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Analysis of the Relative Efficiency and Ranking Research & Development in Iran Compared to Regional Countries

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Abstract

Today's capabilities, development and true independence of countries have direct relations with large amount of ability to produce and knowledge development. The aim of this study is to evaluate the relative efficiency performance of research and development of Iran in comparison with regional countries using combination mechanism of Data Envelopment Analysis and TOPSIS. Among these research and development activities in fourteen countries in the region has been extracted, in this regard to evaluate the relative efficiency of inputs such as enrollment rates in science and engineering, amount of research and development researchers, research and development expenditure and outputs such as number of scientific and engineering papers, international received patents and export advanced technology. Countries performances in this section were calculated from 49 different input and output combinations and using data envelopment analysis techniques, finally TOPSIS technique were used as a complete ranking mechanism. The ranking results indicate that Lebanon had the best performance and Kyrgyzstan had the weakest performance in total different input and output combinations among selected countries. One of the results which have to be thought is the inadequate position of research and development of Iran among selected countries which ranks thirteen among the 14 countries under study.

Keyword: Relative Efficiency, Research And Development, Data Envelopment Analysis, Topsis

Introduction

Today's capabilities, development and true independence of countries have direct relation with large amount of ability to knowledge production and national development. Knowledge production and their development are known as driving factor for comprehensive development and countries sustainability. Undoubtedly, development and progress of industrial, economic and social of each country depends on research and continuous research in all fields and today this has led the country's to be classified based on the ability in production and knowledge application (Seresti et al 2010). Research and development activities which maybe involved in various stages of innovation process, research and development is not only a source of new idea but can also be used to solve the identified issues (Valderrama et al., 2008). In other words, research and development activities a structured process consists of creation, production, publishing, and knowledge application (Wang and Hunng, 2007; Wang, 2007; Lu and Hunng, 2010). Since investment in research and development is one of the most important elements of scientific and technological progress, each country uses the resources in an inefficient way, there are slower in progress so that more investment in such circumstances will help less in making progress (Wang and Hunng, 2007; Wang, 2007). Industrial commission in 1994, research and development a major source of innovation and an important driver is known as the economic growth of each country (Hirons et al., 1998). Recently in many countries large amount of resources are spent on research and development activities. For example, in 2003, research and development gross domestic expenditure to gross domestic production in America, Japan, and 25 European countries were 2.67 %, 3.12 % and 1.86 % respectively (Wang, 2007). The share of research and development in creating economic value can be measured in the combination of two factors: 1) the economic value created by research and development projects. 2) The value of strategic infrastructure meaning the guarantee of the considered project in future (Wang and Hunng, 2007). Research and development activities in addition to objective benefits also create subjective benefits such as creating informal communication, membership in international networks and knowledge transfer mechanisms and the like. Till date some of these benefits have not been stated between beneficiaries in research and development activities. This subjective benefit helps research group to take step to solve industrial problems in successful research companies. Gil Kinson, Barrett stated that research and development may not create rapidly the tangible benefit but in long-term causes the creation of objective and subjective benefits that through these people business and their program develops. Cohen and Levinthal concluded that research and development increases the attraction capacity of companies such as ability to identify, attract and extract new information from internal or external environment. This led to strengthening the work force and improves organization capability and also increases productivity and efficiency and competitive advantages in the market (Kulatunga et al., 2007). Governments, investors and researchers have emphasized on the role of scientific research and development in economic growth and most economists believe that government research and development activities will cause sustainable economic growth (Wang, 2007; Chiesa and Masella, 1996).

With regard to the importance of research and development in economic growth of countries, it is necessary to evaluate the research and development performance of each country in comparison with other countries and determine its position in different regions. Iran like other countries needs itself to progress in research and development and formation and associated institution in this field, orientation content of national and scientific documents such as Fourth Program Act and perspective documents, comprehensive map and also

emphasize senior management system on importance of issues. Considering the importance of research and development and necessity of management at national level and also active interaction with other countries especially neighboring countries and regions in having basic information is essential which can demonstrate a picture of research and development performance status of Iran among countries. In fact, recognition of status and country's research and development performance position in international and regional level are prior basis to enter the path to develop innovative capacity to reach 2025 goals of Iran. The research question is that if Iran must achieve the first rank in the region of Southwest Asia in 2025 with the start of Fifth Development Plan and also the approval of scientific comprehensive plan of the country what are the conditions of this system and Iran's position and ranking in the region (Bakhshi et al., 2011).

