EVALUATING THE ORGANIZATIONAL EFFECTIVENESS OF INDUSTRIAL ENTERPRISES USING GAME THEORY

HASSIBA HADOUGA[1]

Abstract: *Assessment of organizational effectiveness is critical to any organization. The purpose of this paper is to present a mixed approach using game theory analysis to assess the performance of organizational effectiveness within organizations. To assess the competence of each unit in assessing organizational effectiveness, the relationship between different departments within an organization is modeled based on effectiveness indicators. Furthermore, indicators related to each aspect of organizational effectiveness are expressed as inputs and outputs for determining effectiveness. The proposed model has been implemented in 20 different industrial enterprises within Slovakia, based on the information obtained in 2022. This paper is based solely on the financial and economic data of various manufacturing companies in Slovakia. With approximately 500 statements, over a period of 6 years, this paper is expected to be able to describe organizational effectiveness, which may provide a potential indication of the company's level of viability in the coming years. Statistical analyses are also performed to monitor the general practicality of the data.*

Keywords: *organizational effectiveness, game theory, financial data, economic data.*

JEL Classification: C30, C72, C65.

[1] Professor Hassiba Hadouga, Abdelhamid Mehri Constantine University, Algeria,
e-mail: hadouga.hassiba@yahoo.fr, https://orcid.org/0000-0001-6371-8608

EKONOMICKÉ ROZHĽADY – ECONOMIC REVIEW, 2023, 52(4), 203 ─ 217
https://doi.org/10.53465/ER.2644-7185.2023.4.203-217

1 Introduction

Existing organizations face many internal and external pressures and challenges affecting their survival, growth, and ability to continue, since the global system is currently marked by its swift motion, changes and transformations follow, and the forces of change are intensifying in many regions of the world (de Nardis, 2020).

Because circumstances can change rapidly, governments and organizations must adapt by making the required arrangements, enhancing various programs and operations, and even changing their entire culture. Only then will they be better equipped to meet challenges head-on and expand their capacity for survival (Rogers & Song,2023).

The fundamental requirements for these organizations' success are survival, growth, and the capacity to adjust to global changes (Alzate Fernández & Rivas Montoya, 2018). These criteria also serve as indicators that determine the overall level of organizational effectiveness (Bisbe & Malagueño, 2012), which can be viewed as a fundamental need for modern organizations regardless of whether they manufacture goods or provide services. Organizational effectiveness (Pollock, 1993) can be seen as As the primary force behind energy development, modernization, and ongoing performance enhancement in a variety of modern companies (Kumar et al., 2023).

Owing to the fact that organizational effectiveness (Mio, Costantini & Panfilo, 2021) is characterized by a high degree of ambiguity and generality (Kushner, 1996) and that each researcher's definition of effectiveness is dependent on the methodology he employs, the theoretical framework that each entrance to organizational effectiveness uses determines the parameters and standards of organizational effectiveness for each entrance. It makes sense to respond in this way when handling an ambiguous and dynamic notion like efficacy (Xu et al.,2022). This idea has remained associated with subjective standards and personal preferences despite all attempts to limit it to certain objective aspects. It is a conceptual complex that has several dimensions and multiple meanings rather than a single, definitive solution (Dhoopar, Sihag & Gupta,2023).

Various industrial organizations of society have currently acquired great importance, as systems that add a lot to the national product of societies.

Slovakia was a predominantly industrial country in the second half of the

twentieth century. Heavy industries (including coal mining, machinery production, and steel) were built for strategic reasons. In 2010, industry (including construction) accounted for 35.6% of GDP, compared to about 49% in 1990.

