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Original Article

Assessing Financial Performance the Branches of Red Crescent Organization in Eastern Azerbaijan Province by Using Window Data Envelopment Analysis Model (Input-Oriented CCR)

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ABSTRACT

The present research has utilized window data envelopment analysis method based on input-oriented CCR to assess the performance trend and to rank the branches of Red Crescent Organization in Eastern Azerbaijan province based on financial indexes. The results of ranking the branches by using the research model showed that the branches of Bostanabad & Heris were ranked in first and second positions. The branches of Hadishar, Azarshahr and Warzeghan were 14th, 15th, and 16th respectively which show their lack of performance efficiencies during the period under investigation.

Keywords: Data Envelopment Analysis, Branches of Red Crescent Organization, Ranking, Efficiency, Window Analysis, Input-Oriented CCR.

Introduction

The Red Crescent Organization of Iran has always demonstrated magnificent scenes of sacrifice and devotion during its lifetime handling the white peace flag and moving in the humanity favoring route proudly and honorably. The Red Crescent Organization of Iran is currently among 10 superior organizations of the country and is one of the most effective ones among 186 organizations enlisted in International Red Crescent Organizations and it was established in the year 1922 and it was entitled Red Lion & Sun Assembly of Iran and then it was recognized by the international committee of Red Crescent and the international federation of assemblies of Red Crescent in the year 1924 and started to work by establishing different branches in different cities. Currently most activities of this organization are focused on helping the hurt people in natural disaster areas. Also treatment and enabling centers, youth organizations and volunteers'

organizations were established. Besides these activities the manufacturing of drugs and medical equipment is carried out and there are training courses. This organization is serving the people as a donation entity and is considered as the biggest helping organization throughout the country by the help of province branches and the appropriate equipment. Since the branches of Red Crescent receive a part of their performance budget from the government they are responsible to report about their performance status to utilize the resources optimally. In fact to guarantee the value of these efforts to be high we should utilize appropriate performance measurement systems. One of the criteria commonly used in assessing and comparing the performances of different parts and units which have divergent resources to be used is to measure efficiency. This measuring method has been utilized in different fields especially in systems delivering services. There are different models to measure efficiency which can be categorized into two overall models of hard oriented on quantitative and concrete data and soft oriented on abstract and qualitative data (Azar & Torkashvand, 2006). The important thing in quantitative and concrete models related with measuring efficiency is to determine the production function and to use it in the model because we can calculate the performance or efficiency of a unit by having it (Jahanshahloo et al, 2008). There are two main parametric and non-parametric methods to determine and approximate the production function. In parametric methods first a certain form is considered for the production function and then the unknown parameters (coefficients) are estimated by using one of the common function estimation methods in statistics and economics (Mollaee et al, 2011). Then the estimated function is utilized to calculate the optimal amount of production for each input of the entity. After that the efficiency is calculated by dividing the amount of real production into the optimal amount. Parametric methods are used when there is only one input and one output. Non-parametric methods are those through which mathematical planning techniques are used to assess the efficiency of entities. Meanwhile, there is no need to estimate the production function in these methods and there is no limitation in the number of inputs and outputs (Mollaee et al., 2011). Nowadays Data Envelopment Analysis (DEA) is one of the most important non-parametric methods used widely in assessing the efficiency of units. The present research will focus on assessing the performance and ranking the branches of Red Crescent Organization of Eastern Azerbaijan province by using data envelopment analysis method besides considering the importance of activities done by Red Crescent Organization and the importance of assessing the organizations in handling the predetermined goals. It is important to note that since performance assessment has a dynamic nature and is related with the time not only it is necessary to consider several periods in measuring the performances of cases but also it is critical. The present research will use window analysis model as one of the sub-units of data envelopment analysis model to assess the performances of the different branches.

Research literature

Regarding the fact that the present research is going to use window analysis model to assess the financial performance and to rank the branches of Red Crescent Organization, no record researches in the field was recognized to form the literature and present here. Therefore, we are going to refer to researches which have utilized window analysis model to assess performance.

