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Efficiency Analysis of Official Development Assistance Provided by Korea

Yun-Gi Hwang [1], Soohyun Park [1] and Daecheol Kim [2,*]

[1] Department of Business Administration, Graduate School of Hanyang University, Seoul 04763, Korea; hyk0731@naver.com (Y.-G.H.); shcam5748@naver.com (S.P.)
[2] School of Business, Hanyang University, Seoul 04763, Korea
* Correspondence: dckim@hanyang.ac.kr; Tel.: +82-2-2220-1043

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Abstract: Results of the CDI and QODA evaluation developed by OECD showed that Korea's aid presented low efficiency compared to other aid countries. However, these methods represent a qualitative assessment of the effectiveness of each country's aid and are not applicable to the evaluation of actual aid projects and the identification of causes of the inefficiency. Therefore, it is needed to grasp the reality of Korea's aid and to identify the cause of aid inefficiency to set up a better ODA policy. The purpose of this study is to improve the effectiveness of Korea's Official Development Assistance (ODA) provided to developing countries. To do this, we analyzed the efficiency of ODA provided to 33 recipient countries by Korea through data envelopment analysis method. The effects of three factors, illiteracy, integrity, and GDP, on efficiency were also investigated by utilizing a Tobit regression analysis. As a result of the DEA efficiency analysis, it was found that the average efficiency was about 65.74%. By region, the average efficiency scores of Asia, Africa, Central and South America, and Middle East and Eastern Europe were about 47.8%, 78.9%, 70.4%, and 62.7%, respectively. This indicates that Asian countries are inefficient compared to countries from other regions. It was also found that GDP, integrity, and illiteracy have positive effects on efficiency. The methodology proposed in this study can be used for other studies to create an aid policy that produces efficient results.

Keywords: ODA; DEA; Tobit regression; efficiency; GDP; integrity; illiteracy

1. Introduction

Official Development Assistance (ODA) is a type of official transaction and concessional fund aimed at promoting the economic and social development of developing countries [1]. The motivation behind ODA for donor countries is humanitarianism, but at the same time there are thoughts of their economic benefits and the expansion of their influence on the international community. The development of developing countries according to globalization provides direct opportunities for the economic development of developed countries [2]. Especially when there is a high dependency on foreign countries due to a lack of resources like in Korea, it is more important to establish mutual trust and cooperation with developing countries. For this reason, ODA is important for Korea's economic interests as well. According to Jo [3], Korea's reputation has improved due to the humanitarian educational aid that Korea has supplied to developing countries. This better impression of Korea will be directly related to the favorability of Korean products. In other words, although the main purpose of ODA is in humanitarianism, strengthened ties between the donor and recipient countries can lead to an increase in the favorability of donor goods, which in turn can lead to an increase in donor countries' exports to recipient countries [2,4].

Korea is the first country in the world that was a beneficiary of ODA and has now become a donor. Since joining the OECD's Development Assistance Committee (DAC) in 2010, Korea has been providing aid to 122 developing countries as of 2014. Therefore, Korea has become a role model for developing countries as a successful case of the ODA project. Until now, however, it has been difficult to find a beneficiary country that shows the achievement of growth in line with aid, even though it is not as remarkable as in Korea [5–7].

For this reason, donor countries and international organizations have undergone aid fatigue. Therefore, donor countries and international organizations have made efforts to develop indicators as a priority task in order to assess the effectiveness of ODA projects since the 2000s. Commitment to Development Index (CDI) and Quality of Official Development Assistance (QODA) were developed in 2003 and 2008, respectively, and have been used as indicators of the effectiveness of aid [8,9]. Korea had a qualitative evaluation of aid three times. Among the four areas that were evaluated, Korea showed a poor performance in the area of efficiency [1,10]. This is due to the lack of systematic and comprehensive planning for ODA [10]. Thus, it is necessary to first identify what is lacking in order to improve the effectiveness and performance of ODA [11–13].

