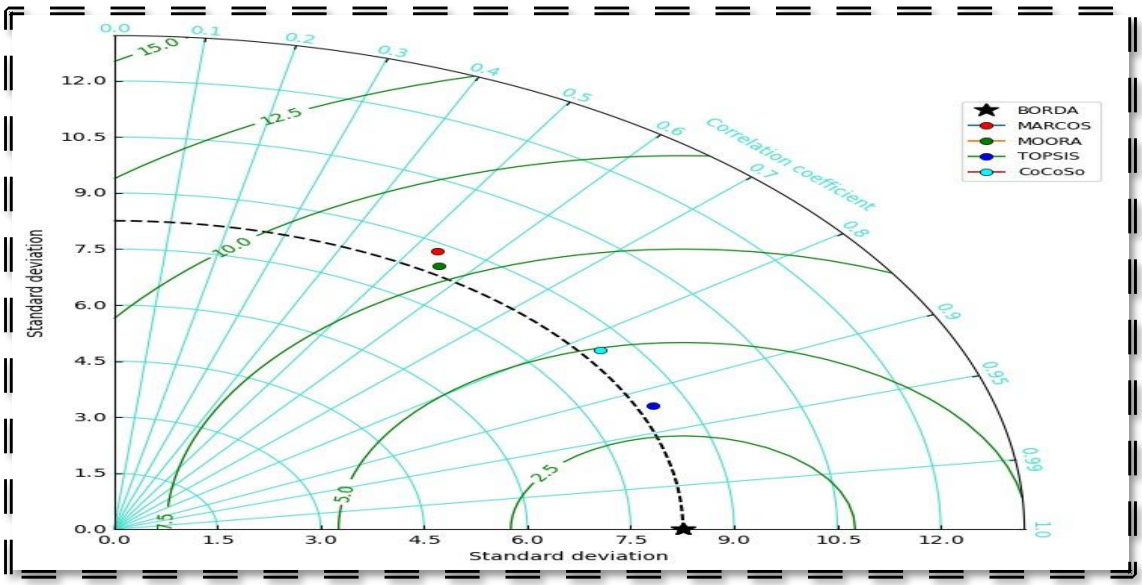

Figure 15. Taylor diagram for comparison of MCDM methods for 2021

Normalized pattern statistics showing differences within four methods for ranking SSA countries. From Figure 2 the correlation coefficient of (TOPSIS) method is about 0.92, and the standard deviation is about 2.5. So, the TOPSIS method is better than the other methods for 2021.

CHAPTER V

CONCLUSION

5.1. Key Findings and Policy Recommendation

In the current research, for the first time, four methods, including MARCOS, MOORA, CoCoSo, and TOPSIS, are utilised to evaluate macroeconomic performance in SSA countries. The criteria weights are measured using more recent weighting methods, such as the Entropy, CRITIC and MEREC methods. Each of these methods calculated the importance of the indicators differently as the study of Bektas (2022). In other words, the indicators had different degrees of importance according to their weighting methods. Similarly, the results of the research with the four MCDM methods providing the ranking orders of countries are different as the studies of Trung (2021) and Selcuk et al. (2023). Due to these, the BORDA method was utilised to unify the final ranking. Then the Taylor diagram was utilised to compare the contribution or effect of the MCDM methods for ranking results.

Drawing on the research findings, the top two countries with the highest macroeconomic performance in SSA countries are Nigeria and South Africa. Although the COVID-19 pandemic brought a strong economic downturn, South Africa and Nigeria maintained their economic performance. However, some other countries have undergone serious changes in their performance rankings pre and during COVID-19. For instance, while Kenya ranked sixth in 2019, it fell to 14th place in 2020. Furthermore, Sierra Leone, Togo, and Namibia have also declined in performance rankings over the period of research. Sudan has lower macroeconomic performance, while the most deviations from the ranking occur when the MOORA method is used. Zimbabwe and Gambia have been found to have the worst macroeconomic performance, according to methods used in research.

The findings also indicated that, according to the entropy method, INF is the most important and UEM has the lowest importance. According to CRITIC results, the criterion FDI is the most important for all years, followed by the criterion UEM. Moreover, the results of MEREC showed that INF and EXP, respectively, are highly important criteria within the span of the research. So, we can expect that these results will affect the rankings obtained by different methods.

From the above overview, we can note that the rank of countries is changing according to the MCDM method used. The reason behind this is that each method has its own special methodological formulation and calculation systematics. So, a significant problem researchers face when dealing with a MCDM method is choosing the most suitable method for their problem. To strengthen the reliability of the conclusions of any research (Selcuk et al., 2023), it is crucial to carry out MCDM analysis with different weighting techniques and different MCDM methods (Maheshwari et al., 2021; Ersoy, 2022; Bektas, 2022).

The main contribution of this research is to provide an evaluation of the macroeconomic performance of 30 SSA countries. The research results may help policymakers improve macroeconomic performance, achieve economic growth, and reduce the ratio of inflation and unemployment towards sustainable economic development. The estimation results may provide useful information and practical suggestions for governments to realise their collective goal of enhancing global competitiveness.

5.2. Limitations and Directions for Future Research

This research, like other research, is not without its limitations. Usually, in all "real-world decision-making issues, there are direct or indirect relationships between the criteria of the issue in question that affect the ranking. One of the main limitations of this research is access to the required data; the research is limited to only 30 out of 48 SSA countries. Furthermore, another limitation can be considered, which is that more criteria have not been used (according to which the alternatives could be evaluated). However, adding more criteria would only complicate the decision-making process.

In future research, it is suggested to use the Choquet integral or fuzzy cognitive map to examine the relationships between criteria. Also, a model based on MEREC, SWARA, and OCRA can be utilized. Also, in future research, different criteria combinations from the criteria utilised in this research can be adopted, and different results can be achieved, or objective criteria weights can be calculated using the formula given in the studies of Zavadskas ve Podvezko (2016) and Bektas (2022).

In addition, since no evaluation of similar criteria or similar countries has been found in the literature and did not have such a variety and many criteria, the lack of comparison can be expressed as a limitation of the research. It is necessary to use this method in other

examples where decision-making is represented because it has shown great flexibility and simplicity in its work.

Moreover, in future research, it is necessary to use a combination of subjective and objective methods, for example, MCDM in agricultural areas. Also, the macroeconomic indicators for the SSA countries can be predicted using machine learning methods.

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APPENDICES

Appendix A. Calculating the Weights for the Criteria

Table 56

Normalize the initial matrix by Entropy method for 2020

Country name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.03261	0.067378	0.029251	0.029432	0.024775	0.044629
Burundi	0.00172	0.000425	0.002592	0.00199	0.008144	0.004441
Congo, Rep.	0.006804	0.021072	0.148956	0.015022	0.001997	0.097092
Cote d'Ivoire	0.04088	0.04665	0.008913	0.042777	0.002698	0.01147
Gambia	0.001176	0.000615	0.082371	0.002319	0.006598	0.021974
Guinea	0.009202	0.023331	0.009794	0.03275	0.011793	0.025635
Kenya	0.065334	0.034212	0.003335	0.059846	0.006012	0.024216
Mauritania	0.005456	0.01205	0.086923	0.015335	0.002654	0.048022
Niger	0.008921	0.004984	0.020661	0.011971	0.003224	0.002932
Rwanda	0.006603	0.006932	0.011812	0.012329	0.010958	0.056099
Sierra Leone	0.002637	0.002162	0.033469	0.005006	0.014958	0.015402
Togo	0.004796	0.006175	0.006309	0.008117	0.00189	0.017369
Zimbabwe	0.013961	0.019654	0.005504	0.020883	0.619837	0.034056
Benin	0.010159	0.010966	0.008754	0.013201	0.003363	0.007205
Cameroon	0.026465	0.021902	0.013039	0.025492	0.002712	0.017019
Chad	0.006955	0.010093	0.04098	0.015212	0.004966	0.007093
Ethiopia	0.069877	0.027052	0.017522	0.0614	0.022645	0.017791
Ghana	0.045463	0.05117	0.021087	0.042117	0.010999	0.016273
Gabon	0.00994	0.025649	0.088253	0.011672	0.001505	0.093682
Madagascar	0.008471	0.009268	0.021626	0.012731	0.004674	0.010189
Mali	0.011336	0.018877	0.024203	0.021442	0.000487	0.015221
Mauritius	0.0074	0.015827	0.015516	0.017917	0.002871	0.037212
Mozambique	0.009189	0.014635	0.17731	0.031446	0.003876	0.016282
Namibia	0.00687	0.012567	0.011172	0.015466	0.002458	0.091569
Nigeria	0.280527	0.123704	0.004346	0.120244	0.014735	0.025867
Senegal	0.015922	0.017903	0.059243	0.032613	0.002829	0.015131
South Africa	0.219139	0.328532	0.007355	0.26467	0.003571	0.104953
Sudan	0.017547	0.004885	0.020881	0.004412	0.18161	0.083186
Tanzania	0.042883	0.031455	0.008162	0.032279	0.00366	0.011987
Zambia	0.011755	0.029876	0.010661	0.01991	0.017502	0.026001

Table 57

Entropy weights for 2020

	GDP	EXP	FDI	IMP	INF	UEM
$1-\mathrm{E}_j$	0.279809	0.243992	0.118097	0.226242	0.454904	0.118115
Sum	1.441159					
W_j	0.194156	0.169303	0.081946	0.156986	0.315651	0.081959

Table 58

Normalize the initial matrix by Entropy method for 2021

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.037928	0.078656	0.045121	0.028693	0.038818	0.044129
Burundi	0.001603	0.000366	0.002435	0.001738	0.012668	0.004811
Congo, Rep.	0.007718	0.020593	0.027086	0.013053	0.002586	0.094493
Cote d'Ivoire	0.041465	0.042754	0.013196	0.042529	0.006168	0.011971
Gambia	0.001177	0.000348	0.084073	0.001908	0.011109	0.021168
Guinea	0.009292	0.018233	0.008357	0.026565	0.018987	0.024733
Kenya	0.063345	0.031152	0.002874	0.057418	0.009211	0.023985
Mauritania	0.005772	0.010394	0.072862	0.01601	0.005374	0.047967
Niger	0.008612	0.004043	0.027141	0.010673	0.005785	0.002839
Rwanda	0.006383	0.005695	0.013044	0.010217	0.00059	0.056585
Sierra Leone	0.002454	0.001896	0.033999	0.00463	0.017897	0.015711
Togo	0.004812	0.005105	0.011124	0.007003	0.00631	0.017743
Zimbabwe	0.016382	0.019001	0.005997	0.023041	0.148533	0.034283
Benin	0.010215	0.009753	0.01331	0.012616	0.002613	0.007446
Cameroon	0.026179	0.019965	0.014463	0.024262	0.003424	0.017517
Chad	0.006802	0.012031	0.040734	0.013695	0.001165	0.006536
Ethiopia	0.064244	0.022379	0.026053	0.048737	0.040454	0.016701
Ghana	0.045706	0.062394	0.022463	0.059336	0.015029	0.016655
Gabon	0.011674	0.029596	0.051474	0.008813	0.001638	0.092797
Madagascar	0.008404	0.008736	0.016717	0.012119	0.00876	0.009817
Mali	0.01115	0.014182	0.022554	0.019966	0.005917	0.011062
Mauritius	0.006627	0.013381	0.015014	0.016286	0.006072	0.032536
Mozambique	0.00911	0.01305	0.22842	0.02854	0.009659	0.01674
Namibia	0.007187	0.01045	0.037766	0.016403	0.005452	0.090383
Nigeria	0.254544	0.124765	0.005115	0.137152	0.025552	0.025226
Senegal	0.015919	0.017868	0.063887	0.032267	0.003286	0.014866
South Africa	0.241946	0.34449	0.066035	0.275572	0.006951	0.122265
Sudan	0.019765	0.00203	0.010396	0.001689	0.541241	0.080957
Tanzania	0.040798	0.026294	0.009949	0.02933	0.005563	0.011644
Zambia	0.012788	0.030399	0.008341	0.01974	0.033191	0.026433

Table 59
Entropy weights for 2021

	GDP	EXP	FDI	IMP	INF	UEM
$1 - \mathrm{E}_j$	0.262171	0.255996	0.150049	0.193586	0.444418	0.108358
Sum	1.414578					
W_j	0.185335	0.18097	0.106073	0.136851	0.31417	0.076601

Table 60
Normalize the decision matrix by CRITIC method for 2020

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.112525	0.204059	0.152587	0.104472	0.039215	0.408707
Burundi	0.001946	0	0	0	0.012363	0.014793
Congo, Rep.	0.020147	0.062927	0.837719	0.049613	0.002438	0.92295
Cote d'Ivoire	0.142129	0.140884	0.036177	0.155275	0.003569	0.083686
Gambia	0	0.000578	0.456616	0.001255	0.009866	0.186644
Guinea	0.028732	0.069811	0.041221	0.1171	0.018255	0.222527
Kenya	0.229666	0.102975	0.004252	0.220254	0.008921	0.208622
Mauritania	0.01532	0.035431	0.48267	0.050805	0.003498	0.44197
Niger	0.027724	0.013895	0.103421	0.037996	0.004419	0
Rwanda	0.019426	0.019833	0.052774	0.03936	0.016905	0.521133
Sierra Leone	0.00523	0.005293	0.176726	0.011484	0.023365	0.122232
Togo	0.012958	0.017524	0.021275	0.023325	0.002265	0.141505
Zimbabwe	0.045767	0.058607	0.016668	0.071926	1	0.305072
Benin	0.032156	0.032127	0.035272	0.042679	0.004642	0.041885
Cameroon	0.090526	0.065456	0.059793	0.08947	0.003591	0.138081
Chad	0.020687	0.029466	0.219717	0.050335	0.007231	0.040786
Ethiopia	0.245931	0.081154	0.085455	0.226168	0.035775	0.145647
Ghana	0.158534	0.154659	0.105855	0.152762	0.016972	0.130769
Gabon	0.031373	0.076879	0.490284	0.036858	0.001643	0.889518
Madagascar	0.026114	0.026952	0.108943	0.040891	0.00676	0.071133
Mali	0.03637	0.056239	0.12369	0.074053	0	0.120456
Mauritius	0.02228	0.046941	0.073973	0.060633	0.003849	0.33601
Mozambique	0.028683	0.04331	1	0.112138	0.005471	0.130854
Namibia	0.020381	0.037005	0.04911	0.051303	0.003181	0.868808
Nigeria	1	0.37573	0.010037	0.450184	0.023004	0.22481
Senegal	0.052786	0.053269	0.324242	0.116579	0.003781	0.119569
South Africa	0.780246	1	0.02726	1	0.004979	1
Sudan	0.058604	0.013594	0.104678	0.009221	0.292439	0.786644
Tanzania	0.1493	0.094573	0.031882	0.115307	0.005123	0.088757
Zambia	0.037869	0.089761	0.046182	0.06822	0.027471	0.22612