Wang et al (2013) used window data envelopment analysis model to assess

environmental and energy yield of 29 regions of China during the time period between 2000 and 2008. The experimental results of their research showed that eastern regions of China have had the highest and the western regions have had the lowest amount of yield regarding environment and energy. Meanwhile, the change trend study showed that yield has increased a little during this period.

Sozen et al (2012) utilized window data envelopment analysis model to assess the yield of 10 water plants producing electricity in Turkey. They first determined the input and output factors of the model based on yield indexes of power plants and after data collection during the years between 2007 and 2009 calculated the performance changes trend based on the basic data envelopment analysis models. They also studied the relationship between the calculated yield and yield indexes which were chosen as the inputs and outputs.

Chou et al (2012) studied 10 countries regarding the exploitation of human resources in science and technology during the years between 2005 and 2010. They first selected 6 indexes from among 323 indexes of human resources in science and technology published in the global competition book published in the year 2010 and then tried to assess the yield of countries in the sample. They used window analysis and the dynamic Malmquist index method to do so. The assessment results of both methods showed that Japan has had the highest rank of yield during the time period under investigations.

Huang et al (2012) assessed the efficiency of hotel industry in China during the years between 2001 and 2006. They used window analysis model to assess the efficiency of hotels present in the sample for the research in first stage and then used Tobit's dynamic model to study the effect of main variables on the efficiency of hotel industry in China. The findings of their research showed that hotel industry in China is approaching the efficient performance stage and it is in the state of improvement after a tough recession due to the spread of SARS in the year 2003. Finally they introduced useful methods for the conditions when an external incident (such spread of a disease) results in lack of consistency.

Hemmasi et al (2011) assessed the financial performance of 10 companies in wood industry in Iran during the time period between 2002 and 2006. They used window data envelopment analysis technique to do the assessment and ranked the units under investigations based on the average efficiency marks.

Halkos & Tzeremes (2011) studied the relationship between oil consumption and economic efficiency in 42 countries during the years between 1986 and 2006 in a research paper. They used window data envelopment analysis method to calculate economic efficiency. They concluded that there is a relationship between oil consumption and economic efficiency of countries. Finally they stated that oil consumption is a main factor in urban development and industrialization in countries without considering the developed state of them.

Pulina et al. (2011) investigated about 150 hotels in Sardina Peninsula by assessing and comparing the yield levels in Italy. They first used window analysis to calculate the technical yield of these hotels during the time period between 2002 and 2005 and then compare the efficiency of hotels categorized based on size. Finally they posed some policies for the hotels which had got low yield and efficiency marks.

Sun (2011) assessed the performances of 13 Taiwanese investing companies during the time period between 2003 and 2009. He utilized an aggregate method comprised of window data envelopment analysis and the

dynamic Malmquist index method to do this assessment. He stated that this method is a complete assessment method and it can help managers in recognizing cases where there is a need for improvement besides being able to assess performance. He introduced this aggregate method as a complete method which was easier and more comprehensible than other methods.

Zhang et al (2011) assessed energy exploitation of 23 countries during the time period between 1980 and 2005. They used window analysis to carry out this assessment. The experimental results of their research showed that Botswana, Mexico, and Panama have had the best yield and Kenya, Serilanka, Syria, and Philippines have had the worst yield during the period under investigations. 11 countries encountered permanent yield reduction during the period and China has had the fastest trend from among 5 countries having developing trends. Finally Tobit's regression analysis results showed that there is a relationship between energy yield and per capita income factors of the countries.

