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FTOPSIS ve TOPSIS YÖNTEMLERİ ile SUDAN'IN MAKROEKONOMİK PERFORMANSININ DEĞERLENDİRİLMESİ

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ÖZET

Bu çalışmada Sudan, enflasyon, gayri safi yurt içi hasıla, döviz kuru, ihracat ve büyüme oranı gibi değişkenler ile, 2000-2019 yıllarına ait performansları açısından değerlendirilmektedir. Veriler Sudan Merkez Bankası ve Merkezi İstatistik Bürosu'ndan derlenmiştir. Çalışmada değerlendirme fuzzy TOPSIS yöntemi ile yapılmıştır. Bu metoda göre elde edilen en önemli sonuç; 2019 yılının en yüksek makroekonomik performansın sergilendiği yıl olmasıdır. 2016 yılı, 2. sırada en iyi performansın sergilendiği yıl olarak belirlenmiştir. 2006 yılı ise makroekonomik göstergeler açısından performansı en düşük yıl olarak görülmektedir. Çalışmada performansların birdenbire aşağıdan yukarıya veya tersine yönde sıralama değiştirmesi dikkat çekmektedir. Örneğin 2008 yılı için sıralama 7 iken 2007 için sıralama 19 dur. Bunun sebebi Sudan'daki ekonomik kriz ve iç savaşlardır. Çalışmada aynı değişkenler ile TOPSIS yöntemi de uygulanarak sonuçlar karşılaştırıldığında iki metodunda sıralamalarının, 2000, 2006, 2012 ve 2014 yılları hariç karşılaştırılan pek çok yıl için birbirine yakın olduğu görülmektedir. Bu çalışma Sudan ekonomisinin başarısını çok kriterli karar verme yöntemi ile analiz eden ilk çalışmadır.

Anahtar Kelimeler: *Fuzzy TOPSIS, performans değerlendirme, sıralama, çok kriterli karar verme, optimizasyon*

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EVALUATION of the MACROECONOMIC PERFORMANCE of SUDANESE USING FTOPSIS and TOPSIS METHOD

ABSTRACT

This paper examines the evaluation of the performance of the Sudanese macroeconomic indicators such as inflation, gross domestic product, exchange rate, export, economic growth during the period 2000-2019 using data from the Central Bank of Sudan and the Central Bureau of Statistics, for each observation. The study employed the FTOPSIS method. One of the most important results of the study is the most successful economic performance in the year 2019. It's followed by the second rank in 2016. 2006 is the year with the lowest macroeconomic performance in Sudan. According to the results of the study, there is a direct skip from bottom to top not step by step, for example, the rank of 2008 is 7 while 2007 is 19. The reason for that is economic crises and the civil wars in Sudan. Using same data, TOPSIS is applied to make comparison of the results obtained by two methods. For most year, the ranks of two method have the results, near to its corresponding year, except the years 2000, 2006, 2012 and 2014. This is the first paper using a multi-criteria decision-making approach to assess the success of the Sudanese economy.

Keywords: *Fuzzy TOPSIS, performance evaluation, ranking, multi criteria decision making, optimization*

1. INTRODUCTION

Macroeconomic performances of countries determine the future of many economic and financial factors, for example macroeconomic indicators have effects on performance capital market therefore an important issue for policymakers and market practitioners alike to the study of Olokoyo et al. (2020). They have also a great impact on the way for the countries to increase their competitiveness, effectiveness and economic welfare. All economic and competitive formations in economy and government policies will have direct effects on the economic development.

The aim of the study is to assess the macroeconomic performance of the Sudanese economy using the fuzzy TOPSIS (FTOPSIS) process, which is one of the multi-criteria decision-making methods. The literature-accepted parameters are used to assess macroeconomic results. The FTOPSIS approach is chosen for the analysis for a variety of reasons. Some of other reasons are that the analysis steps of the method are relatively easy and valuable information may be obtained with the result

of method. The other is that the method creates an ideal solution from alternatives and evaluates all alternatives according to their distances from the ideal solution. Also, another reason is assigning importance ratings to the evaluation criteria in this method (Ela and Kurt, 2019). TOPSIS method is one of the multiple-criteria assessment methods that can provide information to decision-makers (Cam et al., 2015). Also, some of the advantages of TOPSIS method are simplicity, good computational efficiency, comprehensibility, and ability to measure the relative performance (Roszkowska, 2011) Thus TOPSIS is the most preferable technique by most researchers (Senel and Senel, 2012). TOPSIS method is generally used to solve problems in such cases where there are many and mostly inconsistent criteria. TOPSIS methodology has many advantages because it makes possible all the criteria to be evaluated together and helps the management to choose the best alternative among limited numbered alternatives defined by different criteria (Senel and Senel, 2012).