Table 61

Matrix for Correlation Coefficient between Criteria by CRITIC method for 2020

Country Name	GDP	EXP	FDI	IMP	INF	UEM
GDP	1	0.807466	-0.24553	0.855995	-0.05868	0.181277
EXP	0.807466	1	-0.17171	0.972194	-0.06155	0.401842
FDI	-0.24553	-0.17171	1	-0.18173	-0.14649	0.233708
IMP	0.855995	0.972194	-0.18173	1	-0.07241	0.317142
INF	-0.05868	-0.06155	-0.14649	-0.07241	1	0.082728
UEM	0.181277	0.401842	0.317142	0.317142	0.082728	1

Table 62

CRITIC weights for 2020

	GDP	EXP	FDI	IMP	INF	UEM
C_j	0.755746	0.556581	1.332493	0.576748	0.963199	1.085878
W_j	0.143388	0.1056	0.252814	0.109426	0.182748	0.206024

Table 63

Normalize the decision matrix by CRITIC method for 2021

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	1.5E-01	0.227546	0.18889	0.098597	0.070708	0.345741
Burundi	0.0016805	5.26E-05	0	0.000177	0.022339	0.016511
Congo, Rep.	0.0258157	0.058829	0.10908	0.04149	0.003692	0.767454
Cote d'Ivoire	0.1590096	0.123224	0.047616	0.149115	0.010317	0.076471
Gambia	0	0	0.361252	0.0008	0.019456	0.153477
Guinea	0.0320273	0.051969	0.026204	0.090825	0.034028	0.183332
Kenya	0.2453656	0.08951	0.001942	0.203477	0.015945	0.177069
Mauritania	0.0181356	0.029193	0.311645	0.052288	0.008848	0.377873
Niger	0.0293453	0.010737	0.109323	0.0328	0.009608	0
Rwanda	0.0205491	0.015537	0.046943	0.031136	0	0.450039
Sierra Leone	0.0050384	0.004499	0.139673	0.010739	0.032012	0.107786
Togo	0.0143475	0.013822	0.038446	0.019402	0.010579	0.124795
Zimbabwe	0.0600117	0.054203	0.015759	0.077959	0.273639	0.263291
Benin	0.0356696	0.02733	0.048121	0.039896	0.003742	0.038574
Cameroon	0.098679	0.057003	0.053223	0.082419	0.005243	0.122909
Chad	0.0222007	0.033949	0.169476	0.043835	0.001064	0.030959
Ethiopia	0.2489168	0.064019	0.10451	0.17178	0.073733	0.116077
Ghana	0.1757494	0.180294	0.088625	0.210479	0.026707	0.115686
Gabon	0.0414306	0.08499	0.216999	0.02601	0.001939	0.753256
Madagascar	0.0285243	0.024375	0.063199	0.038082	0.015113	0.05843
Mali	0.0393602	0.0402	0.089027	0.066731	0.009853	0.068856
Mauritius	0.0215089	0.037872	0.055661	0.053295	0.01014	0.248666
Mozambique	0.0313092	0.03691	1	0.098039	0.016775	0.116397
Namibia	0.0237192	0.029356	0.156343	0.053723	0.008992	0.733044
Nigeria	1	0.36153	0.011857	0.4946	0.046171	0.18746
Senegal	0.0581837	0.05091	0.27193	0.111646	0.004987	0.100705
South Africa	0.9502776	1	0.281436	1	0.011766	1
Sudan	0.0733625	0.004888	0.035224	0	1	0.654117
Tanzania	0.1563764	0.075395	0.033247	0.100923	0.009199	0.073731
Zambia	0.0458283	0.087323	0.026131	0.065908	0.060299	0.197566

Table 64

Matrix for Correlation Coefficient between Criteria by CRITIC method for 2021

Country Name	GDP	EXP	FDI	IMP	INF	UEM
GDP	1	0.853141	-0.04712	0.917043	-0.02766	0.286968
EXP	0.8531409	1	0.078797	0.968122	-0.08626	0.486479
FDI	-0.047122	0.078797	1	0.076125	-0.13687	0.085244
IMP	0.9170433	0.968122	0.076125	1	-0.10631	0.389018
INF	-0.027659	-0.08626	-0.13687	-0.10631	1	0.261492
UEM	0.2869677	0.486479	0.389018	0.389018	0.261492	1

Table 65

CRITIC weights for 2021

	GDP	EXP	FDI	IMP	INF	UEM
C_j	0.7139366	0.495690	0.9241336	0.5209393	0.9240523	0.8309366
W_j	0.161902	0.112409	0.209569	0.118135	0.20955	0.188434

Table 66

Normalized decision matrix by MEREC method for 2020

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.036069	0.006308	0.088607	0.111204	0.03997	0.425226
Burundi	0.683921	1	1	0.007518	0.013139	0.042317
Congo, Rep.	0.172865	0.020169	0.0174	0.056758	0.003222	0.925103
Cote d'Ivoire	0.028772	0.00911	0.290812	0.161626	0.004352	0.109285
Gambia	1	0.691329	0.031466	0.008763	0.010645	0.209367
Guinea	0.127817	0.018216	0.264645	0.123738	0.019027	0.244248
Kenya	0.018003	0.012422	0.777238	0.226116	0.0097	0.230731
Mauritania	0.215593	0.035269	0.029818	0.05794	0.004282	0.45756
Niger	0.13185	0.08527	0.125446	0.045229	0.005201	0.027938
Rwanda	0.178137	0.061304	0.219422	0.046582	0.017678	0.534511
Sierra Leone	0.446028	0.1966	0.077442	0.018915	0.024133	0.146754
Togo	0.245242	0.068826	0.41083	0.030667	0.00305	0.165489
Zimbabwe	0.084249	0.021623	0.470902	0.078903	1	0.324486
Benin	0.115782	0.038755	0.296065	0.049875	0.005425	0.068652
Cameroon	0.044445	0.019404	0.198783	0.096315	0.004375	0.162161
Chad	0.169118	0.042107	0.063247	0.057475	0.008012	0.067584
Ethiopia	0.016833	0.01571	0.147919	0.231986	0.036533	0.169515
Ghana	0.025872	0.008305	0.122917	0.159131	0.017745	0.155053
Gabon	0.11833	0.016569	0.029369	0.044099	0.002428	0.892605
Madagascar	0.138848	0.045854	0.11985	0.048101	0.007541	0.097083
Mali	0.103758	0.022513	0.107091	0.081014	0.000786	0.145029
Mauritius	0.158948	0.026852	0.167044	0.067695	0.004632	0.35456
Mozambique	0.128007	0.029039	0.014618	0.118812	0.006253	0.155136
Namibia	0.171222	0.033819	0.231994	0.058435	0.003965	0.872473
Nigeria	0.004193	0.003436	0.596449	0.454318	0.023772	0.246467
Senegal	0.073874	0.023738	0.04375	0.12322	0.004564	0.144166
South Africa	0.005367	0.001294	0.352416	1	0.005761	1
Sudan	0.067032	0.086996	0.124127	0.01667	0.292996	0.792605
Tanzania	0.027429	0.013511	0.317545	0.121958	0.005905	0.114215
Zambia	0.100061	0.014225	0.243126	0.075225	0.028236	0.24774

Table 67

The removal effect of each criterion by MEREC method for 2020

	GDP	EXP	FDI	IMP	INF	UEM
V_j	1.418276	1.859748	0.658112	1.186089	2.385967	0.975365

Table 68

MEREC weights for 2020

	GDP	EXP	FDI	IMP	INF	UEM
W_j	0.167	0.219	0.078	0.14	0.281	0.115

Table 69

Normalized decision matrix by MEREC method for 2021

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.031033	0.00442	0.053974	0.104122	0.07172	0.360932
Burundi	0.734353	0.95047	1	0.006305	0.023405	0.039347
Congo, Rep.	0.152505	0.016884	0.089914	0.047366	0.004778	0.772854
Cote d'Ivoire	0.028386	0.008132	0.184558	0.15433	0.011395	0.097914
Gambia	1	1	0.028968	0.006925	0.020525	0.173132
Guinea	0.126674	0.01907	0.291415	0.096398	0.035081	0.202294
Kenya	0.018581	0.011161	0.847284	0.20836	0.017018	0.196177
Mauritania	0.203918	0.033451	0.033425	0.058097	0.009928	0.392318
Niger	0.136669	0.086008	0.089732	0.038729	0.010688	0.023219
Rwanda	0.184384	0.061058	0.186708	0.037074	0.00109	0.462808
Sierra Leone	0.479713	0.183401	0.071631	0.016803	0.033067	0.128502
Togo	0.244589	0.068114	0.218941	0.025413	0.011658	0.145116
Zimbabwe	0.071848	0.018298	0.40612	0.083611	0.274431	0.280396
Benin	0.115229	0.03565	0.182974	0.045781	0.004828	0.060897
Cameroon	0.04496	0.017416	0.16839	0.088043	0.006327	0.143274
Chad	0.173041	0.0289	0.059787	0.049696	0.002152	0.053458
Ethiopia	0.018321	0.015537	0.093478	0.176856	0.074743	0.136601
Ghana	0.025752	0.005573	0.108417	0.215319	0.027767	0.136218
Gabon	0.100822	0.011748	0.047313	0.03198	0.003027	0.758985
Madagascar	0.140051	0.039799	0.14568	0.043978	0.016186	0.080292
Mali	0.105566	0.024517	0.10798	0.072451	0.010932	0.090476
Mauritius	0.177617	0.025984	0.16221	0.059098	0.011219	0.266111
Mozambique	0.129204	0.026644	0.010662	0.103568	0.017846	0.136913
Namibia	0.163777	0.033271	0.064486	0.059523	0.010072	0.739242
Nigeria	0.004624	0.002787	0.476148	0.497698	0.04721	0.206326
Senegal	0.073938	0.019459	0.03812	0.117091	0.006072	0.121585
South Africa	0.004865	0.001009	0.03688	1	0.012843	1
Sudan	0.059551	0.171302	0.234274	0.00613	1	0.662148
Tanzania	0.02885	0.013223	0.244793	0.106434	0.010278	0.095238
Zambia	0.092038	0.011438	0.291995	0.071633	0.061323	0.216197

Table 70

The removal effect of each criterion by MEREC method for 2021

	GDP	EXP	FDI	IMP	INF	UEM
V_j	1.346151	1.904697	0.814856	1.322167	2.093315	1.055665

Table 71

MEREC weights for 2021

	GDP	EXP	FDI	IMP	INF	UEM
W_j	0.158	0.223	0.095	0.155	0.245	0.124

Appendix B. Applying the MARCOS Method

Table 72

Calculate the AI and the AAI by MARCOS method for 2020 with Entropy

Country Name	GDP	EXP	FDI	IMP	INF	UEM
AAI	1812170878	120542434	0.329176	7.833E+10	557.2018	24.34
AI	4.322E+11	9.3184E+10	22.5187	588865206	0.438089	0.68

Table 73

The results of MARCOS method for 2020 with Entropy

Country Name	S_i	K_i^-	K_i^+	$f(K_i^-)$	$f(K_i^+)$	$f(K_i)$	Rank
AAI	0.005689	1	0.005689	0.0056569	0.994343	0.005689	
Angola	0.090819	15.96379	0.090819	0.0056569	0.994343	0.090816	25
Burundi	0.18583	32.66446	0.18583	0.0056569	0.994343	0.185824	8
Congo, Rep.	0.217376	38.20945	0.217376	0.0056569	0.994343	0.217369	4
Cote d'Ivoire	0.143216	25.17399	0.143216	0.0056569	0.994343	0.143212	12
Gambia	0.189516	33.31231	0.189516	0.0056569	0.994343	0.18951	7
Guinea	0.053224	9.355441	0.053224	0.0056569	0.994343	0.053222	29
Kenya	0.101879	17.90787	0.101879	0.0056569	0.994343	0.101876	20
Mauritania	0.151926	26.70498	0.151926	0.0056569	0.994343	0.151921	10
Niger	0.164798	28.96755	0.164798	0.0056569	0.994343	0.164793	9
Rwanda	0.053692	9.43782	0.053692	0.0056569	0.994343	0.053691	28
Sierra Leone	0.095205	16.73467	0.095205	0.0056569	0.994343	0.095201	23
Togo	0.144984	25.48479	0.144984	0.0056569	0.994343	0.14498	11
Zimbabwe	0.038871	6.832642	0.038871	0.0056569	0.994343	0.03887	30
Benin	0.11601	20.39179	0.11601	0.0056569	0.994343	0.116006	16
Cameroon	0.122641	21.55741	0.122641	0.0056569	0.994343	0.122637	14
Chad	0.11516	20.24235	0.11516	0.0056569	0.994343	0.115156	17
Ethiopia	0.091476	16.07931	0.091476	0.0056569	0.994343	0.091473	24
Ghana	0.100719	17.70401	0.100719	0.0056569	0.994343	0.100716	21
Gabon	0.216405	38.03878	0.216405	0.0056569	0.994343	0.216398	5
Madagascar	0.09989	17.55831	0.09989	0.0056569	0.994343	0.099887	22
Mali	0.424357	74.5917	0.424357	0.0056569	0.994343	0.424343	1
Mauritius	0.102962	18.09819	0.102962	0.0056569	0.994343	0.102958	19
Mozambique	0.192767	33.88373	0.192767	0.0056569	0.994343	0.19276	6
Namibia	0.10765	18.92227	0.10765	0.0056569	0.994343	0.107646	18
Nigeria	0.261535	45.97152	0.261535	0.0056569	0.994343	0.261526	3
Senegal	0.140508	24.69794	0.140508	0.0056569	0.994343	0.140504	13
South Africa	0.351856	61.84787	0.351856	0.0056569	0.994343	0.351845	2
Sudan	0.08242	14.48749	0.08242	0.0056569	0.994343	0.082418	26
Tanzania	0.120341	21.15298	0.120341	0.0056569	0.994343	0.120337	15
Zambia	0.05793	10.18277	0.05793	0.0056569	0.994343	0.057929	27
AI	1	175.7759	1	0.0056569	0.994343	0.999968	0

Table 74

Calculate the AI and the AAI by MARCOS method with Entropy weights for 2021

Country Name	GDP	EXP	FDI	IMP	INF	UEM
AAI	2038414974	131923344	0.357862	1.0486E+11	359.093	28.77
AI	4.408311	1.307111	33.56454	642720122	0.391347	0.668

