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Research Article

Measuring the Efficiency of the Kingdom of Saudi Arabia's Economy against Other G20 Economies Using Multi-criteria Decision Making to Endorse Vision 2030

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Abstract

The G20 is an international forum for the governments and central bank governors of 19 countries and the European Union (EU). The group consists of the world's largest and fastest-growing economies. Measuring a national economy through one factor alone could be misleading. Therefore, the aim of this study was to assess and evaluate the national economy of the Kingdom of Saudi Arabia (KSA) using multiple factors to compare the current economic situation with the future situation using Saudi Vision 2030 targets. A model was established using several input and output criteria to calculate economic efficiency. The model used data envelopment analysis (DEA) to measure efficiency, and the technique for preference by similarity to the ideal solution (TOSIS) was used to sort the economies of the G20 countries. The results reveal the economic efficiency of the G20 countries and facilitate sorting their economies based on several economic parameters.

Keywords: *Data Envelopment Analysis (DEA), Economy, G20, Multi-criteria Decision Making (MCDM), Saudi Vision 2030*

1. Introduction

A. Introduction

A national economy is a complex system. Such a system can be measured by several factors. In 2016, the Kingdom of Saudi Arabia (KSA) introduced a new approach (ttps://vision2030.gov.sa/) to reform and improve the country's economic situation despite its position as a G20 member. The G20 is an international forum for the governments and central bank governors of the world's 20 leading economies. The G20 accounts for 80% of world trade and 75% of the world's population (G20.org. 2015).

The aim of this study is to identify the relative economic efficiency of the G20 countries and the KSA economy based on VISION 2030 targets considering country population and total imports as inputs and gross domestic product (GDP), nonoil government revenues, balance of payments, consumption and the inflation rate as outputs. Another goal is to assess the current position of the Kingdom of Saudi Arabia's economy in the G20.

The paper commences with a statement of the problem, in which the significance and necessity of the research is explained. Next, the paper's objectives are presented, including what will be accomplished through the research. Subsequently, the paper's method and real-world implications are introduced, with emphasis on the practical outcomes that will follow from achieving the objectives. Finally, the results of the study are presented and discussed.

B. Statement of the problem

The Kingdom of Saudi Arabia (KSA) is a member of the G20, which means that the Saudi economy ranks among the world's 20 leading economies. Why, therefore, is the Saudi government undertaking economic reform? Each country's economy depends on various components, such as oil production, manufacturing, tourism, or farming. Certain countries have strong economies because they depend on various income sources. However, 75% of Saudi Arabia's economy is based on oil (J. Jiang *et al*, 2011). These circumstances might be hazardous for Saudi Arabia because if oil prices decreased dramatically, the Saudi's economy would collapse, and the Kingdom of Saudi Arabia would lose its position in the G20. Therefore, in 2016, the Saudi Arabian government developed Vision 2030 as a means to initiate economic reform.

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Economic comparison is complex because of the differences between income sources and economic outputs from country to country. For example, although Saudi Arabia's economy is one of the strongest economies in the world, the Saudi government initiated economic reform by establishing Vision 2030. Thus, a country that receives less income from several sources could be more confident than a country with a high income that is dependent on one source. This fact raises several questions: How can national economies be compared? What is the current position of Saudi Arabia among global economies? How will Vision 2030 strengthen the Saudi economy?

C. Objectives

The main objectives of this study are as follows:
1. Measure the economic efficiency of the G20 countries.
2. Assess and evaluate the current economic position of the Kingdom of Saudi Arabia in the G20.
3. Compare the current economic state of Saudi Arabia with that of the economy proposed in Vision 2030.

2. Literature review

Key performance indicators (KPIs) refer to measurable values that indicate the effectiveness of a country in achieving its key objectives and aims. Key areas of performance in a country are used on multiple levels to identify and evaluate the different approaches countries use to reach their targets (J. Jiang *et al,* 2011).