Evaluation process and comparison of research and development activities are difficult due to its complexity with risk, uncertainty, long term development, difficult to identify outputs and existence of various output parameters. However, the performance of organizations research and development can be studied by assessing their relative efficiency (Jyoti et al., 2008). Conventional method of performance management generally considers the output level resulting from organization system performance. While with a systematic approach it can be achieved that assessing to output in the context of utilizing inputs and using appropriate processes. Therefore, only paying attention to the outputs in evaluation and performance management will further misguide us.

One of the methods having many applications in short period of time is the Data Envelopment Analysis (DEA) method. DEA is a method based on mathematical programming which is used to evaluate relative efficiency of similar decision making units. Capabilities of this method in comparison with similar units and also the result analysis are added to its application in various fields. The performance advantage of this technique to evaluate the performance efficiency of research and development units can be referred to the following (Wang and Hunng, 2007).

1) This method is valuable for issues that the relative importance of inputs which are employed by decision making units and outputs which are created by decision making units are not given. This situation occurs when the government assigns their resources to research and development activities of science and technology but no comprehensive agreement weights assigned to inputs and outputs.
2) This issue seems serious that no engineering knowledge is available concerning precise interaction relation between the input and output of research and development. DEA makes it possible that efficiency evaluation will be done without the necessity to define a function that shows exact relationship between research and development and produce knowledge and technology.

The aim of this paper is to assess the relative efficiency of research and development performance of the region and Iran's position in this sector. After reviewing the researches done in performance evaluation centers and research and development projects we will describe the methodology used in this paper. Then analysis the result and finally summarize and present the results of this research.

Research Background

Till date different performance evaluation systems are developed for performance evaluation of research and development of organizations and countries that can be noted to harmonize

evaluation system and DEA which as qualitative and quantitative with regard to certain criteria conducts the evaluation process, following with a brief description of this research.
Heydarizadeh et al., (2006), in a study using DEA mathematical model measured the university efficiency and physical education department of Government University. In this study, the weights of inputs and outputs were calculated using fuzzy hierarchical analysis method. The model inputs included financial capital that is, allocated average budget and human capital that is value of faculty members and staff and their grades and model outputs were educational activities that is value of graduate at various level, research activities that is value of research work and service activities that is value of professional service of each department or educational department. In this research 20 physical education colleges from Government University were evaluated. Bakhshi et al., (2011), in a research assessed the innovative status in Southwest Asia and determining Iran's position with application of promotes decision making method. Their study had two main objectives, the first objective is to evaluate indicators of innovation in Southwest Asia and determining the position of Iran based on these indicators and the second objective is to clarify the application of Promta method. Therefore, initially the innovative indicators are classified and then the status and trends of these indicators are studied in the region. In the next stage, weights are allocated using entropy technique and finally using Promta technique of type 2 the countries are given priority and Iran's position were determined based on combination indicators of innovation. The result showed that on the bases of combination indicators of innovations, countries like Lebanon, Georgia, UAE in groups of countries with good innovation status and Oman, Pakistan and Syria were in country group with weak innovation status. Based on the results of this study among the countries under study Iran is in the middle. In Geisler research (1994), presented a model for evaluating research and development organization that various stages for research and development process are considered and using research and development management literature and interviews with managers and scientists of research and development a set of input and four output categories are identified. Finally, using output key indicators which includes the main indicators of the outputs with weight of each indicator the organization is assessed. In a study conducted by Canto and Gonzalez (1999), to investigate the role of internal and organizational factors on the implementation of research and development functions. This study was performed among 100 Spanish companies. In this study the role of three types of resources were studied including financial resources, physical resources and intangible resources on research and development, and finally intangible resources as the most important factor were identified in the research and development. In a study conducted by Anderson et al., (2007) has used DEA model to measure the efficiency of 54 university technology transfer. DEA model inputs were the total cost spend for research and model outputs includes revenue from licenses, trade agreement, companies established, accepted patents and patents published. In a study by Hashimoto and Haneda (2008), efficiency process of research and development in pharmaceutical industry were evaluated during 1983-1992 using DEA approach. In this study, the DEA model inputs were research and development expenses and model outputs were the number of inventions published in a year, annual drug sale and annual gross profit. According to the study results, the pharmaceutical industry during this decade the research and development has suffered a severe decline as in 1992 the efficiency of research and development of this industry has reached 50 percent of its value at the beginning of 1983 and few innovative companies have remained. A study conducted by Eilat et al., (2008), the relative efficiency of research and development projects during project life cycle was studied. In this study, DEA and balanced score card approach