Sokhanvar et al (2011) studied the efficiency of electricity distribution companies in Iran by using window data envelopment analysis. In this research the companies were divided into two groups based on circuit density of low limit density (group 1) and high limit density (group 2). The research results showed that the average window efficiency of groups 1 and 2 had progressive and regressive trends, respectively regarding the ultra boundary limitation and in both presuppositions of fixed and variable returns compared to the index. Meanwhile, the average window efficiency of companies in group 2 was higher in all windows than group 1. Electricity distribution companies in Shiraz, Golestan, and Mazandaran in group 2 have had inappropriate performances regarding the ultra boundary and group boundaries and the performance of companies having higher circuit density have had less difference with the potential superior performance beyond the boundary. They also found out that increasing the load coefficient of the network will result in efficiency reduction and increasing load coefficient of the transformation equipment will increase efficiency in long-term. Also privatization does not have a meaningful effect on efficiency in short-term but it will have a positive and meaningful effect in long-term.

Fazeli (2011) measured yield and ranked the water industry companies in Iran during the years between 2006 and 2008 in a research paper. First he used the related literature and viewpoints of scholars in the industry to recognize the effective factors on water industry and after the collection of related data utilized window data envelopment analysis method to measure the changes of yield during time pass. Then, he supplied and distributed some questionnaires using couple comparisons among the technicians in distribution industry and entered the results into the model in the form of relative weight limitations in order to apply the priorities and preferences of the managers in the industry. Then, he utilized Anderson-Peterson's ranking method to rank the companies completely.

Karimi et al (2008) studied the efficiency of wheat cultivation regarding the two factors of time and risk by using range data envelopment analysis and window data envelopment analysis. In this research they calculated the efficiency of 8 big provinces of the country in water wheat production during the years between 2004 and 2008 by using the two models mentioned above and the results showed that Khozestan province has had the highest and Hamedan & Eastern Azerbaijan have had the least yields. Also considering the risk conditions Fars province has had the highest and Kordestan has had the lowest efficiency in wheat production.

Window Data Envelopment Analysis

Data envelopment analysis technique is one of the novel tactics which is widely used to assess the performance of units. This technique is an appropriate tool to measure relative efficiency of decision making units which have several similar inputs and outputs (Huang et al, 2012). Because the method mentioned is based on a series of optimization issues there is not any parameters present for analysis. Thus, the method mentioned is a non-parametric method (Azar and Motameni, 2003). Data envelopment analysis model was first posed by Charnes, Cooper, and Rhodes in 1978 and became famous as CCR model which was formed as an acronym comprising of the first names of the three persons mentioned (Khajavi et al, 2005). In CCR model, constant returns to scale are presupposed. By constant returns to scale, we mean that the outputs change as much as the inputs change (Khajavi et al, 2010). 6 years after the presentation of CCR model, the second model of this type was proposed by Banker, Charnes, and Cooper called BCC which was designed based on variable returns to scale (Azar and Motameni, 2004). The difference between the two models of CCR and BCC lies in the presupposition related to the constant or variable returns to scale. In variable returns to scale, we presuppose that outputs do not change compatibly with the inputs (Khajavi et al, 2010). We can study both of these models regarding the two approaches of input-oriented and output-oriented. Models with input-oriented approach are those which use less input without changes in outputs to get the same amount of outputs (Neto Luiz and Lins Marcos, 2004). In other words, if we try to minimize the inputs in assessment process by keeping the output level fixed the pattern approach utilized in input-oriented (Khajavi et al, 2005). Also output-oriented approach models are those which result in more outputs without changing the input amounts (Neto Luiz and Lins Marcos, 2004). In fact if we try to increase output level by keeping the input levels constant in assessment process the pattern used is output-oriented (Khajavi et al, 2005). One of the defects of primary data envelopment analysis models is that they do not consider time factor in assessing performance. In fact in these models efficiency measurement is done permanently and in a certain time (for example one year). Window analysis, as a subunit of data envelopment analysis model, has started a new perspective to compare units dynamically (during different time periods) in assessing efficiency (Fallah Delcheh and Mehregan, 2010). Since this method presupposes that the technical efficiency of all units is measured in a window compared to each other it will be implicitly presupposed that there would be no technical changes in any of the windows. This is an overall issue in window analysis. By reducing window width this problem will be solved to some extent and we should choose the width of categories in a way that ignoring technical changes would seem logical to validate window analysis (Abbott, 2009; Swanson, 2009). Meanwhile, there is not any theoretical support to determine window size. This method calculates the average efficiency of models with constant and variable returns to scale (Sokhanvar et al, 2011). But in this research we have used input oriented window CCR model. The reason to choose this model for performance assessment of the decision making units based on the time is that constant returns to scale shows a less number of companies to be efficient. In fact BCC pattern which is a type of variable returns to scale shows more companies to be efficient and this is less accorded with the reality (Khajavi et al, 2005). Also the flexibility of window analysis model is less compared to models which have the capability of assessing the efficiency by