The internal layout of the study is as follows: In the following section, a literature review on which macroeconomic performances are evaluated by multi-criteria decision-making methods is included. In section 3, the data and methodology used in the analysis are given in detail. In section 4 findings and results are presented. Discussion and conclusion remarks follow in the last section.

2. LITERATURE REVIEW

In the economic literature, new research is being done on evaluating the output of countries' macroeconomic indicators. Recently, the number of studies evaluating macroeconomic performance for countries using the TOPSIS method established by Hwang and Yoon (1981) has increased (Yavuz and Deveci, 2014). In this context, some of the papers in the literature are as follows.

Onder et al. (2015) used the Analytic Network Process (ANP) and TOPSIS methods to assess the output of five vulnerable countries following the Great Recession, using macroeconomic measures such as gross domestic product, inflation, current account balance, consumption, unemployment rate, average consumer prices, export value, and import volume. In this study. After ANP and correlation analysis, 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. Finally, the model shows that

although Turkey has the most fragile economy during the great recession period (2008-2009), afterward the performance of the Turkish economy is relatively high. India has a stable economy and generally, it has a rank of 1 and 2. Indonesia is the best-performing country in 2013.

Senel and Senel (2012) also used TOPSIS methodology to the evaluation of the performance of automotive industry companies traded at Istanbul stock exchange. In this study 17 companies in automotive and automotive supplier industries traded at Istanbul Stock Exchange (IMKB) national market by calculating 18 financial indicators between 2009-2011 and multicriteria decision analysis called TOPSIS. According to the outcomes of this study, Federal-Mogul Izmit Piston and Pin Manufacturing Plants Inc. sustained their stable success at the top in 3 periods.

Cuong et al. (2018) developed a multi-criteria decision model for evaluating the output of Vietnamese commercial banks by combining fuzzy Analytical Hierarchy Process (FAHP) and FTOPSIS. The findings revealed that financial requirements are the most important factors influencing bank success. Since the banking industry is a unique service sector whose success is directly proportional to customer satisfaction. As a result, the banking system must preserve customer loyalty and confidence while also improving financial metrics in order to maintain high efficiency. The results also showed that the bank had the best performance (Vietcombank) is more dominant in financial indicators over other commercial banks. Besides, Techcombank and Military bank are two banks having the worst performance among 5 proposed banks.

Stevic et al. (2016) used an integrated model that recognizes a combination of fuzzy AHP and the TOPSIS approach to compare various suppliers. The expert team was created to compare them based on six parameters, so the fuzzy AHP approach was used to determine their significance. Yousif, M. K. A. (2016) This paper presents a fuzzy logic model based on this survey for measuring and classifying the performance of Sudanese universities, including the computation of criteria weights and overall evaluation of Sudanese universities using TOPSIS techniques. The study suggests that experts use preference linguistic value(s) as a choice if their decision in evaluating success is inconsistent.. Based on the algorithm, the research introduces new tools that allow experts to trace and understand the roots of inconsistency relevant consistent option(s).

Dincer and Hacioglu (2015)’s Using hybrid multi-criteria decision analysis approaches, the research aims to discover the

comparative performance of emerging markets based on the bipolar risks of capital markets. The financial and conflict risk-based performance levels of selected emerging economies were examined using the FTOPSIS and fuzzy AHP-VIKOR methods. The final ranking result for the capital markets in the emerging economies shows that the Turkish stock market is the first in the ranking in both methods.

In the research article of Kiraz et al. (2018), a two-stage decision-making model was build based on the selection of the best value-added projects. In the first stage of the developed model, relations between R&D projects are analysed by using integrated Fuzzy AHP and FTOPSIS methods. 15 projects are evaluated, and 7 projects passed the second stage with a score above the threshold value. In the second stage, 7 projects that passed the first stage are ranked using fuzzy AHP and FTOPSIS methods, and the best 3 applicable projects are determined.