were used. The research output DEA model, five aspects of balanced score card includes financial aspects, customer, internal business process, growth and learning and aspects of uncertainty and their inputs were the amount of investment. Jiut et al., (2008), for the first time in the concept of research and development two techniques of hierarchical analysis and DEA were used to assess the efficiency of research and development organization in India. In this study, the ability to execute, control capabilities and model efficiency among the mentioned set of inputs and outputs, six output scales and one input scale with expert views were chosen. Six output criteria in this study are the most important goals of the organization. These six criteria include published articles, royalties, emerged cash flow, product development, process or technology, awarded doctoral degree and awards gained by organization. The selected input criterion is the annual budget allocated to each organization. In a study by Lee et al (2009), conducted in Korea, relative performance of research and development program which are supported by government and the goals being heterogeneous were measured using DEA approach. The model inputs such as investment level and number of Ph.D. researchers and the model output is classified into three parts as papers, innovations and human resources. In this study, 548 research and development projects completed by 2005 were evaluated and finally six research and development programs were ranked through sponsors of government. Valdrama et al (2009), to prove the existence or lack of communication between four aspects of balanced score card to evaluate the efficiency of research and development activities has used the extension of different DEA models. In a study performed by Wang and Hunng (2007), using technique to examine the relative efficiency of research and development activities in 30 countries. Research and development expense and the force involved in the process were considered as input and patents and academic publications like articles were considered as the model output. Based on the results about one-third of the countries have suitable performance and two-third of the countries in the stages of increase in returns of scale. Many countries in the field of scientific publications have been more active than the patent. In this study, technique of DEA is used to evaluate relative efficiency of research and development measures and Tobit regression is utilized to control the external environment. In a study conducted by Phillips (2002), the type of incubator centers with their features have been identified and finally, technology incubator center performance is compared with other incubator centers. The result of this study shows that technology incubator center in comparison to other incubator centers plays better role, as having more employment rate, income and innovation application. But the cost and average budget deficit are more in these centers. In a study conducted by Liu and Lu (2009), efficiency of research and development of Taiwan were measured using DEA with approach based on two-step network. In this study, variables return to scale model with axis output approach is used. The results obtained by implementing separate DEA model showed that 17 institutions in technology and development stage and 18 institutions in technology publication were functioning. In a study conducted by Lu and Hunng (2010) process of technology development program were considered as two-stage research and development and technology publication development and then performance of technology development program using DEA were calculated. In the first phase the ability of technology development program to create publications, patents and to obtain technology were measured and in step 2, the ability of technology development program in publishing technology were measured. The research result shows that the performance of research and development is better than technology publication. In a study conducted by Guan and Chen (2010), process of innovative creation in industry with high technology level using network

framework by DEA network for 26 provinces in China have been measured. Inputs of this study include: the internal cost of research and development investment, reserves accumulated patents in each province and the model output includes patent employed, tax value and profit of new products, value added of new product, export value, sale income of new product, inputs technological innovation non research and development, cost to import technology and cost to absorb technology.

With regard to the studied background it can be concluded that research and development activities is composed of several input and output which by using several parametric method the standard's are made difficult. But the DEA naturally faces with approach of multiple inputs and multiple outputs and this approach is considered as a powerful tool for evaluating the performance of research and development of organizations and countries. Therefore, in this study, to assess the performance research and development of the region this approach has been used.

Methodology

The present study is descriptive and mathematical according to application purpose and implementation method. In this research countries of Southwest Asia including Afghanistan, Kazakhstan, Yemen, Turkmenistan, Iraq, Tajikistan, Palestine, Kuwait, Qatar, Cyprus, Bahrain, Iran, Armenia, Azerbaijan, Georgia, Jordon, Kyrgyzstan, Lebanon, Oman, Pakistan, Saudi Arabia, Syria, Turkey and United Arab Emirates were evaluated. Testing options based on access to information were adjusted for refining the criteria in the previous step and finally, among them 14 countries including Iran, Armenia, Azerbaijan, Georgia, Jordon, Kazakhstan, Kyrgyzstan, Lebanon, Oman, Pakistan, Saudi Arabia, Syria, Turkey and United Arab Emirates were selected, that these countries dispersion and suitable combination of regional country's of Middle East, Central Asia, Caucasus, Southwest Asia, Arab countries and other independent countries (Bakhshi et al., 2011).