To measure the relative efficiencies of decision making units (DMUs), data envelopment analysis (DEA) and stochastic frontier analysis (SFA) are among the methodologies most often used. Both methods use inputs and outputs to construct a production frontier that represents the maximum output relative to input. The advantages of DEA over SFA are that DEA does not require the assumption of the shape of the frontier and in data. Moreover, the DEA model has been increasingly used by various research communities in the analysis of productive efficiency, and has an extensive number of empirical applications. Moreover, theoretical and methodological research has been continuously developing deeper and more enhanced DEA models to understand more practical problems. Thus, DEA was chosen in this study.

Afonso and St. Auben [14] examined the effects of exogenous factors on the efficiency of health systems in each country, and identified the relationship between health system efficiency and GDP. Therefore, it can be considered that ODA effectiveness may be influenced by the GDP level of the beneficiary country. In addition, Yoon and Kim's [15] study of the relationship between the level of perception of corruption and the national competitiveness of Korea reveals that there is a negative relationship between the corruption perception and the ranking of government efficiency. In other words, corruption leads directly to unproductive profit-seeking behavior, distorting resource allocation, and increasing costs of monitoring corruption. In addition, the literacy rate of the country affects the public administration efficiency of the country. Taken together, these prior studies show that these factors may also affect the efficiency of ODA [16].

Therefore, in this study, first, the efficiency of ODA is measured through Data Envelopment Analysis (DEA) for beneficiary countries assisted by Korea. Based on the results of the efficiency analysis, the effects of external environmental factors such as GDP, corruption, and literacy rate on the efficiency of ODA are analyzed using Tobit analysis. We will discuss the results of the analyses and ways to improve the efficiency of ODA provided by Korea.

2. Theoretical Background

2.1. DEA (Data Envelopment Analysis)

DEA is a methodology mainly utilized to determine the relative efficiency in case there exist multiple input and output variables [17]. This method constructs an "efficient frontier" composed of efficient DMUs and then the relative efficiency levels of other non-frontier units are determined by the distances to the efficient frontier [18].

There exist several different types of models developed for DEA, but they can be classified into two basic models, CRS (constant returns-to-scale) and VRS (variable returns-to-scale), according to whether the same productivity is maintained for all input levels. That is, the ratio of output to input

does not change for any intervals in the CRS model. By contrast, the ratios vary with input volume in the VRS model.

There are also two models, input-oriented and output-oriented, depending on whether the efficiency improvement is achieved by reducing inputs or increasing outputs. In the input-oriented model, efficiency can be improved by minimizing inputs; in the output-oriented model, efficiency is maximized by increasing outputs.

In Equation (1), an output-oriented CCR model is represented. In the equation, let us assume that there are J DMUs DMU_j (j = 1, 2, . . . , J), m inputs $x_{ij}(i = 1, \ldots, m; j = 1, \ldots, J)$, and n outputs $y_{rj}(r = 1, \ldots, n; j = 1, \ldots, J)$

$$\begin{aligned} &max\ \phi_k \\ s.t.\ &\sum_{j=1}^{J} x_{ij}\lambda_j \le x_{ik}, \quad i = 1, \ldots, m \\ &\sum_{j=1}^{J} y_{rj}\lambda_j \ge \phi_k y_{rk}, \quad r = 1, \ldots, n \\ &\lambda_j,\ s_i^-,\ s_r^+ \ge 0, \quad \forall\ i,\ j,\ r \end{aligned} \tag{1}$$

where $\phi_k(k = 1, \ldots, J)$ is an efficiency score of the DMU_k, and s_i^- and s_r^+ indicate input and output slack variables, respectively.

The efficiency of DEA indicates technical efficiency (TE). TE can be broken down into two components, PTE (pure technical efficiency) and SE (scale efficiency). That is, TE is defined as the product of multiplying PTE by SE [19,20].

2.2. Official Development Assistance (ODA)

Recently, various studies related to ODA have been conducted. Lee and Lee [2] conducted a study on how ODA boosts exports. The study found that ODA has a significant impact on exports to beneficiary countries.