Multi-criteria decision making (MCDM) is a practical tool for selecting and ranking a number of alternatives, and its applications are numerous (Dağdeviren *et al*, 2009). Data envelopment analysis (DEA) uses multiple inputs and outputs from several units to create an optimal unit and then compares all the units with the optical one (i.e., relative efficiency comparison) (N. Donthu *et al*, 2005). The technique for order of preference by similarity to ideal solution (TOPSIS) is a multi-criteria technique to classify solutions from a restricted set of alternatives based on the instantaneous minimization of expanse from an ideal point and the maximization of expanse from a lowest point (D. Olson, 2004).

3. Methodology

World Bank Data and Saudi Vision 2030 for the year 2017 were used as data sources. These sources include the input and output data for the G20 countries. The following input and output factors were used: population, total imports, gross domestic product (GDP), unemployment, balance of payments, final consumption expenditure, inflation and total exports.
DEA and Frontier Analyst software were used to calculate the efficiency of the G20 countries. Subsequently, in a second scenario, Saudi Vision 2030 targets were used. Finally, all of the G20 countries were sorted using TOPSIS.

A. Data envelopment analysis (DEA)

Data envelopment analysis is a multi-criteria decision-making method used to assess the relative efficiency of each unit within a set of decision-making units (O. Taylan, 2014).

In this study, the G20 countries were evaluated using DEA. Multiple input and output factors were used as follows: Inputs: population and total imports; Outputs: gross domestic product (GDP), nonoil government revenues, balance of payments, consumption and the inflation rate. The goal of using DEA is to determine an economy's efficiency, which will serve as a criterion for sorting the G20 countries. Data envelopment analysis (DEA) was used as follows (K. Vincová, 2005):

$$Efficiency = \frac{Weighted\ of\ Sum\ of\ Outputs}{Weighted\ sum\ of\ Inputs} = \frac{\sum_{i=1}^{s} u_i y_{iq}}{\sum_{i=1}^{m} v_i x_{iq}}$$

The following DEA model was used:

$$Maximize\ \frac{\sum iu_i y_{iq}}{\sum ju_j y_{jq}}$$

$$S.t.\ \frac{\sum iu_i y_{ik}}{\sum ju_j y_{jk}} \leq 1\ k = 1,2,\dots,n$$
$$u_i\ \geq \in\ \ i = 1,2,\dots,s$$
$$v_j\ \geq \in\ \ j = 1,2,\dots,s$$

where:

V_i,j = 1,2,..., m are weights assigned to the j-th input;
U_i,i = 1,2,..., m are weights assigned to the j-th output.

B. Technique for order of preference by similarity to ideal solution (TOPSIS)

TOPSIS is a multi-criteria decision-making method; it aims to select the best alternatives from among multiple alternatives using a set of criteria (P. W. Bhutia, 2012).

In this study, the G20 countries were evaluated using TOPSIS. The following criteria were used: population, total imports, gross domestic product (GDP), nonoil government revenues, balance of payments, consumption, the inflation rate and efficiency (i.e., the DEA result). The goal of using DEA is to determine an economy's efficiency, which will serve as a criterion for sorting the G20 countries. TOPSIS was used as follows (H. Alidrisi, 2017):

Step 1: Form a decision matrix:

$$D = \begin{array}{c} \\ A_1 \\ A_i \\ A_m \end{array} \begin{array}{c} \begin{array}{ccc} C_1 & C_j & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{ij} & x_{1n} \\ \vdots & \vdots & \vdots \\ x_{m1} & x_{mj} & x_{mn} \end{bmatrix} \end{array}$$

where:

Cj represents criterion j for j = 1; ... ; n
Ai represents alternative i (or element i) for i = 1; ... ; m
xij represents the original data input for the decision matrix.

Step 2: Develop the normalized decision matrix:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum x_{ij}^2}} \; for \; i = 1, \dots, m; j = 1, \dots, n$$

where:

r_{ij} represents the normalized score of the decision matrix.

Step 3: Develop the weighted normalized decision matrix:

$V_{ij} = w_j \, x \, r_{ij}$

where:
w_j represents the weight of each j criterion.

