SYM-OP-IS-2016
XLIII симпозијум о операционим истраживањима

MEASURING THE EFFICIENCY OF PARTICIPATING COUNTRIES IN NATO-LED MISSION IN AFGHANISTAN, ISAF: NON-PARAMETRIC APPROACH

LIDIJA GEORGIEVA
Ss. Cyril and Methodius University in Skopje, Faculty of Philosophy - Skopje, Skopje, georgieva@fzf.ukim.edu.mk

TONI NAUMOVSKI
MoD/Army of the Republic of Macedonia, Skopje, toninaumovski@yahoo.com

VIOLETA CVETKOSKA
Ss. Cyril and Methodius University in Skopje, Faculty of Economics - Skopje, Skopje, vcvetkoska@eccf.ukim.edu.mk

Abstract: The aim of this paper is to measure the relative efficiency of the participating countries in the ISAF mission in a period of three years (2007-2009) by using the non-parametric approach Data Envelopment Analysis (DEA). A key role in DEA analysis is the selection of inputs and outputs, and in our empirical research two inputs are selected: the total population of each participating country and the GDP per capita of the participating countries, and as output the number of soldiers (troops) of each participating country per rotation is selected. The sample consists of 36 participating countries, i.e., Decision Making Units (DMUs). According to the obtained results it is found that 5 countries (Albania, Estonia, Macedonia, United Kingdom, and the United States) are relative efficient in the whole observed period, while Austria is identified as the least efficient country. In addition, it is shown how relative inefficient countries may improve their efficiency and become relative efficient.

Keywords: *Relative Efficiency, DEA, ISAF Mission, Macedonia, Slovenia.*

1. INTRODUCTION

In this paper we measure the relative efficiency of participating countries in a NATO-led mission in Afghanistan, ISAF in a period of three years (2007-2009) by using the non-parametric approach Data Envelopment Analysis (DEA).

DEA was introduced in the literature of the discipline operational research (OR) by Charnes, Cooper & Rhodes in 1978 [1]. It is a non-parametric methodology for measuring the efficiency of homogenous entities (they use the same inputs and produce the same outputs) which in DEA terminology are known as Decision Making Units (DMUs). In order to construct the efficiency frontier, the empirical data are taken for the used inputs and produced outputs. Those DMUs that form the efficiency frontier are relative efficient while the other are relative inefficient, and to improve their efficiency and become relative efficient this non-parametric methodology allows for the sources of inefficiency and the level of inefficiency for each input, i.e. output to be identified [2, p.105].

Data Envelopment Analysis is used for measuring the relative efficiency in banking, education, health care, agriculture, energetics, sport, the defence sector, etc., and in this paper its application in the defence sector is presented. In the literature there are found articles with DEA application in the defence sector but none of them investigates the relative efficiency of participating countries in ISAF.

2. METHODOLOGY

One of the basic DEA models is the Banker-Charnes-Cooper (BCC) model [3] that is built on the assumption of variable returns to scale (VRS) of activities. VRS exist when the proportional increase in inputs does not lead to a proportional increase in outputs [4, p. 40]. Regarding the orientation, DEA models can be oriented on input reduction (known as input-oriented model) or on output augmentation (known as output-oriented model). In our research we have used the output-oriented BCC DEA model. The envelopment form of the output-oriented BCC DEA model is given in (1)-(5), [5, p. 93; 6, p.79]:

$$(BCC\text{-}O_o) \qquad \max_{\eta_B,\lambda} \ \eta_B \tag{1}$$

$$\text{subject to} \qquad X\lambda \le x_o \tag{2}$$

$$\eta_B y_o - Y\lambda \le 0 \tag{3}$$

$$e\lambda = 1 \tag{4}$$

$$\lambda \ge 0 \tag{5}$$

where η_B is a scalar. The input data for DMU$_j$ (j=1,…,n) are $(x_{1j}, x_{2j}, \ldots, x_{mj})$, and the output data are $(y_{1j}, y_{2j}, \ldots, x_{sj})$; the data set is given by two matrices X and Y, where X is the input data matrix, and Y is

the output data matrix, λ is a column vector and all its elements are non-negative, while e is a row vector and all its elements are equal to 1 [5, p. 22, pp. 91-92]. More details about the BCC DEA model can be found in [3, 5, p. 90-94].

3. DATA SELECTION AND DESCRIPTION

The choice of inputs and outputs is a crucial part in DEA analysis. As variables in our empirical research there are selected two inputs and one output.

Inputs are:

1. Total population of each participating country, and,
2. GDP per capita of the participating countries (in US dollars).