3. METHOD

In this study, fuzzy Technique for Order of Preference by Similarity to Ideal Solution (FTOPSIS) is utilized to compute the final ranking (Yousif, 2016). The method was first proposed in 1981 for multi-criteria decision-making problems (Tlig and Rebai, 2017). Where the answer to the near question with the best hypothesis, the most favorable solution is the most distant with the worst hypotheses (Darmawan et. al, 2020). This method determines the alternatives closest to the positive ideal solution and the furthest from the negative ideal solution and makes an order accordingly (Chen, 2000).

This approach was created to optimize complex structures with multiple parameters. It decides the rating list of compromises. The preference stability of the compromise solution obtained with the initial weights, as well as the weight stability intervals. In the presence of contradictory parameters, this approach focuses on rating and choosing from a collection of alternatives. It introduces the multicriteria ranking index based on the particular measure of "nearness" to the "ideal" solution (Opricovic and Tzeng, 2004).

Secondary data was gathered from the Sudanese Central Bank and the Central Bureau of Statistics in order to perform the analysis. Table 1 shows the data for this report, which is made up of some main macroeconomic indicators for the years 2000 to 2019. This information also serves as the foundation for the FTOPSIS method's initial decision matrix.

Table 1: Macroeconomic Indicators for the period 2000-2019

Years	Inflation (%)	Gross domestic product (%)	Exchange rate (%)	Export (%)	Economic Growth (%)
2000	8.02	33771	2.57	1806.7	8.39
2001	4.92	40659	2.58	1698.7	10.8
2002	8.3	47756	2.62	1949.1	6
2003	7.7	55734	2.57	2542.2	6.29
2004	8.46	68721	2.59	3777.8	5.14
2005	8.5	83298	2.43	4824.3	5.64
2006	7.2	96612	2.17	5656.6	6.53
2007	8.19	106527	2.01	8879.5	5.73
2008	14.3	124609	2.08	11670	3.85
2009	11.2	135659	2.28	7833.7	4.5
2010	13	162204	2.31	11404	6.49
2011	18.1	186690	2.66	9598.6	3.79
2012	35.1	243413	3.56	3367.7	0.98
2013	37.1	249630	4.74	7086.2	5.62
2014	36.9	475828	5.71	4350.2	7.9
2015	16.9	582937	6.01	3169	4.9
2016	36.8	605409	6.59	3093.6	6
2017	38.7	833000	6.68	4100.4	5.2
2018	62.9	12667	47.5	3484.7	5.7
2019	50.45	109760	45.6	3973.3	5
Type of Criteria	Min.	Max.	Min.	Max.	Max.

The data in Table 1 is transformed into linguistic terms to use the FTOPSIS method in real-life problems without depending on the experts' opinions, experiences, and skills. When there is a big contrary among them, the effects of experts will directly reflect in the comparison matrix and will lead to obtaining different solutions. In other words, the comparison matrix will change to the experts or teams of experts. Therefore, this study is focused on applying the FTOPSIS method for real-life problems. The steps of the FTOPSIS method are applied in the following;

Step 1. These linguistic variables for both alternatives and criteria can be expressed in form of triangular fuzzy numbers as seen in Table 3 and Table 4.

Table 2: Linguistic Terms for Alternatives

Linguistic Terms	Fuzzy Rates
Very bad	(0,0,1)
Bad	(0,1,3)
Medium bad	(1,3,5)
Medium	(3,5,7)
Medium good	(5,7,9)
Good	(7,9,10)
Very good	(9,10,10)

Source: Ozcakar and Demir, 2011

Table 3: Linguistic Terms for Criteria

Linguistic Terms	Fuzzy Rates
Very low	(0.0,0.0,0.1)
Low	(0.0,0.1,0.3)
Medium Low	(0.1,0.3,0.5)
Medium	(0.3,0.5,0.7)
Medium High	(0.5,0.7,0.9)
High	(0.7,0.9,1.0)
Very High	(0.9,1.0,1.0)

Source: Ozcakar and Demir, 2011

Step 2. The data in Table 1 is transformed into linguistic terms to use in FTOPSIS and it is revealed in Table 4.