This study seeks to provide a model to evaluate the performance of research and development of country's region with DEA approach. The weakness of this method is that the number of units to be assessed is related to the number of inputs and outputs of model. Therefore, as much is the number of variables the power of separation of units under study by the model decreases (Bal et al., 2010). Therefore, in such situations the number of variables in the model must be reduced.

Initially, with a priori review of previous studies and advantage of the views of relevant experts, indicators affecting on efficiency performance of research and development of selected countries was identified. Thus, accordingly using these indicators, inputs indicating the resources used and outputs indicating success and performance level of decision making are determined. With regard to this the assessment is at hyper-national level the evaluation criteria should be internationally agreed, means that first evaluation criteria were determined based on World Bank approach. In the next stage, according to the criteria for which data is present for Iran the criteria are refined and finally six criteria are selected as the input and output of DEA model. Table 1, shows the input and output performance of research and development of selected countries and their relative information. The time internal of these variables are for 2005, 2006 and 2007 and the necessary information is taken from source number.

Table 1:
Data related to input and output performance of country's region.

Country	Inputs			Outputs		
	Enrollment rate in Science and Engineering (%)	Number of researchers of research and development (per million population)	Research and development expenses (% of GDP)	Number of Science and Engineering articles (per million population)	Received international patents (per million population)	Export of advanced technology (% of industrial export)
	A	B	C	1	2	3
Iran	40.52	1272	0.59	38.14	0.02	6.17
Armenia	6.57	1638	0.21	59.61	0.46	2.03
Azerbaijan	7	1203	0.22	13.81	0.12	3.94
Georgia	13.97	2704	0.18	32.33	0.72	7.12
Jordon	22.29	50	0.34	50.78	0.22	1.12
Kyrgyzstan	16.99	397	0.2	2.92	0.01	2.44
Lebanon	23.5	4	0.3	58.27	0.85	2.39
Oman	20.98	3.43	0.17	44.22	0.08	0.46
Pakistan	10.21	80.27	0.44	3.17	2.02	1.37
Saudi Arabia	28.86	42	0.11	24.93	0.08	0.61
Syria	20	23.24	0.12	4.07	0.05	0.82
Turkey	20.84	577.14	0.76	108	0.31	0.38
Emirates	20.93	30	0.2	55.86	1.07	0.66
Kazakhstan	20	783	0.28	6.34	0.12	23

In the next step, using DEA technique and considering different inputs and outputs combinations, the efficiency performance of research and development of the selected countries were evaluated. In the final stage, the TOPSIS techniques were used to rank all the countries. A brief description of DEA technique and TOPSIS technique is given.

Data Envelopment Analysis (DEA)

Data Envelopment Analysis is a non-parametric technique which is widely used in various studies. The aim of this technique is to access relative efficiency of same decision making units with several inputs (input) and multiple-output (output). Although day by day it is added to number of DEA models and each achieving a special aspects but their base is the original model which is designed by their founder of this method. Among these model, Charnes, Cooper and Rhodes (1978) as CCR model can be noted that Constant Returns to Scale (CRS) assumption is used in the analysis and other model provided by Banker, Charnes and Cooper, BCC which is designed by the assumption of Varying Returns to Scale (VRS). Through viewpoints the DEA models are divided into two models of input nature and output nature.

The goal of model with input nature is to provide improved path by reducing the inputs and the goal of model with output nature is to design improved path by increasing the outputs. DEA divides the unit to be evaluated into two groups of efficient and inefficient (Mehregan, 2006).

In this study, model (BCC) the output oriented is used from the other models of DEA. The reason to choose the output axis is that countries have a fixed amount of resources such as budget, researcher and … but the maximum output is from the research and development. Hence countries do not play a role in determining the amount of their inputs, but their output depends on the activities and manner to allocate the resources to different sectors. Therefore, to evaluate them the model output-oriented is appropriate. But BCC models is selected due to the reason that there is no reason for constant returns to scale (CRS) in the performance of research and development activities of countries. Output-oriented BCC model is as follows (Mehregan, 2006).