Lee [4] proposed that the effectiveness of ODA could be secured when ODA is combined with production factors such as the labor force and capital of beneficiary countries of ODA. He also emphasized that if indicators developed based on these factors are used to select the prospective beneficiary countries and a method is adopted to determine how to help them, the effectiveness of ODA can be improved.

In addition, studies are being carried out on the ODA evaluation system of Korea. Yoon [21] stated that it is necessary to establish an evaluation and monitoring system for ODA projects to operate the ODA project efficiently, and stressed that it is necessary to improve the legal, institutional and epistemological aspects of ODA. In order to strengthen and improve the evaluation capacity, it is necessary to clarify role sharing among agencies and emphasize the transparency and objectivity of the evaluation system [22].

Park and Ko [1] analyzed the characteristics and meanings of the indicators of CDI and QuODA, and addressed the need to improve the quality and effectiveness of ODA projects provided by Korea. Despite the importance of improving the qualitative aspects of ODA such as efficiency, current ODA-related research is mainly focused on evaluation systems of ODA or allocation of ODA funds.

In a representative study using DEA for assessing policy efficiency, Arabatzis et al. [23] studied policy efficiency in rural development in Greece. The objectives of LEADER+ were to improve the competitiveness of rural areas of the EU. To evaluate the relative performance of LEADER+ in rural areas, they used PROMETHEE II multi-criteria analysis. The results showed that LEADER+ improved the management of rural, insular, and less-developed areas. Vlontzos and Pardalos [24] implemented DEA window analysis to assess the operational and environmental efficiency of the primary sectors of EU countries. In their study, they verified that there were considerable differences in efficiency among EU member states and an improvement after the implementation of the Common Agricultural

Policy reform. Similarly, in Vlontzos and Pardalos [24]'s study, the DEA window analysis was used to quantify greenhouse gas emissions and verify the efficiency change of primary sectors of EU member states after the application of strong agricultural policy [25].

3. Research Methods

3.1. Input and Output Variables

In the DEA analysis, the determination of input and output variables has a great impact on the efficiency results of each DMU.

In most DEA studies, input and output variables are determined based on prior studies or by considering the variables used by the organization for performance evaluation [26].

In this study, it is difficult to refer to the input and output variables in the preceding literature due to a lack of prior studies that have identified the efficiency of the ODA project using DEA. In addition, Korea's ODA is applied to various fields such as healthcare, education, public administration, agriculture and forestry, fisheries, and industrial energy, and the types of aid are different from each other, such as consulting, dispatching volunteers or experts, and inviting trainees. Therefore, they cannot be treated equally. However, in any types of aid, the amount of input resources can be converted into money. Therefore, the amount of money allocated to each type of aid is selected as the input variable.

As an output variable, the satisfaction level of ODA that KOICA (Korea International Cooperation Agency), which is responsible for Korea's ODA, uses to evaluate ODA performance is selected. The satisfaction levels are assessed with respect to four sub-areas: the process, contents, performance, and sustainability of aid. The selected input and output variables are shown in Table 1.

Table 1. Input and output variables.

Type	Variables	Description
Input	Healthcare Education Public Administration Agriculture, forestry and fisheries Industrial Energy	Amount of money provided (unit: ₩)
Output	Process Contents Performance Sustainability	Satisfaction in each area (Likert 5-point scale)

3.2. Explanatory Variables

Afonso and St. Aubyn [14] found that health system efficiency and GDP are related to each other. The result suggests that countries with higher GDPs are more likely to generate synergies from ODA because their infrastructure is well structured, which will have a positive impact on efficiency.

In addition, Yoon and Kim's [15] study of the relationship between the level of perception of corruption and the national competitiveness of Korea reveals that there is a negative relationship between the corruption perception and the ranking of government efficiency. In other words, corruption leads directly to unproductive profit-seeking behavior, distorting resource allocation and increasing costs of monitoring corruption.