Table 4: Linguistic Terms for All Indicators

Year	Inflation (%)			Gross Domestic Product			Exchange rate (%)			Export (SD)			Economic Growth (%)		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
2000	9	10	10	9	10	10	9	10	10	9	10	10	9	10	10
2001	9	10	10	9	10	10	9	10	10	9	10	10	9	10	10
2002	9	10	10	7	9	10	7	9	10	7	9	10	9	10	10

2003	7	9	10	7	9	10	7	9	10	7	9	10	7	9	10
2004	7	9	10	7	9	10	7	9	10	7	9	10	7	9	10
2005	7	9	10	5	7	9	7	9	10	7	9	10	7	9	10
2006	5	7	9	5	7	9	5	7	9	5	7	9	5	7	9
2007	5	7	9	5	7	9	5	7	9	5	7	9	5	7	9
2008	5	7	9	5	7	9	5	7	9	5	7	9	3	5	7
2009	3	5	7	3	5	7	3	5	7	3	5	7	3	5	7
2010	3	5	7	3	5	7	3	5	7	3	5	7	3	5	7
2011	3	5	7	3	5	7	3	5	7	3	5	7	3	5	7
2012	1	3	5	3	5	7	1	3	5	1	3	5	3	5	7
2013	1	3	5	1	3	5	1	3	5	1	3	5	3	5	7
2014	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5
2015	0	1	3	0	1	3	1	3	5	1	3	5	1	3	5
2016	0	1	3	0	1	3	0	1	3	0	1	3	1	3	5
2017	0	1	3	0	1	3	0	1	3	0	1	3	0	1	3
2018	0	0	1	0	0	1	0	0	1	0	0	1	0	1	3
2019	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1

Step 3. In this step fuzzy weights for criteria and weighted normalized matrix will be computed in the form of fuzzy number. They are presented in Table 5 and Table 6.

Table 5: Fuzzy Weights for Criteria

Years	Inflation (%)			Gross Dom. Product			Exchange rate (%)			Export (SD)			Economic Growth (%)			Fuzzy weights		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
2000	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
2001	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
2002	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1	0.8	0.9	1
2003	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
2004	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
2005	0.7	0.9	1	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.6	0.9	1,0
2006	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9
2007	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9
2008	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.46	0.7	0.9
2009	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7
2010	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7
2011	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7
2012	0.1	0.3	0.5	0.3	0.5	0.7	0.1	0.3	0.5	0.1	0.3	0.5	0.3	0.5	0.7	0.18	0.4	0.6
2013	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.3	0.5	0.7	0.18	0.3	0.5
2014	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5
2015	0	0.1	0.3	0	0.1	0.3	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.06	0.2	0.4
2016	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3	0.1	0.3	0.5	0.02	0.0	0.3
2017	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3
2018	0	0	0.1	0	0	0.1	0	0	0.1	0	0	0.1	0	0.1	0.3	0	0.02	0.14
2019	0	0	0.1	0	0	0.1	0	0	0.1	0	0	0.1	0	0	0.1	0	0	0.1

Table 6: Normalized Fuzzy Matrix

Years	Inflation (%)			Gross Domestic Product			Exchange rate (%)			Export (SD)			Economic Growth (%)		
	l m u			l m u			l m u			l m u			l m u		
2000	9	10	10	9	10	10	9	10	10	9	10	10	9	10	10
2001	9	10	10	9	10	10	9	10	10	9	10	10	9	10	10
2002	9	10	10	7	9	10	7	9	10	7	9	10	9	10	10
2003	7	9	10	7	9	10	7	9	10	7	9	10	7	9	10
2004	7	9	10	7	9	10	7	9	10	7	9	10	7	9	10

2005	7	9	10	5	7	9	7	9	10	7	9	10	7	9	10
2006	5	7	9	5	7	9	5	7	9	5	7	9	5	7	9
2007	5	7	9	5	7	9	5	7	9	5	7	9	5	7	9
2008	5	7	9	5	7	9	5	7	9	5	7	9	3	5	7
2009	3	5	7	3	5	7	3	5	7	3	5	7	3	5	7
2010	3	5	7	3	5	7	3	5	7	3	5	7	3	5	7
2011	3	5	7	3	5	7	3	5	7	3	5	7	3	5	7
2012	1	3	5	3	5	7	1	3	5	1	3	5	3	5	7
2013	1	3	5	1	3	5	1	3	5	1	3	5	3	5	7
2014	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5
2015	0	1	3	0	1	3	1	3	5	1	3	5	1	3	5
2016	0	1	3	0	1	3	0	1	3	0	1	3	1	3	5
2017	0	1	3	0	1	3	0	1	3	0	1	3	0	1	3
2018	0	0	1	0	0	1	0	0	1	0	0	1	0	1	3
2019	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1
			10			10			10			10			10

Table 7 shows the normalized fuzzy decision matrix. By considering the importance of each criterion, we can obtain the weighted normalized fuzzy valued matrix. This matrix is depicted by Table 8 including fuzzy positive ideal solutions (FPIS) and fuzzy negative ideal solution (FNIS) at the below.