Table 75

The results of MARCOS method for 2021 with Entropy weight

Country Name	S_i	K_i^-	K_i^+	$f(K_i^-)$	$f(K_i^+)$	$f(K_i)$	Rank
AAI	0.00513038	1	0.00513	0.00510419	0.994896	0.00513	
Angola	0.10764692	20.98225	0.107647	0.00510419	0.994896	0.107644	17
Burundi	0.19535762	38.07859	0.195358	0.00510419	0.994896	0.195353	5
Congo, Rep.	0.12069074	23.52472	0.120691	0.00510419	0.994896	0.120688	13
Cote d'Ivoire	0.11242519	21.91362	0.112425	0.00510419	0.994896	0.112422	14
Gambia	0.18817115	36.67782	0.188171	0.00510419	0.994896	0.188166	7
Guinea	0.04747808	9.254304	0.047478	0.00510419	0.994896	0.047477	29
Kenya	0.09703302	18.91342	0.097033	0.00510419	0.994896	0.09703	19
Mauritania	0.09695701	18.89860	0.096957	0.00510419	0.994896	0.096954	20
Niger	0.15129356	29.489745	0.151294	0.00510419	0.994896	0.15129	10
Rwanda	0.35433591	69.06623	0.354336	0.00510419	0.994896	0.354327	2
Sierra Leone	0.09268928	18.06675	0.092689	0.00510419	0.994896	0.092687	22
Togo	0.08598532	16.76003	0.085985	0.00510419	0.994896	0.085983	24
Zimbabwe	0.04231784	8.248482	0.042318	0.00510419	0.994896	0.042317	30
Benin	0.13719476	26.74164	0.137195	0.00510419	0.994896	0.137191	11
Cameroon	0.11232515	21.894124	0.112325	0.00510419	0.994896	0.112322	15
Chad	0.23942536	46.668166	0.239425	0.00510419	0.994896	0.239419	4
Ethiopia	0.09297577	18.122595	0.092976	0.00510419	0.994896	0.092973	21
Ghana	0.10577093	20.616593	0.105771	0.00510419	0.994896	0.105768	18
Gabon	0.18964326	36.964768	0.189643	0.00510419	0.994896	0.189638	6
Madagascar	0.0808504	15.759148	0.08085	0.00510419	0.994896	0.080848	25
Mali	0.08859764	17.269221	0.088598	0.00510419	0.994896	0.088595	23
Mauritius	0.07022378	13.687835	0.070224	0.00510419	0.994896	0.070222	27
Mozambique	0.15983667	31.154946	0.159837	0.00510419	0.994896	0.159832	9
Namibia	0.07875205	15.350144	0.078752	0.00510419	0.994896	0.07875	26
Nigeria	0.27081116	52.785804	0.270811	0.00510419	0.994896	0.270804	3
Senegal	0.12882779	25.110776	0.128828	0.00510419	0.994896	0.128824	12
South Africa	0.41707574	81.295315	0.417076	0.00510419	0.994896	0.417065	1
Sudan	0.16016378	31.218706	0.160164	0.00510419	0.994896	0.16016	8
Tanzania	0.10800566	21.052181	0.108006	0.00510419	0.994896	0.108003	16
Zambia	0.05467415	10.6569433	0.054674	0.00510419	0.994896	0.054673	28
AI	1	194.917393	1	0.00510419	0.994896	0.999974	0

Table 76

Calculate the AI and the AAI by MARCOS method wit CRITIC weights for 2020

Country Name	GDP	EXP	FDI	IMP	INF	UEM
AAI	181360979	133258587	0.040557	1.039611	255.305	25.54
AI	4.7451711	1.0605911	21.95791	614607193.6	0.405655	0.552

Table 77

The results of MARCOS method for 2020 with CRITIC weight

Country Name	S_i	K_i^-	K_i^+	$f(K_i^-)$	$f(K_i^+)$	$f(K_i)$	Rank
AAI	0.0065	1.0000	0.0065	0.0064	0.9936	0.0065	
Angola	0.1354	20.9327	0.1354	0.0064	0.9936	0.1354	19
Burundi	0.3711	57.3553	0.3711	0.0064	0.9936	0.3711	1
Congo, Rep.	0.1812	28.0088	0.1812	0.0064	0.9936	0.1812	13
Cote d'Ivoire	0.1671	25.8256	0.1671	0.0064	0.9936	0.1671	16
Gambia	0.2109	32.5924	0.2109	0.0064	0.9936	0.2109	10
Guinea	0.0565	8.7290	0.0565	0.0064	0.9936	0.0565	29
Kenya	0.0869	13.4333	0.0869	0.0064	0.9936	0.0869	24
Mauritania	0.1811	27.9835	0.1811	0.0064	0.9936	0.1811	14
Niger	0.3155	48.7674	0.3155	0.0064	0.9936	0.3155	2
Rwanda	0.0851	13.1566	0.0851	0.0064	0.9936	0.0851	25
Sierra Leone	0.1816	28.0740	0.1816	0.0064	0.9936	0.1816	12
Togo	0.2321	35.8707	0.2321	0.0064	0.9936	0.2321	8
Zimbabwe	0.0547	8.4590	0.0547	0.0064	0.9936	0.0547	30
Benin	0.2225	34.3898	0.2225	0.0064	0.9936	0.2225	9
Cameroon	0.1165	18.0093	0.1165	0.0064	0.9936	0.1165	22
Chad	0.2538	39.2326	0.2538	0.0064	0.9936	0.2538	6
Ethiopia	0.1066	16.4749	0.1066	0.0064	0.9936	0.1066	23
Ghana	0.1520	23.4899	0.1520	0.0064	0.9936	0.1520	17
Gabon	0.1676	25.8973	0.1676	0.0064	0.9936	0.1676	15
Madagascar	0.1333	20.5978	0.1333	0.0064	0.9936	0.1333	20
Mali	0.1867	28.8595	0.1867	0.0064	0.9936	0.1867	11
Mauritius	0.2561	39.5880	0.2561	0.0064	0.9936	0.2561	5
Mozambique	0.3017	46.6274	0.3017	0.0064	0.9936	0.3017	3
Namibia	0.0631	9.7460	0.0631	0.0064	0.9936	0.0631	27
Nigeria	0.2460	38.0244	0.2460	0.0064	0.9936	0.2460	7
Senegal	0.1502	23.2085	0.1502	0.0064	0.9936	0.1502	18
South Africa	0.2672	41.2971	0.2672	0.0064	0.9936	0.2672	4
Sudan	0.0610	9.4224	0.0610	0.0064	0.9936	0.0610	28
Tanzania	0.1282	19.8196	0.1282	0.0064	0.9936	0.1282	21
Zambia	0.0783	12.1088	0.0783	0.0064	0.9936	0.0783	26
AI	1.0000	154.5519	1.0000	0.0064	0.9936	1.0000	0

Table 78

Calculate the AI and the AAI by MARCOS method wit CRITIC weights for 2021

Country Name	GDP	EXP	FDI	IMP	INF	UEM
AAI	2038414974	131923344	0.357862	1.04911	359.093	28.77
AI	4.4083411	1.307111	33.56454	642720122	0.391347	0.668

Table 79

The results of MARCOS method for 2021 with CRITIC weight

Country Name	S_i	K_i^-	K_i^+	$f(K_i^-)$	$f(K_i^+)$	$f(K_i)$	Rank
AAI	0.0084242	1	0.008424	0.0083538	0.991646	0.008424	
Angola	0.1134482	13.466977	0.113448	0.0083538	0.991646	0.11344	18
Burundi	0.239169	28.390786	0.239169	0.0083538	0.991646	0.239152	6
Congo, Rep.	0.1052276	12.491144	0.105228	0.0083538	0.991646	0.10522	23
Cote d'Ivoire	0.1218482	14.464108	0.121848	0.0083538	0.991646	0.12184	13
Gambia	0.218963	25.992212	0.218963	0.0083538	0.991646	0.218948	8
Guinea	0.0551763	6.5497581	0.055176	0.0083538	0.991646	0.055172	29
Kenya	0.0922896	10.955331	0.09229	0.0083538	0.991646	0.092283	25
Mauritania	0.1205305	14.307686	0.12053	0.0083538	0.991646	0.120522	14
Niger	0.260197	30.886939	0.260197	0.0083538	0.991646	0.260179	3
Rwanda	0.2564214	30.438753	0.256421	0.0083538	0.991646	0.256403	4
Sierra Leone	0.1174223	13.938732	0.117422	0.0083538	0.991646	0.117414	16
Togo	0.0931652	11.059271	0.093165	0.0083538	0.991646	0.093159	24
Zimbabwe	0.0472182	5.6050765	0.047218	0.0083538	0.991646	0.047215	30
Benin	0.1568601	18.620227	0.15686	0.0083538	0.991646	0.156849	10
Cameroon	0.1112936	13.211209	0.111294	0.0083538	0.991646	0.111286	20
Chad	0.248149	29.456769	0.248149	0.0083538	0.991646	0.248132	5
Ethiopia	0.1112468	13.205655	0.111247	0.0083538	0.991646	0.111239	21
Ghana	0.1137467	13.502412	0.113747	0.0083538	0.991646	0.113739	17
Gabon	0.1681658	19.962283	0.168166	0.0083538	0.991646	0.168154	9
Madagascar	0.1085996	12.891422	0.1086	0.0083538	0.991646	0.108592	22
Mali	0.1116543	13.254032	0.111654	0.0083538	0.991646	0.111646	19
Mauritius	0.0714066	8.476393	0.071407	0.0083538	0.991646	0.071402	27
Mozambique	0.2713656	32.212716	0.271366	0.0083538	0.991646	0.271347	2
Namibia	0.0833879	9.8986359	0.083388	0.0083538	0.991646	0.083382	26
Nigeria	0.2348037	27.872605	0.234804	0.0083538	0.991646	0.234787	7
Senegal	0.1543517	18.322468	0.154352	0.0083538	0.991646	0.154341	11
South Africa	0.3497657	41.519274	0.349766	0.0083538	0.991646	0.349741	1
Sudan	0.1477422	17.537885	0.147742	0.0083538	0.991646	0.147732	12
Tanzania	0.1186184	14.08071	0.118618	0.0083538	0.991646	0.11861	15
Zambia	0.0597755	7.0957076	0.059775	0.0083538	0.991646	0.059771	28
AI	1	118.70596	1	0.0083538	0.991646	0.99993	0

Table 80

Calculate the AI and the AAI using MARCOS method with MEREC weights for 2020

Country Name	GDP	EXP	FDI	IMP	INF	UEM
AAI	1812170878	120542434	0.329176	7.83310	557.2018	24.34
AI	4.3219911	9.318410	22.5187	588865206	0.438089	0.68

Table 81

The results of MARCOS method for 2020 when the weight calculation by MEREC

	S_i	K_i^-	K_i^+	$f(K_i^-)$	$f(K_i^+)$	$f(K_i)$	Rank
AAI	0.0066027	1	0.006603	0.0065594	0.993441	0.006602	
Angola	0.0997283	15.104106	0.099728	0.0065594	0.993441	0.099724	22
Burundi	0.2349857	35.589174	0.234986	0.0065594	0.993441	0.234975	4
Congo, Rep.	0.1739028	26.338014	0.173903	0.0065594	0.993441	0.173895	8
Cote d'Ivoire	0.1460925	22.126072	0.146092	0.0065594	0.993441	0.146086	10
Gambia	0.1932035	29.261159	0.193203	0.0065594	0.993441	0.193195	6
Guinea	0.0586035	8.8756516	0.058604	0.0065594	0.993441	0.058601	28
Kenya	0.1045887	15.840224	0.104589	0.0065594	0.993441	0.104584	20
Mauritania	0.1261276	19.102337	0.126128	0.0065594	0.993441	0.126122	13
Niger	0.1984047	30.048894	0.198405	0.0065594	0.993441	0.198396	5
Rwanda	0.0548101	8.3011263	0.05481	0.0065594	0.993441	0.054808	29
Sierra Leone	0.1042742	15.792597	0.104274	0.0065594	0.993441	0.10427	21
Togo	0.1359287	20.586743	0.135929	0.0065594	0.993441	0.135923	11
Zimbabwe	0.0472836	7.1612208	0.047284	0.0065594	0.993441	0.047282	30
Benin	0.1258234	19.056271	0.125823	0.0065594	0.993441	0.125818	14
Cameroon	0.1173565	17.773939	0.117356	0.0065594	0.993441	0.117351	17
Chad	0.1222224	18.510895	0.122222	0.0065594	0.993441	0.122217	16
Ethiopia	0.096892	14.674544	0.096892	0.0065594	0.993441	0.096888	23
Ghana	0.1102449	16.696874	0.110245	0.0065594	0.993441	0.11024	18
Gabon	0.1801644	27.286358	0.180164	0.0065594	0.993441	0.180157	7
Madagascar	0.1049541	15.895569	0.104954	0.0065594	0.993441	0.10495	19
Mali	0.3463081	52.449245	0.346308	0.0065594	0.993441	0.346293	2
Mauritius	0.094086	14.249562	0.094086	0.0065594	0.993441	0.094082	25
Mozambique	0.1577329	23.889049	0.157733	0.0065594	0.993441	0.157726	9
Namibia	0.0948027	14.358104	0.094803	0.0065594	0.993441	0.094799	24
Nigeria	0.2762718	41.84207	0.276272	0.0065594	0.993441	0.27626	3
Senegal	0.1266121	19.175729	0.126612	0.0065594	0.993441	0.126607	12
South Africa	0.3956768	59.92626	0.395677	0.0065594	0.993441	0.39566	1
Sudan	0.0907125	13.738633	0.090712	0.0065594	0.993441	0.090709	26
Tanzania	0.1243035	18.826086	0.124304	0.0065594	0.993441	0.124298	15
Zambia	0.0663737	10.052466	0.066374	0.0065594	0.993441	0.066371	27
AI	1	151.45253	1	0.0065594	0.993441	0.999957	0

Table 82

Calculate the AI and the AAI using MARCOS method with MEREC weights for 2021

Country Name	GDP	EXP	FDI	IMP	INF	UEM
AAI	2038414974	131923344	0.357862	1.0511	359.093	28.77
AI	4.408311	1.30711	33.56454	6.4308	0.391347	0.668