ODA generally alleviates poverty in poor countries, but it can result in a decrease in the effectiveness of ODA in countries where corruption is rampant and systems are not established [27]. Because of the nature of ODA, the bureaucrats of the recipient country are involved in the distribution of the ODA fund, so the corruption is likely to affect the efficiency of ODA projects. The higher the integrity of the country, the more likely it is that the effectiveness of ODA will be substantially increased.

In Korea, the largest proportion of ODA is being provided to educational projects. This is because of the poor quality of education in developing countries. Therefore, it is important to understand the relationship between the effectiveness of ODA and the level of education in beneficiary countries.

Brini and Jemmali [28] studied the relationship between public expenditure efficiency and governance, politics, literacy, and economic policy for countries in the Middle East and North Africa. The results of this study reveal that the rate of literacy and school enrollment are the main factors that determine efficiency in public expenditure. Lockheed et al. [29] studied the relationship between farmer education and farming efficiency based on data from 37 farms in low-income countries. Research has shown that the productivity of farms increases in proportion to the level of education of farmers. In other words, the productivity of farmers who completed four years of primary education was 7.4 percent higher than that of farmers who did not receive any education. Brokenness et al. [30] studied the relationship between energy efficiency and energy literacy rates for 1721 Danish households. Research shows that people's energy-related literacy is important in assessing energy efficiency. In a study by Widdowson and Hailwood [31] on the effects of financial literacy on the efficiency of the financial system, financial literacy allowed people to better manage their finances. Therefore, it has made an important contribution to the efficiency and soundness of the financial system. As we have seen in the studies above, efficiency is highly related to GDP, corruption, and literacy rates. Therefore, the efficiency of ODA projects provided by Korea will be influenced by GDP, corruption, and literacy rates of beneficiary countries [32–34].

3.3. DMUs

KOICA provided ODA to 122 countries in 2014, among which 33 countries with no missing data were analyzed in this study. In the DEA method, the number of variables and the number of DMUs influence the validity of the study. In general, to increase the discriminative power of the DEA model, the number of DMUs is more than three times the number of input and output factors [19,35]. Since the number of DMUs to be analyzed is 33, the above condition is satisfied.

Input and output data are based on data from the '2014 KOICA Annual Statistical Report' [36]. The GDP, the corruption index, and the literacy rate are based on data from World Bank, Transparency International (TI) and the Central Intelligence Agency (CIA), respectively [37–39].

4. Results

4.1. Technical Statistics

4.1.1. Input Variables

Table 2 shows the statistical data on the input variables for each region receiving aid from Korea. In this study, as shown in Table 2, there are 11 countries in Asia, 13 countries in Africa, seven countries in Central and South America, and two countries in the Middle East and Eastern Europe. If we look at the average amount of aid in each sector in Asia, we can see that it exceeds the total average value of each sector in all regions. Therefore, most of the aid provided by Korea is directed to Asia. On the other hand, in Africa, the average amounts of aid in all four sectors, excluding agriculture, forestry, and fisheries, are lower than the overall average of each sector. Thus, it can be seen that the smallest average amount of assistance is provided in Korea's ODA projects. Looking at the sectors of aid within each region, it can be seen that the largest amount of support is provided to the education sector, except for Latin America.

Table 2. Input variables.

Region Statistic		Input				
		Healthcare	Education	Public Administration	Agriculture, Forestry, and Fisheries	Industrial Energy
Asia (11)	Mean	3271.82	5755.55	3012.64	2150.73	3166.45
	S.D.	2808.41	4395.26	3086.59	1986.06	2807.02
	Max.	8723.00	17,298.00	9656.00	7147.00	10,001.00
	Min.	264.00	1112.00	280.00	399.00	272.00
Africa (13)	Mean	1319.54	2125.77	1094.31	1671.77	1081.38
	S.D.	1368.27	1579.27	575.12	1857.20	840.11
	Max.	4473.00	5359.00	2321.00	6051.00	3014.00
	Min.	31.00	719.00	290.00	58.00	120.00
Central and South America (7)	Mean	2300.43	1599.14	1598.43	748.29	1414.00
	S.D.	1770.67	845.77	881.12	894.43	1455.97
	Max.	5143.00	2857.00	3610.00	2861.00	4343.00
	Min.	534.00	216.00	698.00	50.00	222.00
Middle East and Eastern Europe (2)	Mean	778.50	4212.00	2047.50	813.00	574.50
	S.D.	607.50	1884.00	1261.50	763.00	144.50
	Max.	1386.00	6096.00	3309.00	1576.00	719.00
	Min.	171.00	2328.00	786.00	50.00	430.00
Mean		2145.58	3350.42	1898.45	1583.48	1816.24
S.D.		2205.44	3317.14	2063.03	1781.24	2074.51
Max.		8723.00	17,298.00	9656.00	7147.00	10,001.00
Min.		31.00	216.00	280.00	50.00	120.00
					(Unit: 1 million won)	