While as output the following is selected:

1. A number of soldiers (troops) of each participating country per rotation.

The sample consists of 36 DMUs - participating countries. Those countries that do not participate in the mission in each observed year are excluded (Bosnia and Herzegovina, Georgia, Jordan, Singapore, Switzerland, and Ukraine).

The total number of soldiers per rotation in ISAF increases from 2007 to 2009, as a result of the increased need for peacekeepers in the ISAF mission. In 2007 the total number of soldiers per rotation was 41.649 (the actual number is 41.741, Jordan and Switzerland are excluded). In 2008 the total number of soldiers was 51.350 (the actual number is 51.361, Georgia and Ukraine are excluded), and in 2009 the total number was 83.913 (the actual number is 84.146, Bosnia and Herzegovina, Georgia, Singapore and Ukraine are excluded). The term rotation refers to the period of time during the year, usually 6 months.

The data of population and GDP for each participating country are derived from the Web site of the World Bank [7; 8], while the data for the number of troops of the ISAF participating countries is obtained from the database of the Stockholm International Peace Research Institute, SIPRI [9].

4. RESULTS AND DISCUSSION

In order to solve the DEA model, 'DEA - Solver, Learning version 3.0.' software is used.

The analysis reflects the contribution of the participating countries to ISAF. It includes NATO member countries and partner countries which participated in ISAF. Table 1 presents the efficiency scores of certain countries for the analyzed period (2007-2009).

Based on the obtained results for 2007, only 6 participating countries in ISAF were identified as relative efficient, thus their contribution to ISAF is the largest.

Table 1: Efficiency scores for certain participating countries in ISAF

	2007		2008		2009	
	DMU	Efficiency score	DMU	Efficiency score	DMU	Efficiency score
1	Albania	1	Albania	1	Albania	1
2	Estonia	1	Estonia	1	Estonia	1
3	Macedonia	1	Macedonia	1	Macedonia	1
4	United Kingdom	1	United Kingdom	1	United Kingdom	1
5	United States	1	United States	1	United States	1
6	Iceland	1	Iceland	1	Iceland	0.9998
7	Luxemburg	0.2868	Luxemburg	0.2782	Luxemburg	1
8	Denmark	0.9501	Denmark	0.9410	Denmark	0.9230
9	Norway	0.8942	Norway	0.7100	Norway	0.7237
10	Netherlands	0.7391	Netherlands	0.7692	Netherlands	0.7846
11	Slovenia	0.3095	Slovenia	0.3002	Slovenia	0.2660
12	Austria	0.0029	Austria	0.0008	Austria	0.0024

They are: Albania, Estonia, Macedonia, United Kingdom, the United States, and Iceland. All listed relative efficient countries are NATO member countries, except Macedonia. The efficiency score of Denmark is 0.9501, Norway has an efficiency score of 0.8942, etc., and the least efficient is Austria, with an efficiency score of 0.0029. In 2008, the same countries were relative efficient. The efficiency score of Denmark is 0.9410, the efficiency score of Norway is 0.7100, etc., and the least efficient is Austria, with an efficiency score of 0.0008. In 2009, relative efficient were the following six countries: Albania, Estonia, Luxembourg, Macedonia, United Kingdom, and the United States. The efficiency score of Denmark is 0.9230, the efficiency score for Norway is 0.7237, and Austria is identified as the least efficient (the efficiency score is 0.0024). Regarding Macedonia, the often stated conclusion from the political and academic community is confirmed, that despite the fact that it is a small country with limited resources, Macedonia was one of the major contributors to the ISAF mission. The results also show that, in terms of all of the NATO partner countries, Macedonia is the largest contributor to the ISAF mission. This raises the question 'Why at the Chicago summit in 2012 on the list of specially invited 13 NATO partner countries Macedonia is not included?'. The list of 13 countries includes: Australia, Austria, Finland, Georgia, Japan, Jordan, the Republic of Korea, Morocco, New Zealand, Qatar, Sweden, Switzerland and the United Arab Emirates. For these countries it is thought that they have made certain political, operational and financial contributions to NATO-led operations and missions. Some of them are included in the analysis.