$$Min\ Z_0 = \sum_{i=1}^{m} v_i\, x_{i0} + w$$

St:

$$\sum_{r=1}^{s} u_r\ y_{r0} = 1$$

$$\sum_{i=1}^{m} v_i\, x_{ij} - \sum_{i=1}^{m} u_r\, y_{rj} + w \geq 0$$

$$u_r\ , v_i\ \geq 0 \qquad (1)$$

where, the variables are defined as follows:

x_{ij}: input level of i^{th} for j^{th} country I = 1, 2, …., m

y_{rj}: output level of r^{th} for j^{th} country r = 1, 2, …., s

v_i: weight given to the i^{th} input

u_r: weight given to the r^{th} output

TOPSIS technique

TOPSIS model was proposed in 1981 by Hunng and Wang. This model is one of the best models of decision making multiple indexes and is used widely. In this model, m option can be evaluated by n index. This technique is based on the concept that the chosen option must have minimum distance with the positive ideal solution (the best possible case, Ai^{+}) and the maximum distance with negative ideal solution (worst case Ai^{-}). It is assumed that the utility of each indicator is steadily increasing or decreasing. The solving of problem by TOPSIS method involves six steps as follows (Percin, 2009).

First step: Converting decision matrix to non-scalar matrix

$$n_{ij} = \frac{r_{ij}}{\sqrt{\sum_{i=1}^{m} r_{ij}^2}} \qquad ,(j = 1,\ldots,n) \qquad (2)$$

The matrix obtained is called ND

Second step: Forzming a weighted non-scalar matrix

$$V = N_D \cdot W_{mn} \quad (3)$$

where, *V* is weighted non-scalar matrix and *W* is a diagonal matrix obtained by weights for indicators.

Third step: Identifying positive and negative ideal solution

$$A^- = \{(\min v_{ij} I_j \in J), (\max v_{ij} I_j \in J')\} \qquad A^+ = \{(\max v_{ij} I_j \in J), (\min v_{ij} I_j \in J')\}$$

$$A^- = \{V_1^-, V_2^-, \ldots\ldots V_N^-\} \qquad A^+ = \{V_1^+, V_2^+, \ldots\ldots V_N^+\}$$

$$j' = \{j = 1,2,3,\ldots n\} \xrightarrow{i} \text{cost} \qquad J = \{j = 1,2,3,\ldots n\} \xrightarrow{i} \text{profit}$$

Fourth step: Calculate the option distance from the positive and negative option

$$d_i^+ = \left\{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2\right\}^{1/2} \quad (5) \qquad d_i^- = \left\{\sum^{n} (v_{ij} - v_j^-)^2\right\}^{1/2}$$

Fifth step: Calculate the relative closeness

$$C_i = \frac{d_i^-}{d_i^+ + d_i^-} \quad (6)$$

In this method, the ranking of countries is based on the values obtained in the fifth step. Most of the values of this stage show higher rank for the concerned country.

Data Analysis

Evaluation results of relative performance of countries with different combinations of indicators

According to Serrano and et al., (2005), the reason to consider the different combinations of inputs and outputs in DEA models are (Broseho and Dash, 2009):

1) With this method all the combinations of inputs and outputs are evaluated equally.
2) With regard to the efficiency score for each unit of decision making in DEA model depends on how the input and output selected, thus after solving the models can assess the strengths and weakness of the units based on the selected inputs and outputs.

In this study, different combinations of inputs and outputs are used for DEA technique. For example, a standard method for the selection of inputs and outputs in this study is considering three input and output for the model which is indicated by the symbols of ABC123 in this paper. The three input variables and three output variables, a total of 49 models for each country were designed with input and output combinations. With respect to 14 countries, total number of 689 models were designed and solved and this operation is conducted using WINQSP software. The results related to the relative efficiency of research and development performance of region based on different models is given in table 2.

Table 2:

Results of the relative performance of countries with different input and output combinations