4.1.2. Output Variables

Table 3 gives the statistical data on the output variables for each region receiving aid from Korea.

Table 3. Output variables.

Region Statistic.		Output			
		Process	Contents	Performance	Sustainability
Asia	Mean	4.56	4.59	4.63	4.59
	S.D.	0.16	0.22	0.20	0.16
	Max.	4.77	4.84	4.95	4.90
	Min.	4.22	4.00	4.27	4.32
Africa	Mean	4.43	4.49	4.45	4.47
	S.D.	0.26	0.26	0.32	0.26
	Max.	4.90	4.86	4.90	4.92
	Min.	3.74	3.81	3.63	3.89
Central and South America	Mean	4.59	4.60	4.61	4.62
	S.D.	0.14	0.16	0.16	0.16
	Max.	4.85	4.94	4.92	4.94
	Min.	4.42	4.39	4.37	4.39
Middle East and Eastern Europe	Mean	4.59	4.53	4.62	4.58
	S.D.	0.18	0.29	0.18	0.24
	Max.	4.78	4.82	4.80	4.82
	Min.	4.41	4.25	4.45	4.34
Total Mean		4.52	4.55	4.55	4.55
Total S.D.		0.22	0.24	0.26	0.22
Max.		4.90	4.94	4.95	4.94
Min.		3.74	3.81	3.63	3.89

In the 'process' section, there is no big difference in the output by region. In terms of 'content', it can be seen that Asia and Central and South America have a higher average than the rest. In the 'performance' category, Africa showed lower satisfaction than other regions. Finally, the 'sustainability' item has the highest satisfaction in the countries of Central and South America.

In addition, it can be seen that the average satisfaction level of each section in Asia is higher than the overall average value of each section of every region. In Africa, on the other hand, the average

satisfaction level of each section is lower than the overall average of each section of every region. Thus, it can be seen that the satisfaction level is formed in proportion to the average amount of aid. In particular, the satisfaction level of each section in Latin America exceeded the overall average satisfaction level of each section of every region, as in the case of Asia. What is interesting is that Latin America is the only region where the education sector is not the most assisted.

4.1.3. Influential Factors

Table 4 describes the basic statistics of the influencing factors. The total average GDP of the recipient countries is about 126,896 million dollars, and Asia is somewhat higher than other regions. The Integrity Index is about 32.64% on average, showing that Asian countries have a slightly higher degree of corruption than other continents. The average literacy rate is 75.29%, which indicates that African countries have a higher literacy rate than other continents.

Table 4. Influence variables.

Region Statistic		GDP (mi.$)	CPI (%)	Literacy Rate (%)
Asia	Mean	175,269.1	29.09091	72.77273
	S.D.	246,351.6	7.763019	21.89637
	Max.	890,487.1	39	97.4
	Min.	1371.17	11	28.1
Africa	Mean	102,371.5	34.76923	66.80769
	S.D.	153,230.1	8.710328	12.21263
	Max.	568,498.9	54	87.4
	Min.	7912.16	25	39
Central and South America	Mean	118,548.9	33.28571	88.61429
	S.D.	120,874.6	4.199125	5.951573
	Max.	378,416	39	93.9
	Min.	25,054.2	27	75.9
Middle East and Eastern Europe	Mean	49,479.89	36	97.65
	S.D.	13,652.96	17	1.75
	Max.	63,132.85	53	99.4
	Min.	35,826.93	19	95.9
Total Mean		126,896.7	32.63636	75.29091
Total S.D.		184,349.3	8.831137	18.0191
Max.		890,487.1	54	99.4
Min.		1371.17	11	28.1