Table 83

The results of MARCOS method for 2021 when the weight calculation by MEREC

	S_i	K_i^-	K_i^+	$f(K_i^-)$	$f(K_i^+)$	$f(K_i)$	Rank
AAI	0.00606	1	0.00606	0.006023	0.993977	0.00606	
Angola	0.114092	18.82772	0.114092	0.006023	0.993977	0.114088	14
Burundi	0.237198	39.14279	0.237198	0.006023	0.993977	0.237189	4
Congo, Rep.	0.109129	18.00857	0.109129	0.006023	0.993977	0.109125	17
Cote d'Ivoire	0.117818	19.44254	0.117818	0.006023	0.993977	0.117814	13
Gambia	0.202782	33.46347	0.202782	0.006023	0.993977	0.202775	6
Guinea	0.052716	8.699276	0.052716	0.006023	0.993977	0.052714	29
Kenya	0.095514	15.76183	0.095514	0.006023	0.993977	0.09551	20
Mauritania	0.091331	15.07155	0.091331	0.006023	0.993977	0.091327	24
Niger	0.192471	31.76185	0.192471	0.006023	0.993977	0.192464	7
Rwanda	0.290113	47.87488	0.290113	0.006023	0.993977	0.290102	2
Sierra Leone	0.10388	17.14244	0.10388	0.006023	0.993977	0.103876	19
Togo	0.091001	15.01705	0.091001	0.006023	0.993977	0.090997	25
Zimbabwe	0.047529	7.843263	0.047529	0.006023	0.993977	0.047527	30
Benin	0.141448	23.34194	0.141448	0.006023	0.993977	0.141443	11
Cameroon	0.108254	17.8642	0.108254	0.006023	0.993977	0.10825	18
Chad	0.226007	37.29602	0.226007	0.006023	0.993977	0.225999	5
Ethiopia	0.095142	15.70051	0.095142	0.006023	0.993977	0.095139	21
Ghana	0.113223	18.68425	0.113223	0.006023	0.993977	0.113219	15
Gabon	0.169668	27.99879	0.169668	0.006023	0.993977	0.169661	9
Madagascar	0.091707	15.13358	0.091707	0.006023	0.993977	0.091703	23
Mali	0.0948	15.64402	0.0948	0.006023	0.993977	0.094796	22
Mauritius	0.069719	11.50521	0.069719	0.006023	0.993977	0.069717	27
Mozambique	0.154658	25.52197	0.154658	0.006023	0.993977	0.154653	10
Namibia	0.073367	12.10708	0.073367	0.006023	0.993977	0.073364	26
Nigeria	0.262115	43.25457	0.262115	0.006023	0.993977	0.262105	3
Senegal	0.123866	20.44064	0.123866	0.006023	0.993977	0.123862	12
South Africa	0.425221	70.17065	0.425221	0.006023	0.993977	0.425206	1
Sudan	0.177384	29.27211	0.177384	0.006023	0.993977	0.177377	8
Tanzania	0.111528	18.40445	0.111528	0.006023	0.993977	0.111523	16
Zambia	0.061987	10.22923	0.061987	0.006023	0.993977	0.061985	28
AI	1	165.0215	1	0.006023	0.993977	0.999964	0

Appendix C. Applying the MOORA Method

Table 84

Weighted Normalized Matrix using MOORA weighted with Entropy for 2020

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	5115.3882	3917.735	-0.03406	1308.295	0.1937	0.978762
Burundi	269.78053	24.711138	0.003018	88.44488	0.063673	0.097403
Congo, Rep.	1067.3552	1225.2262	-0.17347	667.747	0.015615	2.129351
Cote d'Ivoire	6412.6699	2712.4988	0.010379	1901.496	0.021091	0.251547
Gambia	184.50846	35.744391	0.095924	103.0978	0.051585	0.48191
Guinea	1443.5342	1356.5706	0.011405	1455.751	0.092204	0.562197
Kenya	10248.571	1989.2712	0.003883	2660.209	0.047007	0.531085
Mauritania	855.81644	700.65374	0.101225	681.6578	0.020749	1.053185
Niger	1399.3804	289.79925	0.024061	532.1054	0.025206	0.064305
Rwanda	1035.7692	403.08972	0.013756	548.0241	0.085671	1.230308
Sierra Leone	413.66993	125.69258	0.038976	222.5318	0.11695	0.337791
Togo	752.35388	359.03798	-0.00735	360.7918	0.014779	0.380913
Zimbabwe	2190.037	1142.8049	0.00641	928.2829	4.846093	0.746885
Benin	1593.5818	637.61991	0.010195	586.7754	0.026289	0.15802
Cameroon	4151.3789	1273.487	0.015184	1133.124	0.0212	0.373253
Chad	1091.0015	586.86049	0.047723	676.1783	0.038826	0.155562
Ethiopia	10961.308	1572.9576	0.020406	2729.27	0.177043	0.390181
Ghana	7131.526	2975.2934	0.024556	1872.147	0.085992	0.356893
Gabon	1559.273	1491.4028	0.102774	518.811	0.011765	2.054549
Madagascar	1328.8489	538.90904	0.025185	565.9023	0.036544	0.22346
Mali	1778.261	1097.629	0.028185	953.1203	0.00381	0.333819
Mauritius	1160.8113	920.25636	0.018069	796.4225	0.022446	0.816108
Mozambique	1441.399	850.96839	0.206484	1397.805	0.0303	0.357083
Namibia	1077.5977	730.69631	-0.01301	687.4737	0.019215	2.008211
Nigeria	44004.879	7192.8701	0.005061	5344.964	0.115203	0.567304
Senegal	2497.6051	1040.9776	0.068991	1449.665	0.022118	0.331833
South Africa	34375.162	19102.678	0.008565	11764.82	0.027918	2.301745
Sudan	2752.5612	284.04883	0.024317	196.1141	1.419885	1.824374
Tanzania	6726.8717	1828.9725	0.009505	1434.813	0.028616	0.262894
Zambia	1843.9575	1737.1653	0.012415	885.0049	0.136834	0.570235

Table 85

The results of MOORA method weighted with Entropy for 2020

Country Name	Assessment value	Rank
Angola	7723.6213	6
Burundi	205.88873	29
Congo, Rep.	1622.516	17
Cote d'Ivoire	7223.4109	7
Gambia	116.71744	30
Guinea	1343.7105	18
Kenya	9577.0592	4
Mauritania	873.8397	26
Niger	1157.0088	21
Rwanda	889.53255	25
Sierra Leone	316.41494	28
Togo	750.19705	27
Zimbabwe	2398.9724	13
Benin	1644.2522	16
Cameroon	4291.3627	9
Chad	1001.537	23
Ethiopia	9804.4486	3
Ghana	8234.2537	5
Gabon	2529.9012	12
Madagascar	1301.6208	19
Mali	1922.4602	15
Mauritius	1283.8248	20
Mozambique	894.38116	24
Namibia	1118.7799	22
Nigeria	45852.108	1
Senegal	2088.633	14
South Africa	41710.703	2
Sudan	2837.276	10
Tanzania	7120.7492	8
Zambia	2695.4232	11

Table 86

Weighted Normalized Matrix using MOORA weighted with Entropy for 2021

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	6541.189	6199.88	0.041025	1712.722	0.222122	0.945984
Burundi	276.4239	28.83456	0.002214	103.7183	0.072486	0.103125
Congo, Rep.	1331.057	1623.23	0.024627	779.1272	0.014797	2.025613
Cote d'Ivoire	7151.202	3370.028	0.011998	2538.61	0.035292	0.256629
Gambia	202.9926	27.40639	0.07644	113.9078	0.063567	0.45377
Guinea	1602.48	1437.144	0.007598	1585.666	0.108647	0.530203
Kenya	10924.68	2455.475	0.002613	3427.354	0.052705	0.514169
Mauritania	995.4611	819.296	0.066247	955.6493	0.030748	1.028248
Niger	1485.289	318.6484	0.024677	637.0618	0.0331	0.060855
Rwanda	1100.924	448.8619	0.01186	609.8426	0.003375	1.212999
Sierra Leone	423.1539	149.4342	0.030912	276.3907	0.102409	0.336797
Togo	829.9341	402.3584	0.010114	418.0254	0.036105	0.380343
Zimbabwe	2825.309	1497.745	0.005452	1375.338	0.849926	0.734905
Benin	1761.641	768.7709	0.012102	753.0641	0.014951	0.159608
Cameroon	4514.948	1573.678	0.01315	1448.243	0.019594	0.375515
Chad	1173.092	948.3047	0.037036	817.4525	0.006666	0.140112
Ethiopia	11079.85	1763.997	0.023688	2909.15	0.231482	0.358024
Ghana	7882.676	4918.108	0.020424	3541.827	0.085997	0.357022
Gabon	2013.375	2332.868	0.0468	526.046	0.009374	1.989264
Madagascar	1449.414	688.6204	0.0152	723.4077	0.050129	0.210441
Mali	1922.905	1117.874	0.020506	1191.765	0.033857	0.237134
Mauritius	1142.864	1054.745	0.013651	972.1198	0.034745	0.697463
Mozambique	1571.106	1028.626	0.207681	1703.612	0.055271	0.358844
Namibia	1239.446	823.7263	0.034338	979.1106	0.031195	1.937519
Nigeria	43899.77	9834.372	0.00465	8186.748	0.146213	0.540771
Senegal	2745.433	1408.415	0.058087	1926.052	0.018805	0.318668
South Africa	41727.07	27153.69	0.06004	16449.21	0.039774	2.620952
Sudan	3408.697	159.9884	0.009452	100.8271	3.097055	1.735459
Tanzania	7036.138	2072.585	0.009046	1750.758	0.031833	0.249615
Zambia	2205.542	2396.157	0.007583	1178.309	0.189922	0.566643

Table 87

The results of MOORA method weighted with Entropy for 2021

Country Name	Assessment value	Rank
Angola	11027.22	3
Burundi	201.3668	29
Congo, Rep.	2173.144	15
Cote d'Ivoire	7982.339	7
Gambia	116.0503	30
Guinea	1453.327	18
Kenya	9952.237	4
Mauritania	858.1152	26
Niger	1166.806	22
Rwanda	938.739	24
Sierra Leone	295.7891	28
Togo	813.8608	27
Zimbabwe	2946.136	13
Benin	1777.186	17
Cameroon	4640	9
Chad	1303.835	20
Ethiopia	9934.135	5
Ghana	9258.535	6
Gabon	3818.245	10
Madagascar	1414.381	19
Mali	1848.763	16
Mauritius	1224.771	21
Mozambique	895.9129	25
Namibia	1082.127	23
Nigeria	45546.72	2
Senegal	2227.516	14
South Africa	52428.94	1
Sudan	3463.035	11
Tanzania	7357.693	8
Zambia	3422.641	12

Table 88

Weighted Normalized Matrix using MOORA weighted with CRITIC for 2020

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	4103.9725	2679.475	-0.07554	1238.923	0.095989	2.942208
Burundi	216.43947	16.9008	0.006693	83.75511	0.031553	0.292799
Congo, Rep.	856.31753	837.9746	-0.38466	632.3399	0.007738	6.400938
Cote d'Ivoire	5144.7554	1855.172	0.023016	1800.669	0.010452	0.756162
Gambia	148.02741	24.44683	0.212712	97.6311	0.025563	1.448647
Guinea	1158.1183	927.8056	0.025291	1378.56	0.045692	1.689993
Kenya	8222.2211	1360.531	0.008612	2519.152	0.023294	1.596468
Mauritania	686.60423	479.2013	0.224467	645.513	0.010282	3.16593
Niger	1122.6946	198.2037	0.053355	503.8906	0.012491	0.193305
Rwanda	830.97668	275.687	0.030504	518.9653	0.042455	3.69837
Sierra Leone	331.87902	85.9655	0.086429	210.7321	0.057955	1.015417
Togo	603.59831	245.5585	-0.01629	341.6609	0.007324	1.145045
Zimbabwe	1757.0224	781.6038	0.014214	879.061	2.401499	2.245175
Benin	1278.4985	436.0903	0.022607	555.6618	0.013028	0.475017
Cameroon	3330.5674	870.9819	0.033671	1073.04	0.010506	1.122019
Chad	875.28849	401.3742	0.105826	640.3241	0.01924	0.467626
Ethiopia	8794.0357	1075.8	0.045249	2584.551	0.087734	1.172904
Ghana	5721.4791	2034.906	0.054453	1772.877	0.042614	1.07284
Gabon	1250.9732	1020.022	0.227902	491.3012	0.00583	6.176079
Madagascar	1066.1086	368.5785	0.055847	535.8955	0.018109	0.671733
Mali	1426.6628	750.7064	0.0625	902.5813	0.001888	1.003478
Mauritius	931.29548	629.3952	0.040069	754.1923	0.011123	2.453262
Mozambique	1156.4053	582.0067	0.457878	1323.687	0.015016	1.073409
Namibia	864.53486	499.7485	-0.02885	651.0205	0.009522	6.036786
Nigeria	35304.225	4919.453	0.011222	5061.549	0.057089	1.705344
Senegal	2003.7781	711.9606	0.152986	1372.797	0.010961	0.997508
South Africa	27578.497	13064.98	0.018992	11140.99	0.013835	6.919164
Sudan	2208.3242	194.2708	0.053922	185.7152	0.703629	5.484163
Tanzania	5396.8332	1250.898	0.021078	1358.732	0.014181	0.790274
Zambia	1479.3698	1188.107	0.02753	838.0777	0.067808	1.714156

Table 89

The results of MOORA method weighted with CRITIC for 2020

Country Name	Assessment value	Rank
Angola	5541.41	6
Burundi	149.2675	29
Congo, Rep.	1055.1589	17
Cote d'Ivoire	5198.5144	8
Gambia	73.581635	30
Guinea	705.65304	22
Kenya	7061.9899	4
Mauritania	517.3408	25
Niger	816.8553	19
Rwanda	583.98809	24
Sierra Leone	206.12548	28
Togo	506.32728	26
Zimbabwe	1654.9328	13
Benin	1158.4616	16
Cameroon	3127.4101	9
Chad	635.95752	23
Ethiopia	7284.0693	3
Ghana	5982.4471	5
Gabon	1773.74	12
Madagascar	898.15768	18
Mali	1273.8451	15
Mauritius	804.07401	20
Mozambique	414.09444	27
Namibia	707.18766	21
Nigeria	35160.378	1
Senegal	1342.0867	14
South Africa	29495.577	2
Sudan	2210.746	10
Tanzania	5288.215	7
Zambia	1827.6451	11

Table 90

Weighted Normalized Matrix using MOORA weighted with CRITIC for 2021

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	5714.131	3851.052	0.081053	1478.49	0.148154	2.327082
Burundi	241.4733	17.91057	0.004375	89.5338	0.048348	0.253684
Congo, Rep.	1162.76	1008.269	0.048655	672.574	0.009869	4.982923
Cote d'Ivoire	6247.015	2093.291	0.023704	2191.431	0.023539	0.631297
Gambia	177.3265	17.02347	0.151022	98.3298	0.042399	1.116255
Guinea	1399.865	892.6811	0.015012	1368.811	0.072467	1.304278
Kenya	9543.381	1525.217	0.005163	2958.63	0.035154	1.264836
Mauritania	869.5966	508.9054	0.130884	824.9549	0.020509	2.529447
Niger	1297.491	197.9283	0.048754	549.9374	0.022078	0.149701
Rwanda	961.7251	278.8103	0.023431	526.4406	0.002251	2.983927
Sierra Leone	369.651	92.82102	0.061074	238.5916	0.068306	0.828508
Togo	724.9985	249.9247	0.019981	360.8563	0.024082	0.935629
Zimbabwe	2468.081	930.3235	0.010772	1187.247	0.566898	1.807836
Benin	1538.902	477.5217	0.023909	650.0752	0.009972	0.392628
Cameroon	3944.085	977.4892	0.02598	1250.182	0.013069	0.923751
Chad	1024.768	589.039	0.073172	705.6579	0.004446	0.34467
Ethiopia	9678.934	1095.706	0.0468	2511.295	0.154397	0.880724
Ghana	6886.003	3054.881	0.040351	3057.448	0.05736	0.878258
Gabon	1758.807	1449.06	0.092464	454.104	0.006253	4.893506
Madagascar	1266.152	427.7362	0.03003	624.4746	0.033436	0.517677
Mali	1679.776	694.3669	0.040514	1028.78	0.022582	0.583339
Mauritius	998.3621	655.1546	0.02697	839.1729	0.023175	1.71573
Mozambique	1372.457	638.9303	0.410316	1470.626	0.036866	0.88274
Namibia	1082.732	511.6572	0.067841	845.2077	0.020807	4.766216
Nigeria	38349.16	6108.616	0.009188	7067.13	0.097523	1.330274
Senegal	2398.304	874.8363	0.114763	1662.645	0.012543	0.783911
South Africa	36451.16	16866.5	0.118621	14199.62	0.026529	6.447434
Sudan	2977.706	99.3767	0.018674	87.038	2.065724	4.269156
Tanzania	6146.5	1287.385	0.017871	1511.325	0.021232	0.614041
Zambia	1926.676	1488.372	0.014982	1017.164	0.126677	1.393919