Table 7: Normalized Fuzzy Decision Matrix

Years	Inflation (%)			Gross Domestic Product			Exchange rate (%)			Export (SD)			Economic Growth (%)		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
2000	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
2001	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1	0.9	1	1
2002	0.9	1	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.9	1	1
2003	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
2004	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
2005	0.7	0.9	1	0.5	0.7	0.9	0.7	0.9	1	0.7	0.9	1	0.7	0.9	1
2006	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9
2007	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9
2008	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7
2009	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7
2010	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7
2011	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7
2012	0.1	0.3	0.5	0.3	0.5	0.7	0.1	0.3	0.5	0.1	0.3	0.5	0.3	0.5	0.7
2013	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.3	0.5	0.7
2014	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5
2015	0	0.1	0.3	0	0.1	0.3	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5
2016	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3	0.1	0.3	0.5
2017	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3
2018	0	0	0.1	0	0	0.1	0	0	0.1	0	0	0.1	0	0.1	0.3
2019	0	0	0.1	0	0	0.1	0	0	0.1	0	0	0.1	0	0	0.1

Table 8. Weighted Normalized Matrix

Years	Inflation (%)			Gross Domestic Product			Exchange rate (%)			Export (SD)			Economic Growth (%)		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
2000	0.81	1	1	0.81	1	1	0.81	1	1	0.81	1	1	0.81	1	1
2001	0.81	1	1	0.81	1	1	0.81	1	1	0.81	1	1	0.81	1	1
2002	0.70	0.94	1	0.546	0.85	1	0.55	0.85	1	0.55	0.85	1	0.70	0.94	1
2003	0.49	0.81	1	0.49	0.81	1	0.49	0.81	1	0.49	0.81	1	0.49	0.81	1
2004	0.49	0.81	1	0.49	0.81	1	0.49	0.81	1	0.49	0.81	1	0.49	0.81	1
2005	0.46	0.77	0.98	0.33	0.6	0.88	0.46	0.77	0.98	0.46	0.77	1	0.46	0.77	0.98
2006	0.25	0.49	0.81	0.25	0.49	0.81	0.25	0.49	0.81	0.25	0.49	0.8	0.25	0.49	0.81
2007	0.25	0.49	0.81	0.25	0.49	0.81	0.25	0.49	0.81	0.25	0.49	0.8	0.25	0.49	0.81
2008	0.23	0.46	0.77	0.23	0.46	0.77	0.23	0.46	0.77	0.23	0.46	0.8	0.13	0.33	0.60
2009	0.09	0.25	0.49	0.09	0.25	0.49	0.09	0.25	0.49	0.09	0.25	0.5	0.09	0.25	0.49
2010	0.09	0.25	0.49	0.09	0.25	0.49	0.09	0.25	0.49	0.09	0.25	0.5	0.09	0.25	0.49
2011	0.09	0.25	0.49	0.09	0.25	0.49	0.09	0.25	0.49	0.09	0.25	0.5	0.09	0.25	0.49
2012	0.02	0.11	0.29	0.054	0.19	0.41	0.02	0.11	0.29	0.02	0.11	0.3	0.05	0.19	0.41
2013	0.02	0.10	0.27	0.018	0.1	0.27	0.02	0.1	0.27	0.02	0.1	0.3	0.05	0.17	0.38
2014	0.01	0.09	0.25	0.01	0.09	0.25	0.01	0.09	0.25	0.01	0.09	0.3	0.01	0.09	0.25
2015	0	0.02	0.13	0	0.02	0.13	0.01	0.07	0.21	0.01	0.07	0.2	0.01	0.07	0.21
2016	0	0	0.10	0	0	0.1	0	0	0.10	0	0	0.1	0.00	0.01	0.17
2017	0	0.01	0.09	0	0.01	0.09	0	0.01	0.09	0	0.01	0.1	0	0.01	0.09
2018	0	0	0.01	0	0	0.01	0	0	0.01	0	0	0	0	0.00	0.04
2019	0	0	0.01	0	0	0.01	0	0	0.01	0	0	0	0	0	0.01

Step 4: Euclidean distances, $d(V_{ij},V^*)$ from FPIS and FNIS are calculated and shown in Table 9.