	A1	**A2**	**A3**	**A12**	**A13**	**A23**	**A123**	**AB1**	**AB2**	**AB3**
Country										
Iran	0.353	0.01	0.268	0.353	0.6	0.268	0.6	0.353	0.01	0.268
Armenia	1	1	1	1	1	1	1	1	1	1
Azerbaijan	0.226	0.186	1	0.235	1	1	1	1	1	1
Georgia	0.382	0.356	0.503	0.626	0.707	0.676	0.914	0.382	0.356	0.503
Jordon	0.47	0.109	0.049	0.506	0.509	0.149	0.541	0.841	0.141	0.332
Kyrgyzstan	0.031	0.005	0.131	0.031	0.138	0.131	0.138	0.042	0.005	0.209
Lebanon	0.54	0.421	0.104	0.869	0.629	0.495	0.936	1	1	1
Oman	0.409	0.04	0.02	0.409	0.422	0.056	0.422	1	1	1
Pakistan	0.044	1	0.158	1	0.162	1	1	1	1	1
Saudi Arabia	0.231	0.04	0.027	0.235	0.252	0.062	0.255	0.405	0.056	0.18
Syria	0.039	0.025	0.036	0.056	0.071	0.057	0.087	0.088	0.045	0.405
Turkey	1	0.153	0.017	1	1	0.16	1	1	0.153	0.022
Emirates	0.517	0.53	0.029	0.956	0.536	0.53	0.956	1	0.857	0.264
Kazakhstan	0.06	0.059	1	0.108	1	1	1	0.06	0.059	1

Table 3:

Results of the relative performance of countries with different input and output combinations (table 2 continued)

	AB12	**AB13**	**AB23**	**AB123**	**ABC1**	**ABC2**	**ABC3**	**ABC12**	**ABC13**	**ABC23**
Country										
Iran	0.353	0.6	0.268	0.6	0.41	0.01	0.268	0.41	0.6	0.268
Armenia	1	1	1	1	1	1	1	1	1	1
Azerbaijan	1	1	1	1	1	1	1	1	1	1
Georgia	0.626	0.707	0.676	0.914	0.657	1	1	1	1	1
Jordon	0.841	0.841	0.332	0.841	0.841	0.146	0.332	0.841	0.841	0.332
Kyrgyzstan	0.042	0.21	0.209	0.21	0.061	0.012	0.382	0.061	0.391	0.382
Lebanon	1	1	1	1	1	1	1	1	1	1
Oman	1	1	1	1	1	1	1	1	1	1
Pakistan	1	1	1	1	1	1	1	1	1	1
Saudi Arabia	0.405	0.405	0.18	0.405	1	1	1	1	1	1
Syria	0.088	0.405	0.405	0.405	1	1	1	1	1	1
Turkey	1	1	0.16	1	1	0.153	0.022	1	1	0.16
Emirates	1	1	0.857	1	1	1	0.375	1	1	1
Kazakhstan	0.108	1	1	1	0.098	0.087	1	0.112	1	1

Table 4:

Results of the relative performance of countries with different input and output combinations (table 3 continued)

	ABC123	**AC1**	**AC2**	**AC3**	**AC12**	**AC13**	**AC23**	**AC123**	**B1**	**B2**
Country										
Iran	0.6	0.41	0.01	0.268	0.41	0.6	0.268	0.6	0.353	0.01
Armenia	1	1	1	1	1	1	1	1	0.552	0.228
Azerbaijan	1	0.228	0.221	1	0.236	1	1	1	0.128	0.059
Georgia	1	0.657	1	1	1	1	1	1	0.299	0.356
Jordon	0.841	0.715	0.135	0.049	0.715	0.715	0.166	0.715	0.816	0.141
Kyrgyzstan	0.391	0.052	0.011	0.224	0.052	0.224	0.224	0.224	0.032	0.005
Lebanon	1	0.863	0.58	0.104	0.901	0.897	0.631	0.972	1	1
Oman	1	0.967	0.114	0.058	0.967	0.967	0.119	0.967	1	1
Pakistan	1	0.044	1	0.158	1	0.162	1	1	0.049	1
Saudi Arabia	1	1	1	1	1	1	1	1	0.405	0.056
Syria	1	1	1	1	1	1	1	1	0.068	0.044
Turkey	1	1	0.153	0.017	1	1	0.16	1	1	0.153
Emirates	1	0.995	1	0.055	1	0.995	1	1	0.923	0.857
Kazakhstan	1	0.096	0.087	1	0.112	1	1	1	0.059	0.059

Table 5:

Results of the relative performance of countries with different input and output combinations (table 4 continued)