Step 4: Identify the positive ideal solution and the negative solution:

$$A^+ = \{v_1^+, \dots, v_n^+\} \; Positive \; ideal \; soulation$$
$$A^- = \{v_1^-, \dots, v_n^-\} \; Positive \; ideal \; soulation$$

where:

$$v_1^+ = \{max(v_{ij}) if \; j \epsilon J; min(v_{ij}) if \; j \epsilon J^{\sim}\}, j = 1, \dots, n$$
$$v_1^- = \{min(v_{ij}) if \; j \epsilon J; max(v_{ij}) if \; j \epsilon J^{\sim}\}, j = 1, \dots, n$$

J represents the set of benefit criteria;
$J^{\sim}$ represents the set of cost criteria.

Step 5: Determine the separation measures:

$$S_i^+ = \sqrt{\sum (v_i^+ - v_{ij})^2, i = 1, \dots, m}$$
$$S_i^- = \sqrt{\sum (v_i^- - v_{ij})^2, i = 1, \dots, m}$$

Step 6: Identify the relative closeness to the ideal solution:

$$C_i^{\sim} = \frac{S_i^-}{(S_i^+ + S_i^-)}, 0 < C_i^{\sim} < 1$$

4. Results

A. Relative efficiency of the g20 countries (DEA implementation)

The study considers population and total imports as efficiency analysis inputs (Table I). Gross domestic product (GDP), unemployment, balance of payments, final consumption expenditure, inflation and total exports are considered as outputs (Table II). Additionally, the output measures of the KSA based on Vision 2030 are shown in Table III.

The results following DEA implementation are shown in Table IV.

B. Sorting the G20 countries using TOPSIS

All the input and output factors and the efficiency results were used to sort the G20 countries.

5. Discussion

A. Results and discussion

The DEA results indicate that the KSA's economy is relatively efficient in its current status. In addition, it will be relatively efficient after implementing Vision 2030. After the implementation of Vision 2030, only eight countries will have efficient economies, while prior to implementation, ten countries possess efficient economies. Because DEA is based on a composite unit, which is a combination of the best efficiency criteria among all G20 counties, when Saudi Arabia's values increase, the composite unit also increases, thus decreasing the number of efficient economies. Therefore, the KSA economy will be stronger after implementing Vision 2030.

The TOPSIS analysis indicates that China has the best economy and Argentina the worst economy among the G20 countries. TOPSIS considers the values of each criterion. For example, if a country has a population of 10 million but exports goods equivalent to that of a country of 100 million, its economy will be better than that of a country with a population of 20 million that exports goods equivalent to a country of 110 million. Thus, Saudi Arabia's economy increases from ranking number 17 to ranking number 14 because the parameters of Vision 2030 indicate higher values than those of the current KSA economy. According to TOPSIS, the Saudi Arabia economy will be better if the country reaches the required levels of GDP, unemployment, balance of payments and total exports targeted by Vision 2030.

B. Perspectives for future research

This research investigates the main factors considered as inputs and outputs for a country's economy. It also establishes how to compare national economic efficiencies using economic inputs and outputs. Additionally, the research analyzes the positions of the G20 countries to compare them with the position of Saudi Arabia's economy to clearly characterize the Saudi economy and to underline the importance of implementing economic reform. To increase the accuracy of the results, several years' worth of data should be studied. In addition, a forecast for all parameters of a G20 country should be calculated based on Vision-like plans, if a country has such a plan. Moreover, in addition to DEA and TOPSIS, other models could be used to assess the data.

Table I G20 Populations and Total Imports

Country	**Population**	**Total Imports (**$ Billion)
Argentina	**44,570,000**	**84,846**
Australia	**25,182,000**	**305,306**
Brazil	**210,400,000**	**266,778**
Canada	**37,078,000**	**581,116**
China	**1,396,982,000**	**2,548,985**
France	**65,098,000**	**891,893**
Germany	**82,786,000**	**1,606,491**
India	**1,334,221,000**	**638,781**
Indonesia	**265,316,000**	**229,861**
Italy	**60,756,000**	**606,703**
Japan	**126,431,000**	**818,383**
Mexico	**124,738,000**	**502,980**
Russia	**143,965,088**	**344,262**
Saudi Arabia	**33,203,000**	**209,980**
South Africa	**57,420,000**	**108,836**
South Korea	**51,665,000**	**631,474**
Turkey	**71,867,000**	**236,010**
United Kingdom	**66,466,000**	**887,202**
United States	**328,116,000**	**2,928,596**
European Union	**512,600,000**	**8,036,501**