Nowadays, based on long-standing traditions and a highly skilled workforce, the main industries with growth potential are the following: automotive, electronics, mechanical engineering, chemical engineering, information technology

The automotive sector is among the fastest growing in Slovakia due to the recent large investments of Volkswagen (Bratislava), Peugeot (Trnava), Kia Motors (Žilina), and since 2018 also Jaguar Land Rover in Nitra. Passenger car production reached 1,040,000 units in 2016, making Slovakia the largest car producer in terms of per capita cars produced. Other major industrial companies include US Steel (metals), Slovnaft (oil industry), Samsung Electronics (electronics), Foxconn (electronics), Mundi SCP (paper), Slovalco (aluminum production), Hyundai Mobis (automotive), Continental Matador (automobile), and Whirlpool Corporation. In 2006, machinery accounted for more than half of Slovakia's exports (EUROPEAN COMMISSION, 2022).

Thus, in this paper, we will try to evaluate the organizational effectiveness of industrial enterprises in Slovakia, using game theory, by verifying the validity of the following hypothesis:

Industrial enterprises within the country of Slovakia achieve a high level of organizational effectiveness.

2 Literature Review

In academic literature, the question of potential organizational effectiveness has been analyzed by many researchers. Parhizgari (2003) compared internal organizational structures and procedures linked to organizational effectiveness in the public and private sectors in his study. The study's research sample of 11,352 cases came from 28 commercial institutions and 41 public sector organizations. For each industry, nine metrics linked to organizational performance were found and empirically retrieved. Then, these metrics are contrasted between the two industries. The authors came to the conclusion that there are considerable differences in the effectiveness metrics used in the

EKONOMICKÉ ROZHĽADY – ECONOMIC REVIEW, 2023, 52(4), 203 ─ 217
https://doi.org/10.53465/ER.2644-7185.2023.4.203-217

public and private sectors after using rigorous statistical techniques. These results' consequences are then examined.

Trierweiller et al. (2012) study was to use the element response theory (IRT) to assess the efficiency of information and communication technology (ICT) businesses from the perspective of managers. This kind of regulation, which is necessary to ascertain its efficacy, is typically linked with complex, dynamic, and competitive ecosystems. The notion and measurement of organizational performance are hotly debated in academic literature.

A questionnaire to assess the specialists was created based on the efficacy factors. According to the findings, the managers tended to agree with worries about innovation, items 11 (-2.653) and 14 (-3.149), rather than points 6 (-1.222) and 15 (-0.324), relating to society and the environment. Using the two-parameter logistic model (2PLM) of IRT, this construct was successful in assessing the organizational performance of ICT enterprises from the managers' perspective. When using other similar instruments, it is not feasible to assess the value and attributes of each topic inside a single measure: subjects and respondents.

According to Alejandro (2018), the purpose of this study was to assess the organizational performance of water sector managers in Mexico City's sixteen boroughs in the city's drinking water system. An instrument that has been statistically verified was created to measure this phenomenon, using exploratory and descriptive research. The most severely impacted communities were identified by the data, and recommendations were made to enhance programs, look for new water sources, assign adequate funds, and adhere to the criteria.

3 Methodology and Modeling

The main objective of this study was to evaluate the organizational effectiveness (EOE) of industrial enterprises affiliated with the state of the game theory approach. This is an applied and descriptive study according to the purpose and method of data collection (Brown, 2004), quantity and modeling in terms of nature. In terms of objective, temporal, and spatial scales, the current study falls objectively in the field of Performance management issues and in the performance appraisal subgroup. In terms of time (Cooper, 2007), this is a cross-sectional study relating to the year 2022. In terms of location, the scope

of this research is represented by industrial companies of the Slovak Republic, bearing in mind that 20 companies are designated as samples for this research, so no subtraction is made. The criteria evaluated in this study were initially obtained through desk study by examining scientific books and articles and interviewing experts in the field of industry. Finally, the relevant data were extracted from the audited financial and economic data for the year 2022. Then, the search variables were set and adjusted as shown in Table 1.

In other words, the first contribution of the proposed model is the use of game theory (Bestougeff,1998) in evaluating the efficiency of organizational effectiveness, so that each point of view of the indicators of organizational effectiveness is considered. The leader and the other points of view are taken into account. Next, an organizational effectiveness rating is calculated.