presupposing the variable returns to scale (Sokhanvar et al, 2011). Thus, the selection of window model seems sensible by presupposing the constant returns to scale.
Based on a research carried out by Asmild et al (2004) to demonstrate window analysis in a formulaic model presuppose that N unit of DMU exist during the time period of t (t=1, ..., T) and all of the user inputs to produce s outputs. Therefore, the sample will include N*T observations and n DMU during t period, DMU^n_t will have an r dimension vector of inputs $X^n_t= (X^n_{1t}, X^n_{2t}, ..., X^n_{rt})$ and also an s dimensional vector of outputs $Y^n_t= (Y^n_{1t}, Y^n_{2t}, ..., Y^n_{st})$. The window started from the time K ($1\leq K \leq T$) has a width of W ($1\leq W\leq T-K$) is determined by KW and has N*W observations. The matrix of inputs and outputs of window analysis can be observed in the following vectors, respectively.

$$X_{k_w} = \left(x^1_k, x^2_k, \ldots, x^N_k, x^1_{k+1}, x^2_{k+1}, \ldots, x^N_{k+1}, \ldots, x^1_{k+w}, x^2_{k+w}, \ldots, x^N_{k+w}\right),$$

$$Y_{k_w} = \left(y^1_k, y^2_k, \ldots, y^N_k, y^1_{k+1}, y^2_{k+1}, \ldots, y^N_{k+1}, \ldots, y^1_{k+w}, y^2_{k+w}, \ldots, y^N_{k+w}\right)$$

The input oriented DEA window problem for DMU^n_t under a constant returns to scale (CRS) assumption, will be as follows:

$\theta'_K = min_{\theta,\lambda}(\theta)$

$s.t. \quad -x_{KW}\lambda + \theta x'_t \geq 0 \quad t = 1,\ldots,T$
Model (1)

$y_{KW}\lambda - y'_t \geq 0 \quad t = 1,\ldots,T$

$\lambda_n \geq 0 \quad (n = 1,2,\ldots,N\times W)$

Research goals:

Every research is trying to achieve some goals. The goals of the present research are:
Studying the trend of performance changes and financial efficiency of the branches of Red Crescent in Eastern Azerbaijan province by using window analysis model ranking the branches of Red Crescent organization in Eastern Azerbaijan province
Research questions:
Is it possible to rank branches by using window data envelopment analysis model?
Does the performance of different branches change during different time periods?

Research variables

Variables and performance indexes in each research are identified regarding the type of activity of the units under investigations and the goals of the research. Since the present research is going to study the performance of different branches of Red Crescent organization to know whether the branches of Red Crescent utilize the accessible budget and resources appropriately and effectively, we are going to take into consideration the financial performances. Thus, the research variables are as follows:

Money received for help and rescue plans, money received for volunteers' plans, money received for training plans, money received for plans for the youth, and the money spent within the framework of the plans mentioned

Regarding the fact that the present research is going to assess performance by using window analysis the variables should be categorized into two groups of input and output. Thus, the input and output variables of the present research are as follows:

Input variables: Money received for help and rescue plans, money received for volunteers' plans, money received for training plans, money received for plans for the youth

Output variables: money spent within the framework of the plans mentioned

Location and time scope of the present research:

The location scope of the present research entails the branches of Red Crescent Organization in Eastern Azerbaijan province. The present research also deals with the years between 2006 and 2011 regarding the time perspective.