According to the results of the analysis in the observed period (2007-2009), it can be concluded that certain partner countries have expressed a greater willingness and

capability in terms of their contribution to NATO-operations and missions. Actually, due to the fact that the NATO-partner countries, such as Australia, Austria, Finland, New Zealand, and Sweden have far greater human and economic resources than Macedonia, their contribution to NATO missions should be more significant. Concurrently, compared with the NATO member countries, Macedonia's contribution is significantly larger than those NATO member countries that have a far larger population and more economic opportunities (France, Germany, Netherlands, etc.). Additionally, compared to other countries in the region, Albania and Macedonia are major contributors to the ISAF, as opposed to Bulgaria, Greece, and Romania. But what does Macedonia "get" from that contribution? With no invitation for NATO membership in 2008, the question is: "Should Macedonia continue to contribute with significant numbers of troops to NATO missions? [10, p.7]. Slaveski [10, p.7] has proposed to examine the funds allocated for this purpose and they can be reallocated to improve the standard of the employees of the Army and to equip the Army. On the other hand, according to Slaveski, it is necessary to consider the possibilities for greater participation of Macedonia to UN missions, where there is a financial compensation for participation. However, withdrawal of established relations and undertaken obligations, related to participation in NATO-led operations and missions would mean lack of seriousness. The participation should be according to the possibilities, estimated risks and stated Macedonia's national interests, which should not be calculated through cost. The increase of the defense budget and achievement the NATO criteria for defence spending of about 2% of the GDP will greatly contribute to equipping and modernization of the Army.

Regarding the NATO member countries, those relatively efficient are: Albania, Estonia, Iceland (2007 and 2008), United Kingdom, Luxembourg (2009) and the United States. As always, the leading of the NATO operations and missions has the United States accompanied by the United Kingdom. Again, the necessity of the balanced burden sharing between NATO member countries comes to the foreground. Burden sharing has always been important in NATO operations and missions, and raises the question: "What will happen when the Untied States will no longer take the lead in international operations?" [11].

The efficiency score of the Republic of Slovenia is 0.3095, 0.3002 and 0.2660 in 2007, 2008 and 2009 respectively. But if we analyze the relative efficiency of Estonia which, just as Slovenia, has been a NATO member country since 2004, it could be noticed that the contribution of Estonia is far more significant. Estonia belongs to the group of countries that are relatively efficient. This is also determined in the study of Hribernik [12 p. 381] who analyzes the contribution of Estonia and Slovenia to ISAF. Hribernik emphasizes that both states have expanded their military commitments abroad, however the ratio between the two remained fairly similar, with Estonia contributing a significantly larger force both in absolute and relative terms. He points out the fact that the country with the most soldiers in ISAF relative to its population size was Estonia. In 2011 this ratio was 1 soldier for every 8.222 inhabitants of Estonia and 1 soldier for every 23.333 inhabitants of Slovenia. Hribernik in his analysis of ISAF contribution prefigures that in 2009 Slovenia was the last on a list alongside seven comparable countries (Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, and Slovakia). In the DEA analysis Hungary and the Czech Republic are less efficient than Slovenia (the score of efficiency is: 0.1775 for Hungary and 0.2384 for the Czech Republic)

On the other hand, the participation of the Republic of Slovenia in the NATO-led operation in Kosovo is far different. The reason for that should be sought in the fact that a stable and safe neighborhood provides security and prosperity at home. Probably the decision on the extent and level of Slovenia's participation to ISAF is influenced by the fact that Afghanistan is a quite distant region and the presence in the Western Balkans is in the focus of Slovenia's participation in international operations missions. The special interest on the stability and security of the region of South East Europe contributes to the increasing presence of the Slovenian Armed Forces in NATO operations on the Balkans (SFOR in Bosnia and Herzegovina and KFOR in Kosovo). This is also supported by the public opinion on Slovenia's involvement abroad with a more prevalent commitment to the regional focus of Slovenia's participation in NATO-led operations and missions.

With the emergence of the economic crisis in 2008, the GDP of the participating countries in 2009 declined, and this reflected on their relatively efficient. On the other hand, the need for peacekeepers increases, and it requires participating countries to not only reduce the number of troops but also further increase, in order to be relatively efficient. Such is the case with Luxembourg, which becomes relative efficient because with a reduction of GDP Luxembourg does not reduce the number of troops in ISAF. Some of the participating countries do not become more efficient despite the reduction in GDP. Besides the fact that they have increased the number of troops, that number, in terms of the increasing need of peacekeepers, does not increase their relative efficiency. Such is the case with Slovenia. In order for Slovenia to be relative efficient in the ISAF, in the years that are the subject of analysis, it is required to increase the number of troops that are participating in the mission. Table 2 shows a projection of how Slovenia may improve its efficiency and become relative efficient in the second year of the observed period, i.e., in 2008. For inputs (total population and GDP per capita) there is no change and they remain the same, while the output (number of troops) is required to be increased from 70 to 233.