The game theory equation was adopted as follows:

The unit vectors Δn of the standard base (Fukuyama, 2017), which are referred to as the pure strategies and correspond to the initial set of choices, span the simplex in Rn that represents the set of all such mixed strategies

$$(Ay)_i = \sum_{j=1}^{m} a_{ij} y_j \tag{1}$$

The set U of EOE is formed using acceptable game theory ideas, and the choice power function is defined as ps (u) and the rejection power function as pR(u), where pS (u) is the interest rate u. To accomplish the decision-maker's goals, and pR(u) is the cost assigned to this unit. The actions listed below must be taken in order to compute these pathological functions (Tchangani, 2006).

Calculating the average preference of the w_j^s decision makers to the w_J^R input or output will yield the selectability and rejectability weights, respectively, such as the following:

$$W_J^S = \frac{\sum_{k=1}^{d} p_{kj}}{\sum_{j=1}^{m}\sum_{k=1}^{d} p_{kj}} \qquad w_j^R = \frac{\sum_{k=1}^{d} \sigma_{kj}}{\sum_{j=1}^{p}\sum_{k=1}^{d} \sigma_{kj}} \tag{2}$$

Calculating satisficing functions of P_S and p_R as the following:

$$P_S(U) = \frac{g_S(u)}{\sum x \in \mu g_S(x)}, \quad p_R(\mu) = \frac{g_R(u)}{\sum x \in \mu g_R(x)}, \quad \forall \ \mu \in u \tag{3}$$

EKONOMICKÉ ROZHĽADY – ECONOMIC REVIEW, 2023, 52(4), 203 ─ 217
https://doi.org/10.53465/ER.2644-7185.2023.4.203-217

The satisficing set of $\Sigma \subseteq U = \{u \in t : (u) \geq pR(u)\}$, which indicates individual efficiency of DMUs. Equilibrium set ε (within-group efficiency of DMUs) is $\mathscr{E} = \{u \in t : (u) = \emptyset\}$ and ε includes units that are not quite the best units (Zhang, 2017). The set of satisficing equilibrium is $S = \mathscr{E} \cap \Sigma$ and indicates completely efficient units (Stirling, 1999). Set B(u) is complementary to the set ε which includes units that are strongly better than u and are defined as follows:

$$B(u) = B_S(u) \cup B_R(u)$$

$$B_S(u) = \{v \epsilon u : p_R(v) < p_R(u) \quad and\ p_s(v) \geq p_s(u)\} \tag{4}$$
$$B_S(u) = \{v \epsilon u : p_R(v) < p_R(u) \quad and\ p_s(v) > p_s(u)\}$$

In order to implement each of the models included in the GAMS (Stirling, 2003) software and to employ CPLEX for its optimal solution, the mathematical symbols used in the model were defined as follows

Table 1: Mathematical symbols used in the form

Parameters	
Y(j, p^r)	Outputs from the perspective of profitability ratios
W(j, $a^{u\,r}$)	Outputs from the point of view of asset utilization ratios
Z(j, l^r)	Outputs from the perspective of liquidity ratios
F(j,$d^{u\,r}$)	Outputs from the perspective of debt utilization ratios
Outputs	
ROA	Output coefficient in terms of profitability of organizational effectiveness
ROE	Output coefficient in terms of profitability of organizational effectiveness
ROS	Output coefficient in terms of the use of assets for the effectiveness of the organization

RETO	Output coefficient in terms of the use of assets for the effectiveness of the organization
ITO	Output coefficient in terms of the use of assets for the effectiveness of the organization
TATO	Coefficient of system input from the growth and learning perspective for the desired decision-making unit
CR	Output coefficient in terms of liquidity for the effectiveness of the organization
QR	Output coefficient in terms of liquidity for the effectiveness of the organization
DAR	Output coefficient in terms of the use of debt for the effectiveness of the organization
DER	Output coefficient in terms of the use of debt for the effectiveness of the organization
TAN	Output coefficient in terms of the use of debt for the effectiveness of the organization
ETAR	Output coefficient in terms of the use of debt for the effectiveness of the organization
ERIT	Output coefficient in terms of the use of debt for the effectiveness of the organization
TA	Output coefficient in terms of the use of debt for the effectiveness of the organization