	B3	B12	B13	B23	B123	BC1	BC2	BC3	BC12	BC13
Country										
Iran	0.268	0.353	0.6	0.268	0.6	0.41	0.01	0.268	0.41	0.6
Armenia	0.088	0.691	0.627	0.298	1	1	0.415	0.147	1	1
Azerbaijan	0.171	0.167	0.287	0.218	1	0.231	0.104	0.261	0.231	0.405
Georgia	0.31	0.602	0.586	0.629	0.914	0.657	0.847	0.724	0.847	1
Jordon	0.311	0.816	0.816	0.311	0.541	0.816	0.146	0.311	0.816	0.816
Kyrgyzstan	0.191	0.032	0.191	0.191	0.138	0.052	0.009	0.208	0.052	0.211
Lebanon	1	1	1	1	0.936	1	1	1	1	1
Oman	1	1	1	1	0.422	1	1	1	1	1
Pakistan	0.311	1	0.311	1	1	0.049	1	0.311	1	0.311
Saudi Arabia	0.81	0.405	0.405	0.18	0.255	1	1	1	1	1
Syria	0.283	0.068	0.283	0.283	0.087	1	1	1	1	1
Turkey	0.022	1	1	0.16	1	1	0.153	0.022	1	1
Emirates	0.214	1	0.923	0.857	0.956	1	1	0.342	1	1
Kazakhstan	1	0.108	1	1	1	0.098	0.087	1	0.112	1

Table 6:

Results of the relative performance of countries with different input and output combinations (table 5 continued)

	BC23	BC123	C1	C2	C3	C12	C13	C23	C123
Country									
Iran	0.268	0.6	0.409	0.01	0.268	0.41	0.6	0.268	0.6
Armenia	0.478	1	1	0.415	0.147	1	1	0.478	1
Azerbaijan	0.302	0.405	0.228	0.104	0.261	0.229	0.398	0.287	0.398
Georgia	1	1	0.657	0.847	0.724	0.847	1	1	1
Jordon	0.311	0.816	0.714	0.135	0.049	0.715	0.715	0.166	0.715
Kyrgyzstan	0.208	0.211	0.052	0.009	0.196	0.052	0.196	0.196	0.196
Lebanon	1	1	0.862	0.58	0.104	0.901	0.897	0.631	0.972
Oman	1	1	0.966	0.108	0.054	0.967	0.967	0.119	0.967
Pakistan	1	1	0.039	1	0.06	1	0.085	1	1
Saudi Arabia	1	1	1	1	1	1	1	1	1
Syria	1	1	0.143	0.263	0.426	0.263	0.426	0.454	0.454
Turkey	0.16	1	1	0.153	0.017	1	1	0.16	1
Emirates	1	1	0.995	1	0.053	1	0.995	1	1
Kazakhstan	1	1	0.096	0.087	1	0.112	1	1	1

The above tables suggest that the efficiency scores of countries are in the range of 0 and 1. The results obtained from the model ABC123 which considers all the inputs and outputs, indicating that among 14 countries under studies, 11 countries have achieved maximum

efficiency of 1 and this shows that ABC123 model has lower analysis strength in countries assessment. By comparing the relative performance of countries under different combination it can analysis better the strength and weakness performance of countries. For example, Armenia under the evaluation of 49 models, could achieve maximum efficiency by 37 models and relative to other models that is B1, B2, B3, B12, B13, B23, BC2, BC3, BC23, BC2, BC3, BC23, C2, C3 and C23 is ineffective, this shows that this country has failed to maximize the use of input capacity such as B and C. Meanwhile, Iran has failed by at least one model through different inputs and outputs combination to achieve maximum efficiency and this has caused a poor performance with other countries.

Complete ranking of countries

As mentioned earlier the importance of model result in this section an attempt is the aggregate results of different models is to obtain a complete ranking of regional countries. Assuming that with *n* decision making units having each with *m* inputs and *s* outputs and also assume that this decision making units is evaluated by a set of different DEA models and their performance scores is obtained by each of these models. By providing a matrix with dimension E_{n*k}, in which each row of the matrix represents a particular decision making unit and each columns of the matrix represents a specific model with inputs and outputs combinations. Each options of this matrix represent the efficiency score of j^{th} decision making unit according to the view of i^{th} model.

$$E = \begin{array}{c} \begin{matrix} M_1 & M_2 & \dots & M_K \\ \downarrow & \downarrow & \downarrow & \downarrow \end{matrix} \\ \left| \begin{matrix} E_{11} & E_{12} & \dots & E_{1k} \\ E_{21} & E_{22} & \dots & E_{2k} \\ \vdots & \vdots & & \vdots \\ E_{n1} & E_{n2} & \dots & E_{nk} \end{matrix} \right| \end{array} \begin{matrix} \leftarrow 1 \\ \leftarrow 2 \\ \leftarrow \vdots \\ \leftarrow n \end{matrix}$$

j = 1, 2, …, n i = 1, 2, …, k

The above matrix is a multiple index decision matrix were each row is an alternative and each column is an indicator for evaluating the alternative. Finally, in order to rank countries the TOPSIS technique as one of the most widely used multiple indicator decision making technique. The results are summarized in table 4.