Table 91

The results of MOORA method weighted with CRITIC for 2021

Country Name	Assessment value	Rank
Angola	8084.299	5
Burundi	169.5524	29
Congo, Rep.	1493.51	15
Cote d'Ivoire	6148.245	7
Gambia	95.01257	30
Guinea	922.3738	20
Kenya	8108.673	4
Mauritania	551.128	26
Niger	945.3592	19
Rwanda	711.1321	24
Sierra Leone	223.0446	28
Togo	613.1272	25
Zimbabwe	2208.794	13
Benin	1365.97	16
Cameroon	3670.481	9
Chad	907.8736	21
Ethiopia	8262.357	3
Ghana	6882.541	6
Gabon	2748.955	11
Madagascar	1068.893	18
Mali	1344.797	17
Mauritius	812.6319	22
Mozambique	540.2521	27
Namibia	744.4627	23
Nigeria	37389.22	2
Senegal	1609.814	14
South Africa	39111.68	1
Sudan	2983.729	10
Tanzania	5921.943	8
Zambia	2396.379	12

Table 92

Weighted Normalized Matrix using MOORA weighted with MEREC for 2020

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	4779.7884	5556.8573	-0.0233	1585.0773	0.1476	0.0553
Burundi	252.0813	35.0499	0.0021	107.1562	0.0485	0.0055
Congo, Rep.	997.3304	1737.8427	-0.1187	809.0150	0.0119	0.1202
Cote d'Ivoire	5991.9607	3847.3681	0.0071	2303.7745	0.0161	0.0142
Gambia	172.4036	50.6993	0.0656	124.9091	0.0393	0.0272
Guinea	1348.8298	1924.1396	0.0078	1763.7289	0.0703	0.0317
Kenya	9576.2037	2821.5529	0.0027	3223.0001	0.0358	0.0300
Mauritania	799.6698	993.7969	0.0693	825.8688	0.0158	0.0595
Niger	1307.5728	411.0470	0.0165	644.6772	0.0192	0.0036
Rwanda	967.8166	571.7365	0.0094	663.9637	0.0653	0.0695
Sierra Leone	386.5307	178.2805	0.0267	269.6105	0.0891	0.0191
Togo	702.9950	509.2542	-0.0050	437.1206	0.0113	0.0215
Zimbabwe	2046.3576	1620.9375	0.0044	1124.6698	3.6926	0.0422
Benin	1489.0334	904.3906	0.0070	710.9131	0.0200	0.0089
Cameroon	3879.0238	1806.2952	0.0104	1372.8467	0.0162	0.0211
Chad	1019.4254	832.3942	0.0327	819.2301	0.0296	0.0088
Ethiopia	10242.1811	2231.0598	0.0140	3306.6723	0.1349	0.0220
Ghana	6663.6556	4220.1121	0.0168	2268.2174	0.0655	0.0202
Gabon	1456.9754	2115.3836	0.0703	628.5702	0.0090	0.1160
Madagascar	1241.6686	764.3806	0.0172	685.6242	0.0278	0.0126
Mali	1661.5965	1556.8607	0.0193	1154.7617	0.0029	0.0188
Mauritius	1084.6552	1305.2780	0.0124	964.9130	0.0171	0.0461
Mozambique	1346.8347	1207.0010	0.1413	1693.5240	0.0231	0.0202
Namibia	1006.9009	1036.4088	-0.0089	832.9151	0.0146	0.1134
Nigeria	41117.8981	10202.2605	0.0035	6475.7405	0.0878	0.0320
Senegal	2333.7474	1476.5072	0.0472	1756.3546	0.0169	0.0187
South Africa	32119.9473	27094.9553	0.0059	14253.7703	0.0213	0.1300
Sudan	2571.9769	402.8907	0.0166	237.6038	1.0819	0.1030
Tanzania	6285.5491	2594.1875	0.0065	1738.3610	0.0218	0.0148
Zambia	1722.9829	2463.9695	0.0085	1072.2359	0.1043	0.0322

Table 93

The results of MOORA method weighted with MEREC for 2020

Country Name	Assessment value	Rank
Angola	8751.3422	5
Burundi	179.92308	29
Congo, Rep.	1925.9073	16
Cote d'Ivoire	7535.5312	7
Gambia	98.192897	30
Guinea	1509.1463	18
Kenya	9174.6933	3
Mauritania	967.59192	24
Niger	1073.9362	22
Rwanda	875.46405	25
Sierra Leone	295.11925	28
Togo	775.09077	27
Zimbabwe	2538.8949	13
Benin	1682.4889	17
Cameroon	4312.4454	9
Chad	1032.5838	23
Ethiopia	9166.4256	4
Ghana	8615.4814	6
Gabon	2943.7341	11
Madagascar	1320.4017	20
Mali	2063.6931	14
Mauritius	1424.9695	19
Mozambique	860.40974	26
Namibia	1210.2578	21
Nigeria	44844.302	2
Senegal	2053.9116	15
South Africa	44960.987	1
Sudan	2736.0954	12
Tanzania	7141.3455	8
Zambia	3114.5886	10

Table 94

Weighted Normalized Matrix using MOORA weighted with MEREC for 2021

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	5576.422	7639.799	0.037	1939.863	0.173	0.059
Burundi	235.654	35.531	0.002	117.473	0.057	0.006
Congo, Rep.	1134.738	2000.224	0.022	882.455	0.012	0.127
Cote d'Ivoire	6096.464	4152.715	0.011	2875.281	0.028	0.016
Gambia	173.053	33.772	0.068	129.014	0.050	0.028
Guinea	1366.129	1770.920	0.007	1795.957	0.085	0.033
Kenya	9313.388	3025.758	0.002	3881.889	0.041	0.032
Mauritania	848.640	1009.577	0.059	1082.387	0.024	0.065
Niger	1266.222	392.654	0.022	721.549	0.026	0.004
Rwanda	938.548	553.110	0.011	690.720	0.003	0.076
Sierra Leone	360.742	184.140	0.028	313.046	0.080	0.021
Togo	707.526	495.806	0.009	473.464	0.028	0.024
Zimbabwe	2408.601	1845.595	0.005	1557.735	0.663	0.046
Benin	1501.815	947.318	0.011	852.935	0.012	0.010
Cameroon	3849.033	1939.164	0.012	1640.309	0.015	0.024
Chad	1000.072	1168.548	0.033	925.863	0.005	0.009
Ethiopia	9445.675	2173.685	0.021	3294.961	0.181	0.022
Ghana	6720.053	6060.337	0.018	4011.544	0.067	0.022
Gabon	1716.420	2874.675	0.042	595.810	0.007	0.125
Madagascar	1235.639	848.552	0.014	819.346	0.039	0.013
Mali	1639.294	1377.500	0.018	1349.817	0.026	0.015
Mauritius	974.302	1299.710	0.012	1101.042	0.027	0.044
Mozambique	1339.382	1267.523	0.186	1929.545	0.043	0.023
Namibia	1056.639	1015.036	0.031	1108.960	0.024	0.122
Nigeria	37424.953	12118.401	0.004	9272.473	0.114	0.034
Senegal	2340.506	1735.519	0.052	2181.484	0.015	0.020
South Africa	35572.699	33460.123	0.054	18630.707	0.031	0.164
Sudan	2905.945	197.146	0.008	114.199	2.415	0.109
Tanzania	5998.371	2553.942	0.008	1982.944	0.025	0.016
Zambia	1880.244	2952.664	0.007	1334.576	0.148	0.036

Table 95

The results of MOORA method weighted with MEREC for 2021

Country Name	Assessment value	Rank
Angola	11276.1633	3
Burundi	153.650824	29
Congo, Rep.	2252.39071	14
Cote d'Ivoire	7373.86587	7
Gambia	77.8007151	30
Guinea	1340.9804	18
Kenya	8457.18615	5
Mauritania	775.800301	25
Niger	937.320159	23
Rwanda	800.869772	24
Sierra Leone	231.76384	28
Togo	729.82546	26
Zimbabwe	2695.75737	13
Benin	1596.18657	17
Cameroon	4147.86125	9
Chad	1242.77608	20
Ethiopia	8324.21722	6
Ghana	8768.77423	4
Gabon	3995.19523	10
Madagascar	1264.80618	19
Mali	1666.9534	16
Mauritius	1172.91071	21
Mozambique	677.480862	27
Namibia	962.599957	22
Nigeria	40270.7365	2
Senegal	1894.55768	15
South Africa	50401.9736	1
Sudan	2986.37573	12
Tanzania	6569.33711	8
Zambia	3498.15449	11

Appendix D. Applying the TOPSIS Method

Table 96

Normalized matrix using TOPSIS for 2020 with Entropy weight

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.085621	0.179589	0.099253	0.091013	0.038241	0.181849
Burundi	0.004516	0.001133	0.008795	0.006153	0.01257	0.018097
Congo, Rep.	0.017865	0.056164	0.505424	0.046452	0.003083	0.395622
Cote d'Ivoire	0.107335	0.124341	0.030241	0.132279	0.004164	0.046736
Gambia	0.003088	0.001639	0.279493	0.007172	0.010184	0.089536
Guinea	0.024162	0.062185	0.033232	0.101271	0.018203	0.104453
Kenya	0.17154	0.091188	0.011315	0.18506	0.00928	0.098673
Mauritania	0.014325	0.032118	0.294939	0.04742	0.004096	0.195676
Niger	0.023423	0.013284	0.070106	0.037016	0.004976	0.011948
Rwanda	0.017337	0.018478	0.040081	0.038124	0.016913	0.228585
Sierra Leone	0.006924	0.005762	0.113564	0.015481	0.023088	0.06276
Togo	0.012593	0.016458	0.021407	0.025099	0.002918	0.070772
Zimbabwe	0.036657	0.052386	0.018676	0.064577	0.956722	0.138767
Benin	0.026673	0.029228	0.029705	0.04082	0.00519	0.029359
Cameroon	0.069485	0.058377	0.044242	0.078827	0.004185	0.069349
Chad	0.018261	0.026902	0.139051	0.047039	0.007665	0.028903
Ethiopia	0.183469	0.072104	0.059455	0.189864	0.034952	0.072494
Ghana	0.119367	0.136387	0.071549	0.130238	0.016977	0.066309
Gabon	0.026099	0.068366	0.299452	0.036092	0.002323	0.381725
Madagascar	0.022242	0.024704	0.07338	0.039368	0.007215	0.041518
Mali	0.029764	0.050315	0.082123	0.066305	0.000752	0.062022
Mauritius	0.01943	0.042185	0.052648	0.055404	0.004431	0.151629
Mozambique	0.024126	0.039008	0.60163	0.09724	0.005982	0.066344
Namibia	0.018037	0.033495	0.037909	0.047825	0.003794	0.373115
Nigeria	0.73655	0.329721	0.014745	0.371827	0.022744	0.105402
Senegal	0.041805	0.047718	0.201017	0.100847	0.004367	0.061653
South Africa	0.575369	0.875666	0.024955	0.81843	0.005512	0.427652
Sudan	0.046072	0.013021	0.070851	0.013643	0.280315	0.338959
Tanzania	0.112594	0.08384	0.027696	0.099814	0.005649	0.048844
Zambia	0.030864	0.079632	0.036173	0.061566	0.027014	0.105947

Table 97

The values of S_i^+ and S_i^-.

Country Name	S_i^+	S_i^-
Angola	0.179071	0.314204
Burundi	0.210943	0.325891
Congo, Rep.	0.199529	0.327195
Cote d'Ivoire	0.183571	0.322229
Gambia	0.207177	0.326721
Guinea	0.201443	0.318222
Kenya	0.181274	0.31836
Mauritania	0.202387	0.325596
Niger	0.205937	0.326353
Rwanda	0.207471	0.321398
Sierra Leone	0.208392	0.322037
Togo	0.207872	0.32714
Zimbabwe	0.362522	0.121179
Benin	0.204358	0.325923
Cameroon	0.195345	0.324058
Chad	0.203919	0.324988
Ethiopia	0.181621	0.310852
Ghana	0.179825	0.318747
Gabon	0.198146	0.326452
Madagascar	0.204698	0.325338
Mali	0.200686	0.325617
Mauritius	0.20375	0.324479
Mozambique	0.198555	0.325844
Namibia	0.206989	0.324307
Nigeria	0.119409	0.340443
Senegal	0.197889	0.322993
South Africa	0.143652	0.352732
Sudan	0.222937	0.248395
Tanzania	0.187316	0.323211
Zambia	0.198208	0.318032

Table 98

The results of TOPSIS method weighted with Entropy for 2020

Country Name	TOPSIS Score	Rank
Angola	0.636975	6
Burundi	0.607061	28
Congo, Rep.	0.621189	12
Cote d'Ivoire	0.637068	5
Gambia	0.611954	23
Guinea	0.61236	22
Kenya	0.637186	4
Mauritania	0.616679	15
Niger	0.613111	21
Rwanda	0.607709	26
Sierra Leone	0.607126	27
Togo	0.611462	24
Zimbabwe	0.250525	30
Benin	0.614623	17
Cameroon	0.623905	9
Chad	0.614452	18
Ethiopia	0.631205	8
Ghana	0.63932	3
Gabon	0.62229	10
Madagascar	0.613804	20
Mali	0.618687	14
Mauritius	0.614277	19
Mozambique	0.621366	11
Namibia	0.610407	25
Nigeria	0.740332	1
Senegal	0.620088	13
South Africa	0.710603	2
Sudan	0.527007	29
Tanzania	0.633093	7
Zambia	0.616054	16

Table 99

Normalized matrix using TOPSIS for 2021 with Entropy weight

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.100959	0.201014	0.153094	0.08508	0.068439	0.176631
Burundi	0.004266	0.000935	0.008263	0.005152	0.022334	0.019255
Congo, Rep.	0.020544	0.052629	0.0919	0.038704	0.004559	0.378215
Cote d'Ivoire	0.110375	0.109264	0.044772	0.126107	0.010874	0.047917
Gambia	0.003133	0.000889	0.285252	0.005658	0.019586	0.084726
Guinea	0.024733	0.046595	0.028355	0.078769	0.033476	0.098998
Kenya	0.168616	0.079612	0.009752	0.170255	0.016239	0.096004
Mauritania	0.015364	0.026563	0.247216	0.047472	0.009474	0.191991
Niger	0.022925	0.010331	0.092087	0.031646	0.010199	0.011363
Rwanda	0.016992	0.014553	0.044257	0.030294	0.00104	0.226487
Sierra Leone	0.006531	0.004845	0.115357	0.01373	0.031554	0.062886
Togo	0.01281	0.013045	0.037741	0.020766	0.011124	0.071016
Zimbabwe	0.043607	0.04856	0.020346	0.068321	0.261874	0.137219
Benin	0.02719	0.024925	0.04516	0.037409	0.004607	0.029801
Cameroon	0.069686	0.051022	0.049071	0.071942	0.006037	0.070115
Chad	0.018106	0.030746	0.138208	0.040607	0.002054	0.026161
Ethiopia	0.171011	0.057193	0.088396	0.144513	0.071323	0.066849
Ghana	0.121664	0.159456	0.076216	0.175942	0.026497	0.066662
Gabon	0.031075	0.075637	0.174647	0.026132	0.002888	0.371428
Madagascar	0.022371	0.022327	0.056721	0.035936	0.015445	0.039293
Mali	0.029679	0.036244	0.076524	0.059202	0.010432	0.044277
Mauritius	0.017639	0.034197	0.050941	0.048291	0.010705	0.130228
Mozambique	0.024249	0.03335	0.775011	0.084628	0.01703	0.067002
Namibia	0.01913	0.026707	0.128139	0.048638	0.009611	0.361767
Nigeria	0.677567	0.318852	0.017354	0.406681	0.04505	0.100971
Senegal	0.042374	0.045664	0.216765	0.095678	0.005794	0.059501
South Africa	0.644032	0.880383	0.224053	0.817123	0.012255	0.489375
Sudan	0.052611	0.005187	0.035271	0.005009	0.954244	0.324039
Tanzania	0.108599	0.067198	0.033756	0.08697	0.009808	0.046607
Zambia	0.034041	0.077689	0.028299	0.058533	0.058517	0.105802

Table 100

The values of S_i^+ and S_i^-.