Table 2: Projection for Slovenia to become relative efficient in the NATO mission, ISAF

Slovenia	2008	
Input 1	2021316→2021316	no change
Input 2	27501.8→27501,8	no change
Output 1	70→233	233,09% increasing

Based on the analysis it can be concluded that the differences between desires and expectations, expressed in the political commitment of the NATO member countries and its partners for participation in international operations and missions, on the one hand, and the real possibilities on the other, are always present. That requires the necessity to make a real burden sharing in the participation, and the contribution should be in line with the available resources and capabilities of the countries that expressed readiness to take part in NATO-led operations and missions. Activities related to participation in NATO-led operations and missions are constantly monitored by the public and cause certain critical considerations. In addition, the countries should also work on raising awareness on public support for participation in international operations and missions because participation has actually increased their security.

5. CONCLUSION

The aim of this paper was to present the applicability of the non-parametric methodology DEA in measuring the burden sharing in NATO-led mission in Afghanistan, ISAF. There have been analyzed 36 participating countries in the period between 2007 and 2009, by using the output-oriented BCC DEA model. Based on the obtained results, only 5 countries are relative efficient in the whole observed period. All of them are NATO member countries except Macedonia. In terms of all of the NATO partner countries, Macedonia is the largest contributor to the ISAF mission. In the case of Slovenia, as a NATO member country, it is required to increase the number of troops that are participating in the mission, in order to improve its efficiency and become relative efficient.

As usual, the necessity of the balanced burden sharing in NATO-led operations and missions comes to the foreground. Therefore, the application of the DEA, in the paper, shows that it is a powerful methodology that provides real results of burden sharing in NATO-led operations and missions.

Our further research will be the application of the DEA for measuring the efficiency of the participating South East European countries in ISAF in the period between 2007 and 2014.

REFERENCES

[1] Charnes, A., Cooper, W.W., & Rhodes, E.L., "Measuring Efficiency of Decision-Making Units", European Journal of Operational Research, 2(6), 429-444. doi:10.1016/0377-2217(78)90138-8, 1978

[2] Cvetkoska, V., "Evaluating the Relative Efficiency of Bank Branches by Using the COOPER-Framework", Proceedings of the XLII International Symposium on Operational Research (SYM-OP-IS 2015), Editors: Nenad Mladenovic, Dragan Urosevic, Zorica Stanimirovic, 2015, pp. 105-108.

[3] Banker, R. D., Charnes, A. & Cooper, W. W., "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis". Management Science, 30(9), 1984, 1078-1092.

[4] Thanassoulis, E., "Introduction to the Theory and Application of Data Envelopment Analysis: A Foundation Text with Integrated Software", (Boston: Kluwer Academic Publishers), 2001.

[5] Cooper, W.W., Seiford, L.M., & Tone, K., "Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software", (2 ed.), (New York: Springer Science + Business Media, LLC), 2007.

[6] Cvetkoska, V., & Barisic, P.. "Measuring the Efficiency of Certain European Countries in Tourism: DEA Window Analysis", In Book of Proceedings of International May Conference on Strategic Management – IMKSM2014, 23-25 May 2014, Bor, Serbia, 2014, (pp. 77-86) http://media.sjm06.com/2014/07/Final-IMKSM14_Book-of-Proceedings.pdf

[7] The World Bank Population. http://data.worldbank.org/indicator/SP.POP.TOTL?age=1 (date of accession 25.02.2014)

[8] The World Bank GDP per capita. http://data.worldbank.org/indicator/NY.GDP.PCAP.CD?page=1(date of accession 25.02.2014)

[9] SIPRI Multilateral Peace Operations Database-SIPRI. http://www.sipri.org/databases/pko(dateof accession 25.02.2014)

[10] Slaveski, S. "Unfinished business in the Balkans: NATO's role in the stabilization of the Western Balkan" in *Shtit*, Skopje: Ministry of Defense of the Republic of Macedonia, Number.50, October 2013. (InMacedonian)http://www.morm.gov.mk/wp-content/uploads/2011/10/50-Shtit.pdf.

[11] Matlary, H. J. & Petersson, M., "Introduction: Will Europe Lead in NATO", in Matlary, H. J. and Petersson, M. (eds) *NATO's European Allies: Military Capability and Political Will*, New York: PALGRAVE MACMILLAN, 2013.

[12] Hribernik, M., "Regional or Global? The National Security Strategy and Public Opinion in Slovenia" in *Panorama of Global Security Environment,* 2011.http://www.academia.edu/1463918/Regional_or_global_The_National_Security_Strategy_and_public_opinion_in_Slovenia