Methodology and data collection tools:

In the present research we have utilized the two methods of library and field studies to collect information. To study and review the literature we have used library method. To do so, books, local journals, and international journals related with the topic were investigated. Also regarding the data collection and data of the research (research variables) we have used the information statistics database of Eastern Azerbaijan province Red Crescent Organization and the related branches.

Methods and tools of data analysis:

In the present research we have utilized EXCEL software to categorize the data after extracting the data related to the research variables from the database of Eastern Azerbaijan province Red Crescent Organization. To do the calculations related with data envelopment analysis we have used winQSB software which is one of the appropriate ones to resolve linear planning problems.

Society and statistical sample:

Regarding the fact that only 16 branches of 24 branches of Eastern Azerbaijan province Red Crescent Organization have had input and output in four main plans of the present research and due to the lack of experienced financial human forces in some branches, the present research entails 16 branches from among the 24 branches of Eastern Azerbaijan province Red Crescent Organization. The present research is going to investigate about all members of the statistical society so there would not be any statistical sampling.

Research findings:

In the present research we have assessed 16 branches of Eastern Azerbaijan province Red Crescent Organization during a 6 years period (2006 to 2011) and during time periods of 23 years in order to utilize the research model practically. To calculate the efficiency amounts of every window the planning model is resolved for (16*3)48 units and since the time period of the present research is divided into 4 ranges (windows) (48*4)192 models were planned. After resolving the models the average efficiency of each range (window) and the annual average were calculated and they were used as the criteria to rank the branches. Table 1 represents the results of assessing the model utilized in the research.

Table 1. The results of window data envelopment analysis based on CCR model

Branch/Year	2006	2007	2008	2009	2010	2011	Window average	Rank
Azarshahr	0.8286	0.8527	0.8807				0.8535	
		0.8527	0.8807	0.8463			0.8596	
			0.8778	0.7670	0.6954		0.7730	
				0.7652	0.6595	0.8382	0.7470	
Year average	0.8286	0.8527	0.8797	0.7911	0.6770	0.8382	0.8053	15
Ahar	0.7559	0.8805	0.9358				0.8505	
		0.8805	0.9003	0.8489			0.8760	
			0.8800	0.8737	0.8654		0.8731	
				0.8059	0.8574	0.7913	0.8173	
Year average	0.7559	0.8805	0.9048	0.8419	0.8614	0.7913	0.8535	11
Oskoo	0.9027	1.0000	0.9011				0.9324	
		1.0000	0.8909	0.8867			0.9230	
			0.8930	0.8255	0.7052		0.8001	