Table 7:
Complete ranking of countries using TOPSIS technique

Country	di^+	di^-	cl_i	**Rank**
Iran	1.933	0.782	0.288	13
Armenia	1.056	2.138	0.669	2
Azerbaijan	1.659	1.596	0.49	9
Georgia	1.054	1.806	0.631	4
Jordon	1.745	1.21	0.409	12
Kyrgyzstan	2.395	0.257	0.097	14
Lebanon	1.011	2.075	0.672	1
Oman	1.44	1.948	0.575	6
Pakistan	1.425	2.001	0.584	5
Saudi Arabia	1.579	1.775	0.529	7
Syria	1.858	1.453	0.439	11
Turkey	1.781	1.686	0.486	10
Emirates	1.159	2.014	0.635	3
Kazakhstan	1.692	1.793	0.514	8

As the table suggests the results of complete ranking of countries show that the performance of research and development of Lebanon ranks first than other countries and allocated as the best performance in this area among other countries of the region. Kyrgyzstan ranks last which is 14th and has the weakest performance among other countries in the region. The point to be considered in this study is to determine the position of Iran in the final ranking which has achieved 13th rank among the selected countries. Considering that Iran's performance in research and development between 49 different input and output combinations could not achieve good performance score, has result in not having an appropriate place in final ranking.

Conclusion and Recommendations

Today, evaluation of research and development section of countries is very important due to the importance of growth and economic development of countries. Current approach to perform evaluation is generally considered the output level resulting from organization operation system. While a system approach can easily be possible to assess the output in context to input productivity using appropriate processes. Therefore, only giving attention to output in evaluating and performance management will misguide us. In this study, the DEA technique is used as an effective tool for evaluating decision making units with similar multiple input and output. But in this method, to increase the distinction between efficient and inefficient units, the number of units to be assessed must be proportional to the number of input and output variables. Therefore in this study, different inputs and outputs combinations were used for DEA model and the efficiency of research and development performance of countries was calculated with various combinations. Overall performance score for each country were obtained from 49 different combinations. The results indicate that countries in different combination have obtained different efficiency score. In order to complete the ranking of countries, TOPSIS technique was used. Thus preparing the matrix, that the columns of this matrix is the model of different inputs and outputs combinations and the rows are the countries using TOPSIS technique the complete ranking of countries is obtained. The ranking results show that the country of Lebanon is the best performance and

the country of Kyrgyzstan is the weakest performance in all different inputs and outputs combinations among the selected countries in research and development section. Inappropriate place of research and development section of the country among the selected countries is a result to be reflected upon. Research and development performance of Iran among 14 countries under study ranks 13th that this place for Islamic Republic of Iran is not a suitable rank and with the outlined objectives in the twenty year Document Perspective which is to achieve the first place of economic, science and technology in Southwest Asia with emphasize on the software and knowledge production and also science and innovation objectives of the country is to achieve first rank based on indicators of innovation and technology there is a big gap. This findings to some extent with the findings of Tabatabaei and et al., (2010), and Bakhshi et al (2011), concerning the status of Iran's innovative ability based on the combined indicators is confirmed. The positive point of this study relative to previous studies conducted in the application technique of DEA in research and development performance evaluation is considering different inputs and outputs combination for countries. This causes all countries with different combinations be evaluated equally. Thus, the number of units under evaluation than the input and outputs units is less than a certain amount and that cannot distinguish between them using DEA model, this approach is very appropriate. However due to the fact that the information of this study is related to a few years ago and also with regard to data limitations all innovation criteria in evaluation is not considered. It is recommended in future research to consider more up-to-date inputs and outputs to evaluate the research and development performance of Iran in comparison with other countries. It is also recommended to use the combination technique of DEA and analysis the main components to evaluate research and development performance of countries. Initially use of single-input and single-output is better than main variables. Then principal component analysis method on single-input single-output be applied and further by selecting the main components and analyzed as the inputs to the DEA model.

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