Source: author

Table 1 shows the data formed for industrial enterprises of Slovakia. Finally, the following table was obtained by solving the form. In this table, the efficiency of each unit of decision-making is identified based on game theory (non-cooperative – leader, follower)

According to Table 1A in the appendix and the displayed outputs, if the profitability ratios perspective is defined as leader, the efficiency in the ten organizational effectiveness units equals one. From the point of view of asset utilization ratios, liquidity ratios, debt utilization ratios that are considered affiliated, and the efficiency reaches 50% of the units' organizational effectiveness process from the perspective of profitability ratios.

According to Table 2A in the appendix and the provided outputs, if the ARU

EKONOMICKÉ ROZHĽADY – ECONOMIC REVIEW, 2023, 52(4), 203 ─ 217
https://doi.org/10.53465/ER.2644-7185.2023.4.203-217

perspective is defined as a leader, the efficiency in 9 organizational effectiveness units (45%) equals one - from the perspective of profitability ratios, liquidity ratios, debt utilization ratios, which are dependent.

Based on Table 3A in the appendix and the output provided, if the liquidity ratios perspective is defined as leader, then the efficiency in 9 units of organizational effectiveness (45%) equals one. In terms of profitability ratios, asset utilization ratios, debt utilization ratios, who are considered dependents.

According to Table 4A in the appendix and the outputs provided, if the Debt Utilization Ratios perspective is defined as a leader, the efficiency in 8 units of organizational effectiveness (40%) equals one. In the perspective of profitability ratios, asset utilization ratios, liquidity ratios that are intended for affiliates.

4 Conclusion

In recent years, managers have placed a high value on the subject of assessing organizational effectiveness.

The evaluation of an organization's or business' organizational effectiveness is one of the performance measurement subsets. Improved resource allocation to boost revenues and save expenses is the goal of assessing organizational performance. In order to categorize and evaluate the effectiveness of industrial units in Slovakia, a game theory organizational effectiveness model is provided in this article. As can be seen, the strategy map was used to establish the first profitability ratios, asset utilization ratios, liquidity ratios, and debt utilization ratios for organizational effectiveness indicators.

The stage of analyzing the performance of the units has started with the collection of data on 20 industrial units in the holding. The model is constructed in the next stage with consideration to the relationships between the indicators. Then, to investigate the subordinate leader in organizational effectiveness units, Stackelberg's theory and game theory were used.

At this point, the suggested model had been put into practice four times, with one of the two organizational effectiveness viewpoints in each stage serving as the leader and the other as the follower. Organizational effectiveness was shown to be a key factor in the results of the model's adoption. It is essential

to the efficacy of organizational effectiveness units from the standpoint of profitability ratios

In other words, it may be claimed that the businesses examined in this research operate as leaders and that other points of view function as followers. The effectiveness of all organizational effectiveness units will be based on the fact that the companies under scrutiny are leaders in financial and economic operations, as is the case from the perspective of asset utilization ratios and liquidity ratios, which are essential in all organizational effectiveness units and indicate that the management of the companies under study is able to meet its current obligations, and the timely distribution of the company's assets during the research phase. The evaluation of the study model from the standpoint of debt utilization ratios confirmed the existence of competence in all organizational effectiveness units, highlighting the knowledge and sophistication of the officials of the institutions under study in managing corporate debt. The best response from followers is to choose strategies that boost their efficiency, which depends on the organizational decisions made by the leader and the concept of solutions chosen by the followers. This is because followers are highly efficient in adopting policies that enable institutions to succeed and their ability to achieve the highest levels of profits, which confirms the validity of the study hypothesis.