Country Name	S_i^+	S_i^-
Angola	0.17781	0.29989
Burundi	0.218086	0.31522
Congo, Rep.	0.208159	0.317203
Cote d'Ivoire	0.191876	0.3142
Gambia	0.209096	0.31683
Guinea	0.209596	0.308018
Kenya	0.192518	0.311018
Mauritania	0.20568	0.316833
Niger	0.211616	0.317738
Rwanda	0.214084	0.318918
Sierra Leone	0.213488	0.311956
Togo	0.2144	0.317357
Zimbabwe	0.223063	0.242233
Benin	0.21098	0.31889
Cameroon	0.203115	0.316903
Chad	0.207768	0.319795
Ethiopia	0.192824	0.295987
Ghana	0.183738	0.30832
Gabon	0.200974	0.318833
Madagascar	0.211438	0.315694
Mali	0.208122	0.316166
Mauritius	0.210797	0.315853
Mozambique	0.195755	0.323199
Namibia	0.21031	0.315315
Nigeria	0.141582	0.323369
Senegal	0.200883	0.316589
South Africa	0.130992	0.35714
Sudan	0.367305	0.112272
Tanzania	0.197735	0.315764
Zambia	0.205017	0.301766

Table 101

The results of TOPSIS method weighted with Entropy for 2021

Country Name	TOPSIS Score	Rank
Angola	0.627779	3
Burundi	0.591068	28
Congo, Rep.	0.60378	15
Cote d'Ivoire	0.620856	6
Gambia	0.602424	17
Guinea	0.595072	26
Kenya	0.617668	7
Mauritania	0.606364	12
Niger	0.600237	19
Rwanda	0.598343	23
Sierra Leone	0.5937	27
Togo	0.596808	24
Zimbabwe	0.5206	29
Benin	0.601827	18
Cameroon	0.609408	11
Chad	0.606174	13
Ethiopia	0.605524	14
Ghana	0.626593	4
Gabon	0.613368	9
Madagascar	0.59889	22
Mali	0.603039	16
Mauritius	0.59974	21
Mozambique	0.622789	5
Namibia	0.599886	20
Nigeria	0.695491	2
Senegal	0.6118	10
South Africa	0.731646	1
Sudan	0.234107	30
Tanzania	0.614926	8
Zambia	0.595454	25

Table 102

Normalized matrix using TOPSIS for 2020 with CRITIC weight

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.085621	0.179589	0.099253	0.091013	0.038241	0.181849
Burundi	0.004516	0.001133	0.008795	0.006153	0.01257	0.018097
Congo, Rep.	0.017865	0.056164	0.505424	0.046452	0.003083	0.395622
Cote d'Ivoire	0.107335	0.124341	0.030241	0.132279	0.004164	0.046736
Gambia	0.003088	0.001639	0.279493	0.007172	0.010184	0.089536
Guinea	0.024162	0.062185	0.033232	0.101271	0.018203	0.104453
Kenya	0.17154	0.091188	0.011315	0.18506	0.00928	0.098673
Mauritania	0.014325	0.032118	0.294939	0.04742	0.004096	0.195676
Niger	0.023423	0.013284	0.070106	0.037016	0.004976	0.011948
Rwanda	0.017337	0.018478	0.040081	0.038124	0.016913	0.228585
Sierra Leone	0.006924	0.005762	0.113564	0.015481	0.023088	0.06276
Togo	0.012593	0.016458	0.021407	0.025099	0.002918	0.070772
Zimbabwe	0.036657	0.052386	0.018676	0.064577	0.956722	0.138767
Benin	0.026673	0.029228	0.029705	0.04082	0.00519	0.029359
Cameroon	0.069485	0.058377	0.044242	0.078827	0.004185	0.069349
Chad	0.018261	0.026902	0.139051	0.047039	0.007665	0.028903
Ethiopia	0.183469	0.072104	0.059455	0.189864	0.034952	0.072494
Ghana	0.119367	0.136387	0.071549	0.130238	0.016977	0.066309
Gabon	0.026099	0.068366	0.299452	0.036092	0.002323	0.381725
Madagascar	0.022242	0.024704	0.07338	0.039368	0.007215	0.041518
Mali	0.029764	0.050315	0.082123	0.066305	0.000752	0.062022
Mauritius	0.01943	0.042185	0.052648	0.055404	0.004431	0.151629
Mozambique	0.024126	0.039008	0.60163	0.09724	0.005982	0.066344
Namibia	0.018037	0.033495	0.037909	0.047825	0.003794	0.373115
Nigeria	0.73655	0.329721	0.014745	0.371827	0.022744	0.105402
Senegal	0.041805	0.047718	0.201017	0.100847	0.004367	0.061653
South Africa	0.575369	0.875666	0.024955	0.81843	0.005512	0.427652
Sudan	0.046072	0.013021	0.070851	0.013643	0.280315	0.338959
Tanzania	0.112594	0.08384	0.027696	0.099814	0.005649	0.048844
Zambia	0.030864	0.079632	0.036173	0.061566	0.027014	0.105947

Table 103

The values of S_i^+ and S_i^-.

Country Name	S_i^+	S_i^-
Angola	0.177775	0.195173
Burundi	0.204977	0.211638
Congo, Rep.	0.158013	0.230984
Cote d'Ivoire	0.188532	0.206207
Gambia	0.162698	0.217573
Guinea	0.197344	0.200244
Kenya	0.190797	0.200125
Mauritania	0.161632	0.212029
Niger	0.191881	0.212482
Rwanda	0.202476	0.196317
Sierra Leone	0.186377	0.207809
Togo	0.201686	0.208181
Zimbabwe	0.265696	0.102009
Benin	0.198203	0.210381
Cameroon	0.191463	0.206176
Chad	0.179865	0.212253
Ethiopia	0.181319	0.198368
Ghana	0.179455	0.203569
Gabon	0.171161	0.208086
Madagascar	0.190926	0.209728
Mali	0.187794	0.208216
Mauritius	0.196062	0.20159
Mozambique	0.135893	0.25386
Namibia	0.210695	0.193995
Nigeria	0.165307	0.219535
Senegal	0.167447	0.211089
South Africa	0.19242	0.213299
Sudan	0.207983	0.153802
Tanzania	0.190299	0.206951
Zambia	0.195387	0.200628

Table 104

The results of TOPSIS method weighted with CRITIC for 2020

Country Name	TOPSIS Score	Rank
Angola	0.523325	15
Burundi	0.507994	22
Congo, Rep.	0.593795	2
Cote d'Ivoire	0.522389	17
Gambia	0.572153	3
Guinea	0.503646	26
Kenya	0.51193	21
Mauritania	0.567437	5
Niger	0.525473	13
Rwanda	0.492277	27
Sierra Leone	0.527186	10
Togo	0.507924	23
Zimbabwe	0.277421	30
Benin	0.514902	20
Cameroon	0.5185	19
Chad	0.541299	8
Ethiopia	0.522451	16
Ghana	0.531478	9
Gabon	0.548682	7
Madagascar	0.523464	14
Mali	0.525784	11
Mauritius	0.506951	24
Mozambique	0.651335	1
Namibia	0.479367	28
Nigeria	0.570455	4
Senegal	0.557646	6
South Africa	0.52573	12
Sudan	0.425119	29
Tanzania	0.52096	18
Zambia	0.506616	25

Table 105

Normalized matrix using TOPSIS for 2021 with CRITIC weight

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.100959	0.201014	0.153094	0.08508	0.068439	0.176631
Burundi	0.004266	0.000935	0.008263	0.005152	0.022334	0.019255
Congo, Rep.	0.020544	0.052629	0.0919	0.038704	0.004559	0.378215
Cote d'Ivoire	0.110375	0.109264	0.044772	0.126107	0.010874	0.047917
Gambia	0.003133	0.000889	0.285252	0.005658	0.019586	0.084726
Guinea	0.024733	0.046595	0.028355	0.078769	0.033476	0.098998
Kenya	0.168616	0.079612	0.009752	0.170255	0.016239	0.096004
Mauritania	0.015364	0.026563	0.247216	0.047472	0.009474	0.191991
Niger	0.022925	0.010331	0.092087	0.031646	0.010199	0.011363
Rwanda	0.016992	0.014553	0.044257	0.030294	0.00104	0.226487
Sierra Leone	0.006531	0.004845	0.115357	0.01373	0.031554	0.062886
Togo	0.01281	0.013045	0.037741	0.020766	0.011124	0.071016
Zimbabwe	0.043607	0.04856	0.020346	0.068321	0.261874	0.137219
Benin	0.02719	0.024925	0.04516	0.037409	0.004607	0.029801
Cameroon	0.069686	0.051022	0.049071	0.071942	0.006037	0.070115
Chad	0.018106	0.030746	0.138208	0.040607	0.002054	0.026161
Ethiopia	0.171011	0.057193	0.088396	0.144513	0.071323	0.066849
Ghana	0.121664	0.159456	0.076216	0.175942	0.026497	0.066662
Gabon	0.031075	0.075637	0.174647	0.026132	0.002888	0.371428
Madagascar	0.022371	0.022327	0.056721	0.035936	0.015445	0.039293
Mali	0.029679	0.036244	0.076524	0.059202	0.010432	0.044277
Mauritius	0.017639	0.034197	0.050941	0.048291	0.010705	0.130228
Mozambique	0.024249	0.03335	0.775011	0.084628	0.01703	0.067002
Namibia	0.01913	0.026707	0.128139	0.048638	0.009611	0.361767
Nigeria	0.677567	0.318852	0.017354	0.406681	0.04505	0.100971
Senegal	0.042374	0.045664	0.216765	0.095678	0.005794	0.059501
South Africa	0.644032	0.880383	0.224053	0.817123	0.012255	0.489375
Sudan	0.052611	0.005187	0.035271	0.005009	0.954244	0.324039
Tanzania	0.108599	0.067198	0.033756	0.08697	0.009808	0.046607
Zambia	0.034041	0.077689	0.028299	0.058533	0.058517	0.105802

Table 106

The values of S_i^+ and S_i^-

Country Name	S_i^+	S_i^-
Angola	0.181088	0.216991
Burundi	0.217941	0.234912
Congo, Rep.	0.21275	0.221016
Cote d'Ivoire	0.199054	0.230589
Gambia	0.180105	0.238188
Guinea	0.211744	0.224287
Kenya	0.20312	0.225313
Mauritania	0.184736	0.230482
Niger	0.203213	0.23702
Rwanda	0.214512	0.225956
Sierra Leone	0.201833	0.230987
Togo	0.212358	0.232736
Zimbabwe	0.218853	0.182638
Benin	0.209181	0.235937
Cameroon	0.204226	0.231717
Chad	0.195848	0.237919
Ethiopia	0.191289	0.218963
Ghana	0.191465	0.225313
Gabon	0.198944	0.224223
Madagascar	0.208004	0.233515
Mali	0.203758	0.23325
Mauritius	0.209812	0.228083
Mozambique	0.14305	0.279711
Namibia	0.208182	0.220567
Nigeria	0.178375	0.239187
Senegal	0.182386	0.235162
South Africa	0.17517	0.248093
Sudan	0.295498	0.101348
Tanzania	0.202767	0.232259
Zambia	0.20973	0.220462

Table 107

The results of TOPSIS method weighted with CRITIC for 2021

Country Name	TOPSIS Score	Rank
Angola	0.545095	8
Burundi	0.518739	23
Congo, Rep.	0.509528	28
Cote d'Ivoire	0.536699	11
Gambia	0.569429	4
Guinea	0.514383	25
Kenya	0.5259	20
Mauritania	0.555087	6
Niger	0.538397	10
Rwanda	0.51299	26
Sierra Leone	0.533679	15
Togo	0.522891	21
Zimbabwe	0.4549	29
Benin	0.530054	17
Cameroon	0.53153	16
Chad	0.548495	7
Ethiopia	0.533727	14
Ghana	0.540607	9
Gabon	0.529869	18
Madagascar	0.52889	19
Mali	0.533743	13
Mauritius	0.520862	22
Mozambique	0.661629	1
Namibia	0.514443	24
Nigeria	0.572818	3
Senegal	0.563197	5
South Africa	0.586144	2
Sudan	0.255384	30
Tanzania	0.533897	12
Zambia	0.512474	27

Table 108

Normalized matrix using TOPSIS for 2020 with MEREC weight

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.085621	0.179589	0.099253	0.091013	0.038241	0.181849
Burundi	0.004516	0.001133	0.008795	0.006153	0.01257	0.018097
Congo, Rep.	0.017865	0.056164	0.505424	0.046452	0.003083	0.395622
Cote d'Ivoire	0.107335	0.124341	0.030241	0.132279	0.004164	0.046736
Gambia	0.003088	0.001639	0.279493	0.007172	0.010184	0.089536
Guinea	0.024162	0.062185	0.033232	0.101271	0.018203	0.104453
Kenya	0.17154	0.091188	0.011315	0.18506	0.00928	0.098673
Mauritania	0.014325	0.032118	0.294939	0.04742	0.004096	0.195676
Niger	0.023423	0.013284	0.070106	0.037016	0.004976	0.011948
Rwanda	0.017337	0.018478	0.040081	0.038124	0.016913	0.228585
Sierra Leone	0.006924	0.005762	0.113564	0.015481	0.023088	0.06276
Togo	0.012593	0.016458	0.021407	0.025099	0.002918	0.070772
Zimbabwe	0.036657	0.052386	0.018676	0.064577	0.956722	0.138767
Benin	0.026673	0.029228	0.029705	0.04082	0.00519	0.029359
Cameroon	0.069485	0.058377	0.044242	0.078827	0.004185	0.069349
Chad	0.018261	0.026902	0.139051	0.047039	0.007665	0.028903
Ethiopia	0.183469	0.072104	0.059455	0.189864	0.034952	0.072494
Ghana	0.119367	0.136387	0.071549	0.130238	0.016977	0.066309
Gabon	0.026099	0.068366	0.299452	0.036092	0.002323	0.381725
Madagascar	0.022242	0.024704	0.07338	0.039368	0.007215	0.041518
Mali	0.029764	0.050315	0.082123	0.066305	0.000752	0.062022
Mauritius	0.01943	0.042185	0.052648	0.055404	0.004431	0.151629
Mozambique	0.024126	0.039008	0.60163	0.09724	0.005982	0.066344
Namibia	0.018037	0.033495	0.037909	0.047825	0.003794	0.373115
Nigeria	0.73655	0.329721	0.014745	0.371827	0.022744	0.105402
Senegal	0.041805	0.047718	0.201017	0.100847	0.004367	0.061653
South Africa	0.575369	0.875666	0.024955	0.81843	0.005512	0.427652
Sudan	0.046072	0.013021	0.070851	0.013643	0.280315	0.338959
Tanzania	0.112594	0.08384	0.027696	0.099814	0.005649	0.048844
Zambia	0.030864	0.079632	0.036173	0.061566	0.027014	0.105947

Table 109

The values of S_i^+ and S_i^-.