Table 9: FTOPSIS Score

Years	Total Distances from FPIS	Total Distances from FNIS	FTOPSIS Score
2000	3.75	10.4	0.735
2001	4.238	8.34	0.663
2002	3.975	7.62	0.657
2003	3.975	7.62	0.657
2004	2.952	5.98	0.67
2005	2.827	3.18	0.53
2006	3.199	0.52	0.14
2007	2.416	19.8	0.891
2008	3.405	31.2	0.902
2009	3.754	26.9	0.878
2010	3.498	26.9	0.885
2011	3.41	15.8	0.823
2012	2.661	14.9	0.848
2013	2.502	19.9	0.888
2014	2.965	13	0.814
2015	2.24	27.7	0.925
2016	3.337	34.1	0.911
2017	3.673	30.7	0.893
2018	3.42	29.6	0.896
2019	4.633	12.2	0.725

In Table 10, obtained FTOPSIS are ordered in descending order to create the priorities of the years. Final rankings show that the year 2015 is the best year for Sudan according to the selected macroeconomic criteria. Using same macroeconomic indicators, TOPSIS method is applied to compare the results. After the analysis, result is shown in Table 11.

Table 10. Final Ranking for FTOPSIS

Years	FTOPSIS Score	Rank of FTOPSIS
2015	0.9252	1
2016	0.9109	2
2008	0.9016	3
2018	0.8965	4
2017	0.8932	5
2007	0.8914	6
2013	0.8884	7
2010	0.8851	8
2009	0.8777	9
2012	0.8481	10
2011	0.8229	11
2014	0.8144	12
2000	0.7351	13
2019	0.7252	14
2004	0.6695	15
2001	0.663	16
2002	0.6572	17
2003	0.6572	18
2005	0.5295	19
2006	0.1401	20

Table 11. Final Ranking for TOPSIS

Years	TOPSIS SCORE C_i	Rank of TOPSIS
2018	0.6964	1
2019	0.5315	2
2017	0.3534	3
2015	0.32774	4
2001	0.29664	5
2016	0.2950	6
2008	0.2922	7
2007	0.2919	8
2006	0.2801	9
2009	0.2752	10
2010	0.2752	11
2000	0.2734	12
2014	0.27328	13
2011	0.2723	14
2005	0.2684	15
2003	0.2657	16
2004	0.2622	17
2002	0.2611	18
2013	0.2210	19
2012	0.1731	20

4. FINDINGS AND RESULTS

This section summarizes the findings and results of this paper and it highlights the general results more than three findings were obtained using the FTOPSIS and TOPSIS methods. In this case, future research will obtain additional information by combining the linguistically expressed predictor and actual data. Except for the years 2006 and 2012, as well as 2000 and 2014, FTOPSIS can be used for mixed variants because the findings are identical.

5. DISCUSSION AND CONCLUSION

Recently economic crises and the civil wars in Sudan are diminishing resources for production. Therefore, the country must evaluate its macroeconomic indicators. This will enable the country to function adequately both in crises and in wartime. This study aims to evaluate the performance of the Sudanese economy through five macroeconomic indicators (Inflation, Gross domestic product, Exchange rate, Export, Economic growth) during the period from 2000-2019 using FTOPSIS method. According to the results of this study, there is a direct skip from bottom to top not step by step, for example, the rank of 2007 is 6 while 2008 is 13 the reason for that is economic crises and the civil wars in Sudan. The final ranking results show that the most successful economic performance in the year 2015, It`s followed by the second rank in 2016. 2006 is the year with the lowest macroeconomic performance in Sudan. The findings of this study would help the government and decision makers of Sudan for taking necessary precautions and foreign investors for creating more effective investment strategies.

Another issue that needs to be considered is that there are other indicators such as long-term interest rates, investment, and unemployment, gross national product, and import volumes, affecting macroeconomic performance. Due to the limitation of data access, the number of indicators used in the study is limited.

Finally, this study recommends decision-makers in the Central Bank of Sudan and the Ministry of Finance and Economic planning to pay attention to the periodic performance evaluation process of the Sudanese macroeconomic indicator and awareness of the evaluation criteria and evaluation process. Another decision-making approach can be used for feature analysis, or this method can be used for Sudan in other socioeconomic and cultural areas.

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