REFERENCES

[1] Alzate Fernández, F., & Rivas Montoya, L. M. (2018). Multi-business companies: The Leonisa case. Cuadernos de Administración, 34(60). https://doi.org/10.25100/cdea.v34i60.6219

[2] Bestougeff, H., & Rudnianski, M. (1998). Games of deterrence and satisficing models applied to business process modeling. In Proceedings AAAI Spring Symposium, Stanford (Vol. 374).

[3] Bisbe, J., & Malagueño, R. (2012). Using strategic performance measurement systems for strategy formulation: Does it work in dynamic environments? Management Accounting Research, 23(4), 296 – 311. https://doi.org/10.1016/j.mar.2012.05.002

[4] Brown, R. (2004). Consideration of the origin of Herbert Simon's theory of "satisficing" (1933-1947). Management Decision, 42(10), 1240 – 1256. https://doi.org/10.1108/00251740410568944

[5] Cooper, W. W., Seiford, L. M., & Tone, K. (2007). *Data Envelopment Analysis.* Springer Press. https://doi.org/10.1007/978-0-387-45283-8

[6] de Nardis, F. (2020). International System and Globalisation. Understanding Politics and Society, 179 – 212. https://doi.org/10.1007/978-3-030-37760-1_6

[7] Dhoopar, A., Sihag, P., & Gupta, B. (2023). Antecedents and measures of organizational effectiveness: A systematic review of literature. Human Resource Management Review, 33(1), 100915. https://doi.org/10.1016/j.hrmr.2022.100915

[8] European Commision. (2022). 2022 Country Report – Slovakia. Accompanying the document Recommendation for a council recommendation.

[9] Fukuyama, H., & Matousek, R. (2017). Modelling bank performance: A network DEA approach. *European Journal of Operational Research*, 259(2), 721 – 732. https://doi.org/10.1016/j.ejor.2016.10.044

[10] de San, J. A. S. R. (2018). Evaluación de la efectividad organizacional en el sistema de agua potable de la Ciudad de México. Espacios, 39(45).

[11] Kumar, A., Shrivastav, S. K., Shrivastava, A. K., Panigrahi, R. R., Mardani, A., & Cavallaro, F. (2023). Sustainable Supply Chain Management, Performance Measurement, and Management: A Review. Sustainability, 15(6), 5290. https://doi.org/10.3390/su15065290

[12] Kushner, R. J., & Poole, P. P. (1996). Exploring structure-effectiveness relationships in nonprofit arts organizations. Nonprofit Management and Leadership, 7(2), 119 – 136. Portico. https://doi.org/10.1002/nml.4130070203

[13] Mio, C., Costantini, A., & Panfilo, S. (2021). Performance measurement tools for sustainable business: A systematic literature review on the sustainability balanced scorecard use. Corporate Social Responsibility and Environmental Management, 29(2), 367 – 384. Portico. https://doi.org/10.1002/csr.2206

[14] Parhizgari, A. (2004). Measures of organizational effectiveness: private and public sector performance. *Omega*, 32(3), 221 – 229. https://doi.org/10.1016/j.omega.2003.11.002

[15] Pollock S. (1993). Doing organizational effectiveness, effectively. *The Journal for Quality and Participation,* 16 (5), 36

[16] Rogers, J., & Song, A. (2023). Digital Marketing in The Legal Profession: What's Going On and Does It Matter? Law, Technology and Humans. https://doi.org/10.5204/lthj.2828

[17] Stirling, W. C., & Goodrich, M. A. (1999). Satisficing Games. *Information Sciences,* 114, 257. https://doi.org/10.1016/S0020-0255(98)10048-8

[18] Stirling, W. C. (2003). *Satisficing Games and Decision Making: With Applications to Engineering and Computer Science.* Cambridge University Press. https://doi.org/10.1017/CBO9780511543456

[19] Tchangani, A. P. (2006). A Satisficing Game Theory Approach for Group Evaluation of Production Units. *Decision Support Systems,* 42, 778 – 788. https://doi.org/10.1016/j.dss.2005.05.010

[20] Trierweiller, A., Peixe, B. C. S., Tezza, R., Pereira, V., Bornia, A., Júnior, W., Weise, A., & Rotta, M. (2012). Evaluating the Organizational Effectiveness with the Item Response Theory: a Case Study in Information and Communication Technology Companies. Conference ICIEOM 2012, Portugal.