Country Name	S_i^+	S_i^-
Angola	0.192936	0.282045
Burundi	0.231896	0.292469
Congo, Rep.	0.220568	0.291814
Cote d'Ivoire	0.201072	0.289529
Gambia	0.228823	0.292577
Guinea	0.219481	0.284969
Kenya	0.203153	0.285225
Mauritania	0.222997	0.290805
Niger	0.227136	0.292949
Rwanda	0.228575	0.28675
Sierra Leone	0.229489	0.288607
Togo	0.228309	0.293034
Zimbabwe	0.347386	0.111357
Benin	0.224578	0.2924
Cameroon	0.215602	0.290431
Chad	0.224237	0.291596
Ethiopia	0.205161	0.278687
Ghana	0.197248	0.286391
Gabon	0.21844	0.291021
Madagascar	0.225154	0.291751
Mali	0.219884	0.291864
Mauritius	0.22316	0.290043
Mozambique	0.218932	0.292427
Namibia	0.228271	0.288864
Nigeria	0.138438	0.307154
Senegal	0.218001	0.28957
South Africa	0.134041	0.342433
Sudan	0.241428	0.221375
Tanzania	0.207665	0.290013
Zambia	0.215538	0.284901

Table 110

The results of TOPSIS method weighted with MEREC for 2020

Country Name	TOPSIS Score	Rank
Angola	0.593802	3
Burundi	0.557758	26
Congo, Rep.	0.569525	14
Cote d'Ivoire	0.590151	5
Gambia	0.561137	24
Guinea	0.56491	20
Kenya	0.584025	6
Mauritania	0.565986	16
Niger	0.563272	22
Rwanda	0.556446	28
Sierra Leone	0.557053	27
Togo	0.562075	23
Zimbabwe	0.242743	30
Benin	0.565595	17
Cameroon	0.573937	9
Chad	0.565291	18
Ethiopia	0.575981	8
Ghana	0.592159	4
Gabon	0.571233	11
Madagascar	0.564418	21
Mali	0.570328	13
Mauritius	0.565162	19
Mozambique	0.571862	10
Namibia	0.558585	25
Nigeria	0.689316	2
Senegal	0.570502	12
South Africa	0.718681	1
Sudan	0.478336	29
Tanzania	0.582732	7
Zambia	0.569302	15

Table 111

Normalized matrix using TOPSIS for 2021 with MEREC weight

Country Name	GDP	EXP	FDI	IMP	INF	UEM
Angola	0.100959	0.201014	0.153094	0.08508	0.068439	0.176631
Burundi	0.004266	0.000935	0.008263	0.005152	0.022334	0.019255
Congo, Rep.	0.020544	0.052629	0.0919	0.038704	0.004559	0.378215
Cote d'Ivoire	0.110375	0.109264	0.044772	0.126107	0.010874	0.047917
Gambia	0.003133	0.000889	0.285252	0.005658	0.019586	0.084726
Guinea	0.024733	0.046595	0.028355	0.078769	0.033476	0.098998
Kenya	0.168616	0.079612	0.009752	0.170255	0.016239	0.096004
Mauritania	0.015364	0.026563	0.247216	0.047472	0.009474	0.191991
Niger	0.022925	0.010331	0.092087	0.031646	0.010199	0.011363
Rwanda	0.016992	0.014553	0.044257	0.030294	0.00104	0.226487
Sierra Leone	0.006531	0.004845	0.115357	0.01373	0.031554	0.062886
Togo	0.01281	0.013045	0.037741	0.020766	0.011124	0.071016
Zimbabwe	0.043607	0.04856	0.020346	0.068321	0.261874	0.137219
Benin	0.02719	0.024925	0.04516	0.037409	0.004607	0.029801
Cameroon	0.069686	0.051022	0.049071	0.071942	0.006037	0.070115
Chad	0.018106	0.030746	0.138208	0.040607	0.002054	0.026161
Ethiopia	0.171011	0.057193	0.088396	0.144513	0.071323	0.066849
Ghana	0.121664	0.159456	0.076216	0.175942	0.026497	0.066662
Gabon	0.031075	0.075637	0.174647	0.026132	0.002888	0.371428
Madagascar	0.022371	0.022327	0.056721	0.035936	0.015445	0.039293
Mali	0.029679	0.036244	0.076524	0.059202	0.010432	0.044277
Mauritius	0.017639	0.034197	0.050941	0.048291	0.010705	0.130228
Mozambique	0.024249	0.03335	0.775011	0.084628	0.01703	0.067002
Namibia	0.01913	0.026707	0.128139	0.048638	0.009611	0.361767
Nigeria	0.677567	0.318852	0.017354	0.406681	0.04505	0.100971
Senegal	0.042374	0.045664	0.216765	0.095678	0.005794	0.059501
South Africa	0.644032	0.880383	0.224053	0.817123	0.012255	0.489375
Sudan	0.052611	0.005187	0.035271	0.005009	0.954244	0.324039
Tanzania	0.108599	0.067198	0.033756	0.08697	0.009808	0.046607
Zambia	0.034041	0.077689	0.028299	0.058533	0.058517	0.105802

Table 112

The values of S_i^+ and S_i^-.

Country Name	S_i^+	S_i^-
Angola	0.188651	0.252779
Burundi	0.234761	0.267146
Congo, Rep.	0.226182	0.262846
Cote d'Ivoire	0.206863	0.262242
Gambia	0.228231	0.267333
Guinea	0.224843	0.257779
Kenya	0.21076	0.257366
Mauritania	0.224194	0.264047
Niger	0.22929	0.268159
Rwanda	0.231775	0.26552
Sierra Leone	0.231057	0.263649
Togo	0.231115	0.267087
Zimbabwe	0.232391	0.210494
Benin	0.227575	0.268403
Cameroon	0.219883	0.265071
Chad	0.224608	0.269092
Ethiopia	0.212533	0.24764
Ghana	0.196864	0.256772
Gabon	0.218852	0.264802
Madagascar	0.228109	0.265955
Mali	0.224522	0.265402
Mauritius	0.226889	0.264007
Mozambique	0.215753	0.271527
Namibia	0.229735	0.261094
Nigeria	0.158041	0.269015
Senegal	0.218559	0.264334
South Africa	0.148774	0.320005
Sudan	0.329881	0.127805
Tanzania	0.214732	0.264319
Zambia	0.218668	0.254102

Table 113

The results of TOPSIS method weighted with MEREC for 2021

Country Name	TOPSIS Score	Rank
Angola	0.572636	3
Burundi	0.532262	27
Congo, Rep.	0.537487	21
Cote d'Ivoire	0.559026	5
Gambia	0.539452	16
Guinea	0.534122	24
Kenya	0.54978	8
Mauritania	0.540812	15
Niger	0.539068	17
Rwanda	0.533929	25
Sierra Leone	0.532941	26
Togo	0.536103	23
Zimbabwe	0.475279	29
Benin	0.54116	14
Cameroon	0.54659	11
Chad	0.545052	12
Ethiopia	0.538145	19
Ghana	0.566031	4
Gabon	0.547502	9
Madagascar	0.5383	18
Mali	0.541721	13
Mauritius	0.537806	20
Mozambique	0.557231	6
Namibia	0.531946	28
Nigeria	0.629929	2
Senegal	0.547396	10
South Africa	0.682635	1
Sudan	0.279242	30
Tanzania	0.551756	7
Zambia	0.537475	22

Appendix E. Applying the CoCoSo Method

Table 114

The values of the sum of weighted comparability S_i and P_i

Country Name	S_i	P_i
Angola	0.583615	0.157297
Burundi	0.549767	0.153001
Congo, Rep.	0.608521	0.162915
Cote d'Ivoire	0.587549	0.161032
Gambia	0.586513	0.157722
Guinea	0.54783	0.153268
Kenya	0.57906	0.160391
Mauritania	0.586151	0.15922
Niger	0.566038	0.156106
Rwanda	0.537125	0.152208
Sierra Leone	0.557743	0.152941
Togo	0.554164	0.155075
Zimbabwe	0.122785	-0.00349
Benin	0.561799	0.155851
Cameroon	0.572302	0.158232
Chad	0.574287	0.156832
Ethiopia	0.575302	0.156918
Ghana	0.592259	0.160455
Gabon	0.584071	0.160398
Madagascar	0.564818	0.155899
Mali	0.570773	0.157735
Mauritius	0.554281	0.155543
Mozambique	0.640631	0.164919
Namibia	0.532501	0.153889
Nigeria	0.734235	0.187448
Senegal	0.585117	0.159111
South Africa	0.728573	0.192034
Sudan	0.422346	0.109491
Tanzania	0.583675	0.160172
Zambia	0.555115	0.153348

Table 115

Final aggregation and CoCoSo ranking of the countries with Entropy weight

Country Name	k_{ia}	k_{ib}	k_{ic}	k_i	Rank
Angola	0.740912	-214.207	0.799888	50.526975	12
Burundi	0.702768	-196.273	0.758708	45.690554	25
Congo, Rep.	0.771436	-231.326	0.832842	46.105763	4
Cote d'Ivoire	0.748581	-220.772	0.808168	51.842495	6
Gambia	0.744235	-215.853	0.803476	43.7777	9
Guinea	0.701098	-195.923	0.756905	41.59145	26
Kenya	0.73945	-216.716	0.798311	48.83288	13
Mauritania	0.745371	-217.768	0.804702	47.870363	7
Niger	0.722144	-206.183	0.779626	48.519205	18
Rwanda	0.689333	-190.766	0.744204	42.298258	27
Sierra Leone	0.710683	-199.042	0.767253	43.186782	21
Togo	0.709239	-200.524	0.765694	47.741425	23
Zimbabwe	0.119295	1	0.12879	-0.2630197	30
Benin	0.71765	-204.304	0.774775	47.418095	20
Cameroon	0.730535	-211.304	0.788685	48.544728	16
Chad	0.731119	-210.161	0.789316	49.240432	15
Ethiopia	0.73222	-210.647	0.790504	44.358212	14
Ghana	0.752714	-221.744	0.81263	51.659551	5
Gabon	0.744469	-218.601	0.803729	45.892735	8
Madagascar	0.720717	-205.466	0.778086	45.996399	19
Mali	0.728507	-210.077	0.786496	48.649587	17
Mauritius	0.709824	-201.172	0.766326	46.5715	22
Mozambique	0.805549	-246.528	0.869671	55.513453	3
Namibia	0.68639	-191.213	0.741027	39.437778	28
Nigeria	0.921683	-321.147	0.995049	83.105912	1
Senegal	0.744228	-217.235	0.803468	48.14461	10
South Africa	0.920607	-326.467	0.993888	81.704717	2
Sudan	0.531838	-107.904	0.574172	25.439713	29
Tanzania	0.743847	-218.146	0.803057	50.554981	11
Zambia	0.708463	-198.632	0.764856	43.841989	24

Table 116

The values of the sum of weighted comparability S_i and P_i

Country Name	S_i	P_i
Angola	0.5770	0.1296
Burundi	0.5201	0.1211
Congo, Rep.	0.5189	0.1247
Cote d'Ivoire	0.5654	0.1308
Gambia	0.5581	0.1255
Guinea	0.5169	0.1211
Kenya	0.5539	0.1297
Mauritania	0.5491	0.1263
Niger	0.5419	0.1248
Rwanda	0.5173	0.1235
Sierra Leone	0.5295	0.1216
Togo	0.5271	0.1233
Zimbabwe	0.4311	0.0942
Benin	0.5390	0.1254
Cameroon	0.5482	0.1276
Chad	0.5535	0.1270
Ethiopia	0.5467	0.1242
Ghana	0.5707	0.1311
Gabon	0.5444	0.1282
Madagascar	0.5340	0.1239
Mali	0.5404	0.1253
Mauritius	0.5262	0.1237
Mozambique	0.6390	0.1350
Namibia	0.5152	0.1232
Nigeria	0.7077	0.1584
Senegal	0.5627	0.1283
South Africa	0.7885	0.1791
Sudan	0.1495	0.0088
Tanzania	0.5590	0.1295
Zambia	0.5209	0.1204