Table II G20 Gross Domestic Products (GDPs), Unemployment, Balance of Payments, Final Consumption Expenditures, Inflation and Total Exports

Country	GDP ($ Billion)	Unemployment (%)	BOP ($ Billion)	Consumption Rate ($ Billion)	Inflation (%)	Total Exports ($ Billion)
Argentina	518,092	8.3	-27,740	**420,946**	34.27	**74,667**
Australia	1,418,275	5.6	-30,437	**1,078,023**	1.97	**310,569**
Brazil	1,868,184	12.3	-14,511	**1,570,554**	3.66	**276,656**
Canada	1,711,387	5.8	-45,287	**1,353,891**	2.24	**544,861**
China	13,407,398	3.9	49,200	**6,467,893**	2.1	**2,655,609**
France	2,775,252	9.4	-19,584	**2,147,538**	2.1	**870,409**
Germany	4,000,386	3.7	294,300	**2,876,742**	1.92	**1,877,006**
India	2,716,746	2.7	-68,453	**1,926,543**	3.48	**536,965**
Indonesia	1,022,454	4.2	-31,060	**687,161**	3.19	**218,498**
Italy	2,072,201	11.2	53,487	**1,649,675**	1.24	**658,594**
Japan	4,971,929	2.4	174,103	**3,652,842**	0.97	**863,818**

Table III Gross Domestic Product (GDP), Unemployment, Balance of Payments, Final Consumption Expenditure, Inflation and Total Exports for the Kingdom of Saudi Arabia Based on Vision 2030

Country	GDP ($ Billion)	Unemployment (%)	BOP ($ Billion)	Total Exports ($ Billion)
Saudi Arabia (vision 2030)	2,000,000	7	135,000	1,000,000

Table IV Efficiency Score

Country	**Efficiency % (Actual Data)**	**Efficiency % (Saudi Vision 2030 Target)**
Argentina	100	100
Australia	100	100
Brazil	100	78.3
Canada	87.3	76.3
China	100	100
France	87.5	71.5
Germany	100	100
India	73.5	55.3
Indonesia	77	47.9
Italy	90.9	56.6
Japan	100	100

Table V G20 Ranking Based on TOPSIS

Rank	Country (Actual Data)	Country (Saudi Vision 2030 Target)
1	China	China
2	India	India
3	Japan	Japan
4	Germany	Germany
5	European Union	European Union
6	United States	United States
7	Russia	Russia
8	France	France
9	Italy	Italy
10	Brazil	Brazil
11	South Korea	South Korea
12	Indonesia	Indonesia
13	United Kingdom	United Kingdom
14	Canada	Saudi Arabia
15	Australia	Canada
16	Mexico	Australia
17	Saudi Arabia	Mexico
18	South Africa	South Africa
19	Turkey	Turkey
20	Argentina	Argentina

Conclusion

A country's economy impacts the lifestyle of the country's population and increases quality of life. A national economy can be assessed using several factors. In this research, several factors were used to analyze economic efficiency. The economy of Saudi Arabia was assessed against the economies of the G20 countries using several input and output factors in a relative manner. In addition, the targets of Saudi Vision 2030 were assessed and compared to their equivalents in the G20 countries.

World Bank data and Saudi Vision 2030 were the analyzed data sources. The data were analyzed using data envelopment analysis (DEA) and Frontier Analyst software to determine economic efficiency. Subsequently, TOPSIS was used to sort the G20 countries.

It was found that the Saudi Arabian economy is efficient at present and will continue to be so after implementation of Vision 2030. In addition, most G20 countries have efficient economies. The exceptions were Brazil, Canada, France, India, Italy, Mexico, South Africa, South Korea, Turkey and the United Kingdom. In addition, Russia has an efficient economy compared to the current KSA economy. However, compared to the Vision 2030 version of the KSA economy, the Russian economy will not be efficient. It was also concluded that China, India and Japan have the strongest economies, while Turkey and Argentina have the least efficient economies.

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