				0.8216	0.6750	0.6234	0.6972	
Year average	0.9027	1.0000	0.8950	0.8435	0.6898	0.6234	0.8264	12
	0.8363	0.9987	0.8241				0.8797	
Bonab		1.0000	0.7932	0.8728			0.8807	
			0.7776	0.9339	1.0000		0.8937	
				0.8041	0.8125	1.0000	0.8634	
Year average	0.8363	0.9994	0.7978	0.8670	0.8965	1.0000	0.8793	8
	0.9762	1.0000	1.0000				0.9920	
Bostanabad		1.0000	1.0000	1.0000			1.0000	
			1.0000	0.9930	1.0000		0.9977	
				0.9923	1.0000	1.0000	0.9974	
Year average	0.9762	1.0000	1.0000	0.9951	1.0000	1.0000	0.9967	1
	0.8333	1.0000	1.0000				0.9375	
Sarab		1.0000	1.0000	0.8008			0.9234	
			0.9780	0.8012	1.0000		0.9173	
				0.7741	1.0000	0.7021	0.8074	
Year average	0.8333	1.0000	0.9926	0.7918	1.0000	0.7021	0.8932	7
	0.9860	0.9535	0.9088				0.9483	
Shabestar		0.9535	0.8768	0.8161			0.8786	
			0.8682	0.8092	0.8268		0.8340	
				0.8008	0.8173	0.9223	0.8435	
Year average	0.9860	0.9535	0.8843	0.8087	0.8220	0.9223	0.8739	9
	0.8538	0.9799	1.0000				0.9399	
Kaleibar		0.9547	1.0000	0.9054			0.9518	
			1.0000	0.9373	0.7765		0.8943	
				0.8406	0.7741	1.0000	0.8617	
Year average	0.8538	0.9671	1.0000	0.8926	0.7753	1.0000	0.9105	6
	0.9174	0.7648	0.7950				0.8207	
Maragheh		0.7648	0.7699	0.9399			0.8174	
			0.7607	0.9178	1.0000		0.8813	
				0.9127	1.0000	0.8620	0.9214	
Year average	0.9174	0.7648	0.7750	0.9233	1.0000	0.8620	0.8580	10
	0.9760	0.9903	0.9030				0.9548	
Mianeh		0.9847	0.8962	0.9512			0.9426	
			0.9103	0.9646	0.9894		0.9537	
				0.9494	0.9493	0.9521	0.9503	
Year average	0.9760	0.9875	0.9032	0.9550	0.9690	0.9521	0.9503	4
	0.9223	0.9731	0.9664				0.9534	
Marand		0.9504	0.9527	1.0000			0.9672	
			0.8950	1.0000	0.9665		0.9517	
				0.9812	0.8795	1.0000	0.9505	
Year average	0.9223	0.9616	0.9370	0.9936	0.9210	1.0000	0.9557	3
	0.9767	0.7500	0.6702				0.7794	
Malekan		0.7500	0.6655	0.8059			0.7359	
			0.7004	1.0000	1.0000		0.8752	
				0.7260	1.0000	1.0000	0.8883	
Year average	0.9767	0.7500	0.6784	0.8290	1.0000	1.0000	0.8146	13
	0.8251	1.0000	0.6863				0.8177	
Hadishahr		1.0000	0.6646	0.7692			0.7885	
			0.6618	0.7924	0.9926		0.7935	
				0.7138	0.9250	0.8644	0.8244	

Year average	0.8251	1.0000	0.6707	0.7570	0.9576	0.8644	0.8057	14
Hashtrood	0.8902	0.9366	0.9266				0.9173	
		0.9241	0.9079	0.9383			0.9233	
			0.9067	0.9670	1.0000		0.9563	
				0.9308	0.9624	0.9533	0.9487	
Year average	0.8902	0.9303	0.9137	0.9452	0.9809	0.9533	0.9362	5
Heris	1.0000	0.9849	1.0000				0.9949	
		1.0000	1.0000	1.0000			1.0000	
			1.0000	1.0000	1.0000		1.0000	
				0.9463	1.0000	1.0000	0.9815	
Year average	1.0000	0.9924	1.0000	0.9815	1.0000	1.0000	0.9940	2
Warzeghan	0.7305	1.0000	0.7135				0.7957	
		1.0000	0.6930	0.6812			0.7670	
			0.6905	0.7055	0.6621		0.6855	
				0.6382	0.6109	0.8320	0.6809	
Year average	0.7305	1.0000	0.6988	0.6738	0.6354	0.8320	0.7289	16

Conclusion

Regarding the results achieved we can respond to the two questions posed in the present research as follows: firstly it is possible to do ranking in the branches of Red Crescent Organization by using window data envelopment analysis model and this method is able to represent valuable information about performance trends. Secondly the results of the present research showed that the performance of branches during different time periods may differ and even it is possible to see different results in different time periods. Overall results show that the window average which represents the final ranking during the time period under investigations introduced Bostanabad as the first rank regarding all dimensions and organization plans to act efficiently. Heris branch has carried out the activities in a desirable status and has achieved the second rank following Bostanabad branch. Also there are some branches from among the branches under investigations that have achieved the last ranks which are Hadishar, Azarshahr, and Warzeghan which have achieved 14th, 15th, and 16th ranks among the 16 branches under investigations, respectively.

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