[21] Zhang, S. Z., & Gong, Z. W. (2017). DEA Game Cross Efficiency Method for Dynamic Change of Competitive and Cooperative between Decision Making Units. *Operations Research & Management Science,* 25(3), 24.

[22] Xu, Y., Zhao, J., Fang, Q., Wang, H., Wang, D., Zeng, B., & Wang, Y. (2022). The Theory and Method of Organizational Effectiveness Evaluation. In 2022 8th International Conference on Humanities and Social Science Research (ICHSSR 2022) (pp. 2419 ─ 2423). Atlantis Press. https://doi.org/10.2991/assehr.k.220504.437

EKONOMICKÉ ROZHĽADY – ECONOMIC REVIEW, 2023, 52(4), 203 ─ 217
https://doi.org/10.53465/ER.2644-7185.2023.4.203-217

Appendix:

Table A1. Results of efficiency using GAMS software (profitability ratios perspective)

Efficiency using Game Theory (financial perspective – leader)					
EOE $_j$	**θ p-Leader**	**θ A-Follow**	**θ I-Follow**	**θ D-Follow**	**θ Total**
1	0.367845	0.692026	0.239114	0.125487	0.198745
2	1	0.711256	0.522238	0.021564	0.168794
3	0.478984	0.682365	0.695874	0.023698	0.013695
4	1	0.158739	0.735489	0.054789	0.087451
5	1	0.001606	0.365129	0.032198	0.098475
6	1	0.000687	0.362948	0.087451	0.039654
7	0.487987	0.019835	1	0.032169	0.058749
8	0.352146	0.000742	0.698475	0.039874	0.032145
9	0.369784	0.013718	0.489651	0.065419	0.012369
10	1	0.052666	0.365149	0.095874	0.023648
11	1	0.025149	0.263104	0.006548	0.059874
12	0.547891	0.036527	0.932107	0.009874	0.045987
13	1	0.051894	0.736501	0.012587	0.036587
14	1	0.036257	0.520316	0.036547	0.056984
15	0.325479	0.015469	0.987451	0.098745	0.025649
16	1	0.136987	0.369587	0.021458	0.098745
17	0.621983	0.021548	0.892013	0.054879	0.156987
18	0.364730	0.154897	0.564123	0.147895	0.036215
19	0.362536	0.362781	0.487910	0.098745	0.063254
20	1	0.012587	0.321654	0.154874	0.087495

Table 2A. Results of efficiency using GAMS software (Perspective of asset utilization ratios)

Efficiency using Game Theory (Perspective of asset utilization ratios – leader)					
EOE_j	**$\theta^{P\text{-}Follow}$**	**$\theta^{A\text{-}Leader}$**	**$\theta^{I\text{-}Follow}$**	**$\theta^{D\text{-}Follow}$**	**θ^{Total}**
1	0.147894	0.3265487	0.365418	0.036598	0.126514
2	0.478957	0.5487910	0.569847	0.015478	0.126541
3	0.365498	0.3695410	0.458791	0.025104	0.059841
4	0.641587	1	0.578946	0.014879	0.125418
5	0.698475	1	0.236541	0.021054	0.132014
6	0.365497	0.625148	0.120365	0.025698	0.098471
7	0.487951	1	0.598741	0.045781	0.136514
8	0.693847	1	0.639548	0.012547	0.123145
9	0.362154	1	0.874956	0.026541	0.102154
10	0.745181	0.695847	0.365241	0.010458	0.098745
11	0.369874	0.395621	0.230148	0.015784	0.112084
12	0.478951	0.321874	0.365412	0.010245	0.185410
13	0.365987	0.231987	0.648794	0.013652	0.102148
14	0.214587	0.365987	0.356489	0.002561	0.096854
15	0.574891	1	0.548974	0.002653	0.136548
16	0.361498	1	0.321548	0.002416	0.148715
17	0.354870	1	0.365489	0.014513	0.136954
18	0.265498	1	0.451298	0.002380	0.17894
19	0.365418	0.569874	0.365241	0.012549	0.128745
20	0.478591	0.625498	0.215489	0.002310	0.136547