Table 117

Final aggregation and CoCoSo ranking of the countries with Entropy weight

Country Name	k_{ia}	k_{ib}	k_{ic}	k_i	Rank
Angola	0.706564	56.95128	0.730183	29.2568	4
Burundi	0.641203	47.97973	0.662637	23.22315	25
Congo, Rep.	0.643594	49.26912	0.665107	23.8893	23
Cote d'Ivoire	0.696189	56.32463	0.719461	28.65075	6
Gambia	0.683656	53.36416	0.706509	26.84324	9
Guinea	0.63797	47.67141	0.659295	23.00659	28
Kenya	0.683604	54.72427	0.706455	27.51421	10
Mauritania	0.675398	52.80837	0.697975	26.35872	13
Niger	0.666736	51.5293	0.689023	25.51914	16
Rwanda	0.640891	48.68147	0.662314	23.54952	26
Sierra Leone	0.651049	49.03059	0.672812	23.94384	20
Togo	0.650403	49.49129	0.672145	24.1499	21
Zimbabwe	0.525351	30.93916	0.542912	13.61062	29
Benin	0.664453	51.48781	0.686664	25.44352	18
Cameroon	0.675809	53.29223	0.698399	26.60652	12
Chad	0.68058	53.56142	0.70333	26.86124	11
Ethiopia	0.670848	51.703	0.693273	25.70441	15
Ghana	0.701849	57.00683	0.72531	29.15126	5
Gabon	0.672657	53.17178	0.695142	26.46742	14
Madagascar	0.657879	50.38352	0.67987	24.75215	19
Mali	0.6657	51.57045	0.687953	25.51395	17
Mauritius	0.649903	49.5921	0.671627	24.18673	22
Mozambique	0.773991	65.69331	0.799863	35.97901	3
Namibia	0.638422	48.34658	0.659762	23.33622	27
Nigeria	0.866076	85.37586	0.895026	51.10565	2
Senegal	0.691041	55.00683	0.714141	27.85264	7
South Africa	0.967654	107.5762	1	71.21344	1
Sudan	0.158297	1	0.163589	0.449261	30
Tanzania	0.688537	55.14627	0.711553	27.85473	8
Zambia	0.641299	47.78273	0.662736	23.13167	24

Table 118

The values of the sum of weighted comparability S_i and P_i

Country Name	S_i	P_i
Angola	0.509677	0.089442
Burundi	0.495689	0.087436
Congo, Rep.	0.578354	0.111992
Cote d'Ivoire	0.518557	0.09105
Gambia	0.571069	0.107343
Guinea	0.480759	0.084898
Kenya	0.498377	0.086994
Mauritania	0.552004	0.103578
Niger	0.521379	0.093672
Rwanda	0.452805	0.079137
Sierra Leone	0.517988	0.0938
Togo	0.490081	0.08636
Zimbabwe	0.261863	0.043992
Benin	0.505407	0.089511
Cameroon	0.507947	0.089812
Chad	0.539839	0.098598
Ethiopia	0.514772	0.091475
Ghana	0.52931	0.093651
Gabon	0.515817	0.09537
Madagascar	0.5156	0.092426
Mali	0.516396	0.092586
Mauritius	0.480958	0.084931
Mozambique	0.686292	0.136629
Namibia	0.419342	0.072039
Nigeria	0.614463	0.1031
Senegal	0.553984	0.102606
South Africa	0.527052	0.085057
Sudan	0.384285	0.066304
Tanzania	0.516381	0.090667
Zambia	0.488582	0.085753

Table 119

Final aggregation and CoCoSo ranking of the countries with CRITIC weight

Country Name	k_{ia}	k_{ib}	k_{ic}	k_i	Rank
Angola	0.599119	3.957234	0.728039	2.336823	18
Burundi	0.583125	3.762306	0.708604	2.202879	22
Congo, Rep.	0.690347	5.622592	0.838898	3.46935	3
Cote d'Ivoire	0.609607	4.098564	0.740784	2.433272	13
Gambia	0.678412	5.321271	0.824394	3.266716	4
Guinea	0.565657	3.543069	0.687376	2.057905	26
Kenya	0.585372	3.763599	0.711334	2.209149	21
Mauritania	0.655582	4.963211	0.796652	3.002528	6
Niger	0.615051	4.239535	0.747399	2.51695	9
Rwanda	0.531942	3.110588	0.646406	1.786171	27
Sierra Leone	0.611788	4.217702	0.743434	2.497078	11
Togo	0.576441	3.673945	0.700481	2.144784	23
Zimbabwe	0.305855	1	0.37167	0.597067	30
Benin	0.594918	3.927073	0.722934	2.311301	20
Cameroon	0.597759	3.960099	0.726386	2.334579	19
Chad	0.638437	4.620479	0.775818	2.774435	7
Ethiopia	0.606248	4.087643	0.736702	2.418744	17
Ghana	0.622961	4.30304	0.757011	2.570758	8
Gabon	0.611187	4.270339	0.742704	2.52089	12
Madagascar	0.608026	4.136772	0.738863	2.447366	15
Mali	0.608981	4.150297	0.740023	2.456559	14
Mauritius	0.565889	3.545897	0.687659	2.059763	25
Mozambique	0.822921	8.139664	1	5.55363	1
Namibia	0.491381	2.622353	0.597118	1.493427	28
Nigeria	0.717562	5.499281	0.871969	3.509889	2
Senegal	0.656589	4.934258	0.797876	2.991223	5
South Africa	0.612109	3.891511	0.743825	2.339753	10
Sudan	0.450589	2.211809	0.547548	1.251881	29
Tanzania	0.607049	4.064203	0.737675	2.409632	16
Zambia	0.574335	3.636965	0.697922	2.122356	24

Table 120

The values of the sum of weighted comparability S_i and P_i

Country name	S_i	P_i
Angola	0.5513	0.0983
Burundi	0.5098	0.0921
Congo, Rep.	0.4648	0.0839
Cote d'Ivoire	0.5434	0.0980
Gambia	0.5811	0.1074
Guinea	0.4965	0.0898
Kenya	0.5226	0.0942
Mauritania	0.5481	0.1010
Niger	0.5430	0.0991
Rwanda	0.4801	0.0869
Sierra Leone	0.5305	0.0967
Togo	0.5117	0.0927
Zimbabwe	0.4326	0.0762
Benin	0.5282	0.0958
Cameroon	0.5292	0.0958
Chad	0.5570	0.1019
Ethiopia	0.5402	0.0978
Ghana	0.5486	0.0989
Gabon	0.5007	0.0907
Madagascar	0.5254	0.0954
Mali	0.5324	0.0969
Mauritius	0.5028	0.0911
Mozambique	0.7370	0.1403
Namibia	0.4724	0.0860
Nigeria	0.6440	0.1132
Senegal	0.5730	0.1056
South Africa	0.6524	0.1136
Sudan	0.2194	0.0322
Tanzania	0.5388	0.0972
Zambia	0.4988	0.0894

Table 121

Final aggregation and CoCoSo ranking of the countries with CRITIC weight

Country Name	k_{ia}	k_{ib}	k_{ic}	k_i	Rank
Angola	0.649687	7.686586	0.74055	4.258346	7
Burundi	0.601972	6.660238	0.686162	3.566463	21
Congo, Rep.	0.548639	5.527049	0.62537	2.865799	28
Cote d'Ivoire	0.641375	7.54725	0.731076	4.152854	11
Gambia	0.688477	8.848696	0.784765	5.034273	4
Guinea	0.586258	6.317676	0.66825	3.349081	25
Kenya	0.616845	6.982386	0.703115	3.776897	19
Mauritania	0.649129	7.850771	0.739914	4.336845	8
Niger	0.642079	7.625588	0.731878	4.194328	10
Rwanda	0.566987	5.914592	0.646284	3.098392	26
Sierra Leone	0.627277	7.275567	0.715006	3.96033	15
Togo	0.604366	6.724409	0.688891	3.605773	20
Zimbabwe	0.508753	4.670847	0.579906	2.379181	29
Benin	0.62406	7.176677	0.711339	3.899312	17
Cameroon	0.625042	7.187671	0.712458	3.908652	16
Chad	0.658858	8.04546	0.751004	4.478753	6
Ethiopia	0.637949	7.487713	0.727171	4.10879	12
Ghana	0.647498	7.690169	0.738055	4.250255	9
Gabon	0.59138	6.439021	0.674089	3.423787	23
Madagascar	0.620819	7.104693	0.707645	3.851461	18
Mali	0.629287	7.311372	0.717297	3.986068	14
Mauritius	0.593922	6.49438	0.676986	3.458843	22
Mozambique	0.877303	14.65879	1	9.798765	1
Namibia	0.558402	5.758528	0.636498	3.000044	27
Nigeria	0.757199	10.33232	0.863099	6.235063	3
Senegal	0.678601	8.579889	0.773508	4.845204	5
South Africa	0.76602	10.5056	0.873153	6.390491	2
Sudan	0.251525	1	0.286702	0.53678	30
Tanzania	0.635999	7.42339	0.724948	4.069004	13
Zambia	0.588198	6.321298	0.670461	3.357616	24

Table 122

The values of the sum of weighted comparability S_i and P_i

Country name	S_i	P_i
Angola	0.567117	0.119236
Burundi	0.532437	0.110941
Congo, Rep.	0.547609	0.11297
Cote d'Ivoire	0.572031	0.120393
Gambia	0.551586	0.11221
Guinea	0.527169	0.111635
Kenya	0.556518	0.117893
Mauritania	0.54503	0.112651
Niger	0.545068	0.113057
Rwanda	0.507049	0.108202
Sierra Leone	0.533939	0.11023
Togo	0.532809	0.111979
Zimbabwe	0.202335	0.020442
Benin	0.543078	0.113492
Cameroon	0.55121	0.115676
Chad	0.550233	0.113544
Ethiopia	0.552653	0.115313
Ghana	0.575909	0.120466
Gabon	0.535239	0.112923
Madagascar	0.543191	0.11303
Mali	0.548171	0.114708
Mauritius	0.528175	0.111985
Mozambique	0.591005	0.116738
Namibia	0.493866	0.107881
Nigeria	0.71895	0.149078
Senegal	0.555629	0.114803
South Africa	0.729711	0.164385
Sudan	0.412706	0.082382
Tanzania	0.565648	0.118528
Zambia	0.537801	0.113132

Table 123

Final aggregation and CoCoSo ranking of the countries with MEREC weight

Country Name	k_{ia}	k_{ib}	k_{ic}	k_i	Rank
Angola	0.686353	16.3487	0.76765	8.805498	7
Burundi	0.643378	14.28122	0.719585	7.418629	21
Congo, Rep.	0.66058	14.9568	0.738824	7.885297	28
Cote d'Ivoire	0.692424	16.65039	0.77444	9.015292	11
Gambia	0.663796	14.964	0.742421	7.914905	4
Guinea	0.638804	14.22829	0.714469	7.358475	25
Kenya	0.674411	15.86246	0.754294	8.453489	19
Mauritania	0.65768	14.84424	0.735581	7.806267	8
Niger	0.658126	14.89884	0.736079	7.836842	10
Rwanda	0.615251	13.26443	0.688126	6.727856	26
Sierra Leone	0.644169	14.22969	0.72047	7.399464	15
Togo	0.644788	14.42485	0.721162	7.499437	20
Zimbabwe	0.222777	1	0.249164	0.50915	29
Benin	0.65657	14.90156	0.734339	7.825727	17
Cameroon	0.666886	15.41574	0.745877	8.16551	16
Chad	0.663777	15.10476	0.7424	7.984795	6
Ethiopia	0.667966	15.40754	0.747085	8.17046	12
Ghana	0.696375	16.77341	0.778859	9.115389	9
Gabon	0.648162	14.6128	0.724936	7.617366	23
Madagascar	0.656222	14.84401	0.73395	7.79452	18
Mali	0.662879	15.20244	0.741395	8.02601	14
Mauritius	0.640161	14.30023	0.715986	7.403611	22
Mozambique	0.707743	16.68047	0.791574	9.174903	1
Namibia	0.601746	12.88119	0.673022	6.457567	27
Nigeria	0.868028	25.91287	0.970844	16.52968	3
Senegal	0.670432	15.42209	0.749844	8.198449	5
South Africa	0.894096	29.00128	1	18.94177	2
Sudan	0.495087	8.220042	0.553729	3.84078	30
Tanzania	0.684176	16.20956	0.765215	8.715111	13
Zambia	0.650933	14.70993	0.728035	7.686652	24

Table 124

The values of the sum of weighted comparability S_i and P_i

Country Name	S_i	P_i
Angola	0.5728	0.1093
Burundi	0.5168	0.0978
Congo, Rep.	0.4937	0.0969
Cote d'Ivoire	0.5586	0.1069
Gambia	0.5463	0.1004
Guinea	0.5100	0.0977
Kenya	0.5402	0.1038
Mauritania	0.5310	0.0997
Niger	0.5359	0.1006
Rwanda	0.4994	0.0967
Sierra Leone	0.5227	0.0979
Togo	0.5195	0.0988
Zimbabwe	0.4412	0.0811
Benin	0.5329	0.1011
Cameroon	0.5389	0.1027
Chad	0.5465	0.1026
Ethiopia	0.5371	0.1006
Ghana	0.5652	0.1085
Gabon	0.5193	0.1007
Madagascar	0.5281	0.0999
Mali	0.5335	0.1011
Mauritius	0.5153	0.0988
Mozambique	0.6194	0.1083
Namibia	0.4890	0.0950
Nigeria	0.6850	0.1312
Senegal	0.5515	0.1031
South Africa	0.7642	0.1571
Sudan	0.2057	0.0256
Tanzania	0.5508	0.1049
Zambia	0.5177	0.0990

Table 125

Final aggregation and CoCoSo ranking of the countries with MEREC weight

Country Name	k_{ia}	k_{ib}	k_{ic}	k_i	Rank
Angola	0.6821851	5.5374767	0.934623	3.5616332	4
Burundi	0.6146518	4.469707	0.842099	2.7466561	23
Congo, Rep.	0.5905468	4.2282808	0.809074	2.549386	27
Cote d'Ivoire	0.6655967	5.2822585	0.911896	3.355281	6
Gambia	0.646733	4.8506324	0.886052	3.0543393	10
Guinea	0.607669	4.4050207	0.832532	2.6912466	25
Kenya	0.6440044	4.9588921	0.882313	3.1009735	11
Mauritania	0.6307384	4.6825931	0.864138	2.9098982	17
Niger	0.6365143	4.765983	0.872052	2.9733395	14
Rwanda	0.596053	4.2685061	0.816618	2.5862872	26
Sierra Leone	0.6205241	4.522143	0.850144	2.7928	19
Togo	0.6182986	4.5381618	0.847095	2.7934844	21
Zimbabwe	0.5223072	3.1648355	0.715583	1.8618654	29
Benin	0.6340005	4.7627294	0.868608	2.9627205	16
Cameroon	0.6416168	4.8950051	0.879042	3.058829	12
Chad	0.6491203	4.9569728	0.889322	3.1189877	9
Ethiopia	0.6377075	4.7758218	0.873686	2.9826983	13
Ghana	0.6737354	5.4222418	0.923046	3.4636848	5
Gabon	0.6200344	4.6234253	0.849473	2.8427013	20
Madagascar	0.6280504	4.6660402	0.860456	2.8920395	18
Mali	0.6346142	4.7681032	0.869448	2.9676783	15
Mauritius	0.6141259	4.5021024	0.841379	2.7612996	24
Mozambique	0.7277227	5.9329841	0.997011	3.9874599	3
Namibia	0.5840058	4.1086619	0.800113	2.4708789	28
Nigeria	0.8162003	7.9456243	1.118229	5.7106719	2
Senegal	0.6545867	5.0268965	0.896812	3.1764295	8
South Africa	0.9212373	10.610989	1.262134	8.3773413	1
Sudan	0.2313572	0.4663076	0.316969	0.3496099	30
Tanzania	0.6556575	5.1077041	0.898279	3.2232963	7
Zambia	0.6166466	4.5291808	0.844832	2.783398	22