4.2. Results of DEA

To justify the selection of variables, an isotonicity test (i.e., when inputs increase, the level of any output should not be reduced but an increase of at least one output should occur) was conducted. As shown in Table 5, all the correlation coefficients are positive.

Table 6 shows the technical efficiency (TE), divided into Pure Technical Efficiency (PTE) and Scale Efficiency (SE), using CCR and BCC models. We also used the 'order-m' method to minimize the impact of outliers since DEA is sensitive to outliers. It can be seen that the efficiency value obtained by using the order-m method is generally larger than the efficiency value measured without considering outliers [40].

Table 5. Correlation coefficients of input and output variables.

Variable	Process	Contents	Performance	Sustainability	Healthcare	Education	Public Admin	Agri., Forest. & Fish.	Industrial Energy
process	1	0.866	0.876	0.821	0.651	0.669	0.747	0.744	0.552
contents	0.866	1	0.863	0.778	0.760	0.682	0.641	0.759	0.597
performance	0.876	0.863	1	0.840	0.641	0.682	0.639	0.736	0.565
sustainability	0.821	0.778	0.840	1	0.514	0.607	0.631	0.633	0.447
healthcare	0.651	0.760	0.641	0.514	1	0.798	0.494	0.766	0.514
education	0.669	0.682	0.682	0.607	0.798	1	0.587	0.431	0.482
public admin	0.747	0.641	0.639	0.631	0.494	0.587	1	0.318	0.575
agri., forest. & fish.	0.744	0.759	0.736	0.633	0.766	0.431	0.318	1	0.480
industrial energy	0.522	0.597	0.565	0.447	0.514	0.482	0.575	0.480	1

The efficiency scores of DMUs are shown in the third column of Table 6, where constant returns-to-scale is assumed. The value represents the overall efficiency of the unit; both pure technical efficiency and scale efficiency are aggregated into a single value. As one can see, the number of efficient DMUs is 10 and that of inefficient DMUs is 23. The average efficiency of the 33 beneficiary countries of ODA provided by Korea is 64.5% and the average inefficiency is 35.5%. The regional efficiencies of Asia, Africa, Central and South America, and the Middle East and Eastern Europe are 46.50%, 77.68%, 69.15%, and 62.09%, respectively. The average efficiency is the highest in Africa. In addition, the efficiency of ODA provided to Asian countries is low compared to the magnitude of the aid, so efficiency improvements should be prepared. The fourth column of Table 6 shows the result of efficiency scores when considering outliers. Since DEA is sensitive to outliers, we used the 'order-m' method to minimize the impact of outliers. It can be seen that the efficiency value obtained by using the order-m method is generally larger, with an average of 0.822, than the efficiency value measured without considering outliers (0.645).

Table 6. Results of DEA.