EKONOMICKÉ ROZHĽADY – ECONOMIC REVIEW, 2023, 52(4), 203 ─ 217
https://doi.org/10.53465/ER.2644-7185.2023.4.203-217

Table 3A. Results of efficiency using GAMS Software (Liquidity ratios perspective)

Efficiency using Game Theory (Liquidity ratios perspective – leader)					
EOE $_j$	**θ P-Follow**	**θ A-Follow**	**θ I-Ledear**	**θ D-Follow**	**θ Total**
1	0.365471	0.125487	1	0.125487	0.015987
2	0.365412	0.125478	0.698745	0.158741	0.096845
3	0.369847	0.362541	0.238457	0.148754	0.078459
4	0.365987	0.359874	1	0.178450	0.063698
5	1	0.745891	0.369584	0.487951	0.012548
6	0.587496	0.359841	1	0.369548	0.098747
7	0.365148	0.584791	0.784510	0.874591	0.065418
8	0.354187	0.369584	0.218745	0.362514	0.089745
9	0.458910	0.458794	0.369545	0.396845	0.049875
10	0.897451	0.651484	1	1	0.069874
11	0.954120	0.689847	0.984571	0.651247	0.048597
12	0.369874	0.104587	1	0.102458	0.039845
13	0.748541	0.125487	1	0.875491	0.089745
14	0.369548	0.147894	0.569847	0.320154	0.096854
15	0.654120	0.265984	0.654871	0.125478	0.003547
16	0.945217	0.036548	0.569874	0.124587	0.032158
17	0.632541	0.065874	1	0.968547	0.012548
18	0.562147	0.078495	1	0.487951	0.098744
19	0.325148	0.036984	1	0.698475	0.096847
20	1	0.087451	0.698470	0.589745	0.036548

Table 4A. Results of efficiency using GAMS software (The debt utilization ratios perspective)

Efficiency using Game Theory (The debt utilization ratios perspective – leader)					
EOE_j	**$\theta^{P\text{-}Follow}$**	**$\theta^{A\text{-}Follow}$**	**$\theta^{I\text{-}Follow}$**	**$\theta^{D\text{-}Leader}$**	**θ^{Total}**
1	0.587491	0.125487	0.365984	0.326541	0.012874
2	0.265487	0.215487	0.265487	0.198745	0.001254
3	0.987450	0.125487	0.698475	1	0.013654
4	0.132654	0.125487	0.365418	0.369874	0.023654
5	1	0.021458	0.698470	1	0.036987
6	0.584794	0.145879	0.569874	1	0.047584
7	0.598745	0.152046	0.365184	0.548791	0.036548
8	0.365984	0.125987	0.369847	1	0.039874
9	0.365487	0.120469	0.365987	0.365984	0.045874
10	0.987451	0.102547	1	1	0.045874
11	0.698745	0.125984	0.654871	0.369847	0.036548
12	0.698475	0.123654	0.698457	0.789451	0.036984
13	0.635417	0.125487	0.569847	0.569874	0.036987
14	0.587495	0.154789	0.745987	0.563987	0.041874
15	0.458712	0.102548	0.256987	0.563298	0.036521
16	0.236541	0.126984	0.398745	1	0.012547
17	0.365489	0.158745	0.265417	0.745894	0.030214
18	0.365478	0.129874	0.365487	1	0.023654
19	0.321456	0.126598	0.698745	0.698745	0.019874
20	1	0.148790	0.568745	1	0.048741