DMUs	Countries	TE (CCR)	TE (Order-m)	PTE (BCC)	SE	∑λ	RTS
DMU1	Nepal	0.369	0.631	0.966	0.383	2.9738	DRS
DMU2	East Timor	1	1	1	1	1.0000	CRS
DMU3	Mongolia	0.124	0.143	0.971	0.128	8.1377	DRS
DMU4	Bangladesh	0.350	0.566	0.951	0.367	3.1164	DRS
DMU5	Vietnam	0.106	0.135	0.945	0.112	9.3185	DRS
DMU6	Sri Lanka	0.501	0.647	0.974	0.514	2.0683	DRS
DMU7	Afghanistan	1	1	1	1	1.0000	CRS
DMU8	Indonesia	0.260	0.459	0.895	0.290	3.5113	DRS
DMU9	Cambodia	0.220	0.428	0.935	0.235	5.1570	DRS
DMU10	Pakistan	0.987	1	1	0.987	1.1159	DRS
DMU11	Philippines	0.344	0.826	0.988	0.349	3.3939	DRS
DMU12	Ghana	0.868	1	1	0.868	1.2579	DRS
DMU13	Nigeria	1	1	1	1	1.0000	CRS
DMU14	Nigeria	0.410	0.583	0.927	0.442	2.4336	DRS
DMU15	Morocco	0.733	0.788	0.972	0.755	1.3744	DRS
DMU16	Mozambique	1	1	1	1	1.0000	CRS
DMU17	Senegal	1	1	1	1	1.0000	CRS
DMU18	Ethiopia	0.477	1	0.975	0.489	2.4341	DRS
DMU19	Uganda	0.681	1	0.920	0.740	1.5336	DRS
DMU20	Egypt	1	1	1	1	1.0000	CRS
DMU21	Cameroon	0.561	0.857	0.885	0.634	1.7244	DRS
DMU22	Kenya	1	1	1	1	1.0000	CRS
DMU23	Tanzania	0.524	0.895	0.975	0.537	2.0732	DRS
DMU24	Tunisia	1	1	1	1	1.0000	CRS
DMU25	Guatemala	1	1	1	1	1.0000	CRS
DMU26	Bolivia	0.788	1	0.954	0.826	1.3249	DRS
DMU27	Ecuador	0.497	0.974	0.934	0.533	2.2672	DRS
DMU28	El Salvador	0.743	0.99	1	0.743	1.4009	DRS
DMU29	Columbia	0.386	0.971	0.957	0.403	2.7107	DRS
DMU30	Paraguay	0.619	0.817	0.960	0.645	2.0759	DRS
DMU31	Peru	0.895	1	0.957	0.936	1.1167	DRS
DMU32	Jordan	1	1	1	1	1.0000	CRS
DMU33	Uzbekistan	0.254	0.419	0.906	0.280	3.7406	DRS
Mean		0.6454	0.822	0.9617	0.6639	CRS: 10 DRS: 23 IRS :0	

The next column shows the result of the BCC model under the assumption of variable returns-to-scale. The efficiency score of the BCC model represents pure technical efficiency, which reflects the managerial performance. As one can see, the number of efficient DMUs is 13 and the number of inefficient DMUs is 20. The average efficiency is 96.17%, which is higher than that of the CCR model.

The results of the scale efficiency are shown in the sixth column of Table 6. The ratio of overall technical efficiency to pure technical efficiency results in scale efficiency. By measuring the scale efficiency, the management is able to decide the optimal size of resources. Ten DMUs are at scale

efficiency, which means that aid in 10 countries is on an optimal scale. In the last two columns, whether to increase or decrease the scale to improve scale inefficiency can be determined. For example, if the value in the seventh column is greater than 1, the scale efficiency can be improved by reducing the scale. Twenty-three DMUs out of the total of 33 are at decreasing returns-to-scale, which implies that aid in 23 countries is at diseconomies of scale. There are no countries experiencing economies of scale. From the results, we can conclude that Korea's aid projects are suffering from supra-optimum scale size [20].

4.3. Analysis of Factors Affecting the Efficiency of ODA

In this study, we conducted a regression analysis of the effects of GDP, CPI, and literacy rateLiteracy Rate on the efficiency of ODA projects provided by Korea, as shown in Table 7. Although the technical efficiency scores are bounded between 0 and 1, they do not correspond to the principles that determine the use of techniques for censored samples like Tobit estimation because they are merely fractional data [41]. As a result, GDP has a positive effect on the efficiency at a 1% significance level. Therefore, it can be seen that the higher the GDP of the recipient country, the better the effectiveness of ODA. This result is similar to that of Alfonso and St. Louis [14], who studied the relationship between healthcare system efficiency and GDP. That is, countries with higher GDP have better economic infrastructure, and therefore generate more effective ODA support. In the case of integrity, it is found that a country that is not politically corrupt has effective ODA projects. Therefore, when planning aid, it is desirable to support countries with high integrity in terms of efficiency improvement. On the other hand, it can be seen that the literacy rate has a negative effect on efficiency. In other words, the higher the literacy rate, the lower the efficiency. This means that the lower the education level, the higher the satisfaction with aid. In other words, the higher the level of education, the higher the expectation of ODA support, and the less easily a country will be satisfied. A similar result was found in a study of the difference in customer satisfaction between branches in the state-owned commercial bank service in China [42]. In the ODA projects provided by Korea, educational projects account for as much as 31% of total ODA projects, which may be the reason why Korea's ODA satisfaction is low. In addition, highly educated countries may want to support areas other than education.

Table 7. Results of regression.

Statistic	GDP	CPI	Literacy Rate
Coefficient	6.194×10^{-5} ***	1.806 ***	−6.197 ***
S.D.	6.982×10^{-7}	1.290×10^{-2}	5.581×10^{-3}

*** 0.01.

5. Conclusions

This study is important in that the efficiency of ODA using DEA was measured and presented for the first time. Using the CCR model, it was found that 10 countries are efficient among the 33 countries studied, and the overall average is 65.74%. The inefficiency of the 23 countries receiving aid from Korea appears to be due to the scale rather than pure technological efficiency. This means that these inefficient DMUs are at overinvestment in scale, so that the amount of input needs to be reduced.

On the other hand, as a result of analyzing the factors affecting the efficiency, the GDP, which indicates the economic level of the recipient country, has a positive effect on the efficiency of ODA at the 1% significance level. This means that the better the economic base of the beneficiary country, the higher the efficiency of aid that can be expected. Therefore, in order to improve the quality of aid, assistance to vulnerable countries where basic economic infrastructure is not set up should be supported in areas that can reinforce the economic base. Integrity also has a positive effect on the efficiency of aid at a 1% significance level: the less corrupted s country is, the more appropriately the

ODA funds are distributed. In other words, it can be seen that efficient ODA is possible when the integrity of the recipient country is considered strong.

The literacy rate of the recipient country has a negative effect on the efficiency of ODA. From this, we can see that it is more difficult to satisfy the more educated people since their expectation level is higher than the less educated as similarly in Chang et al. [41]. It is worth noting that aid for the education sector accounts for most of the Korea's total ODA program. This might be one of the reasons for the low satisfaction with the Korea's ODA program. In addition, countries with relatively high levels of education are more likely to seek assistance in other sectors than in the education sector. This result suggests that in areas with high levels of education, it is desirable to seek other forms of assistance, such as strengthening the economic base and developing industry.

Methodologically, we used a known two-stage DEA. In this way, it can be theoretically meaningful to demonstrate that the variables affecting the efficiency in other environments have the same effect on the efficiency of the ODA aid project. From a practical point of view, Korea's aid is generally inefficient; in particular, the amount of input is excessive. In terms of efficiency, it is advantageous to support countries with a basic economic base and a high level of integrity. On the other hand, it is necessary to consider the fact that the higher the education level, the higher the expectations for aid and the lower the satisfaction level.

It is difficult to generalize the results obtained in this study because it was carried out with only Korean data. However, as the results of the study show that the effects of GDP, CPI, and literacy rate on efficiency are similar to those of other studies conducted in other environments, it can be used as an example for generalization.

It is difficult to pinpoint the relationship between the literacy rate and educational aid because of the difference between the time at which the data were collected and the time at which educational aid was performed. However, it seems unreasonable to conclude that the educational aid distributed in 2014 directly affected the literacy rate that year. In addition, it may be unreasonable to judge that the effect of this aid has had a great influence on the literacy rate of the country, since the beneficiary area of educational aid is partial. However, there is a possibility that aid to education will affect the literacy rate, so, in this context, the literacy rate is a rather ambiguous variable for the regression part of the analysis. Therefore, this may be a limitation of this study.

For future study, it will be useful to compare the suitability of other methodologies being applied for assessing ODA projects with the method proposed in this study.

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