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Analyzing TALIS Indicators and PISA Results with Data Envelopment: Comparison of EMS, DEAP, and R Software

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Abstract

The Teaching and Learning International Survey (TALIS) and the Programme for International Student Assessment (PISA) are large-scale measurements about teaching and learning. There is a link between TALIS indicators and PISA results. We investigated which countries are effective according to TALIS indicators as inputs and PISA 2015 mathematics, scientific, and reading literacy scores as outputs in this research. Common 24 countries' data from TALIS 2013 and PISA 2015 were analyzed. Data envelopment analysis was used in this quantitative research. Belgium, Denmark, Finland, Italy, Korea, Mexico, Netherlands, Norway, and Portugal were effective countries in EMS 1.3, DEAP-XP 2.1, and R-4.1.3 software according to the input-oriented Charnes, Cooper, and Rhodes (CCR) model. Belgium, Canada, Denmark, Estonia, Finland, Italy, Japan, Korea, Mexico, Netherlands, Norway, and Portugal were effective countries in EMS 1.3, DEAP-XP 2.1, and R-4.1.3 software according to the input-oriented Banker, Charnes, and Cooper (BCC) model. The results obtained from the BCC and CCR model differ partially. Italy and Norway should be taken as references mostly by ineffective countries for getting better PISA scores according to both models analyzing with EMS 1.3, DEAP-XP 2.1, and R-4.1.3.

Keywords: TALIS, PISA, Efficiency, Data envelopment analysis

Introduction

One of the most important factors affecting the learning, shaping, and development of students in education is undoubtedly the qualifications of the teachers (Boonen, Van Damme & Onghena, 2014, p. 126; Buddin & Zamarro, 2009, p.103; Ingersoll & Collins, 2017, p. 75). Recently, the relationships between many variables related to teachers and student achievement have been revealed by researchers. The first of these variables related to teachers is the qualifications of teachers' background ("such as teachers' degree, certification, coursework, college ratings, teaching experience, and teachers' test scores"). The second is variables related to teachers' beliefs and attitudes (such as teachers' job satisfaction, and teachers' self-efficacy). The last one is the variables related to the classroom practices of teachers (Boonen et al., 2014, p. 126-127). The Organisation for Economic Co-operation and Development's (OECD) TALIS collects international teacher qualifications and education data. In the 2013 application, the second cycle of TALIS, information was provided for useful and comparable policies by considering learning and teaching conditions (Rutkowski, Rutkowski, Bélanger, Knoll, Weatherby, & Prusinski, 2013, p. 5). The main aim of the TALIS program is to increase the international knowledge available to OECD countries and partner countries about teachers, teaching, and the effects of teachers on students' learning (Rutkowski et al., 2013: p. 7). Educational background and readiness for teachers' jobs; their professional development, instructional and professional practices; self-efficacy and job satisfaction; school leadership, feedback systems, and school climate issues are discussed at TALIS for many countries' economies (Ainley & Carstens, 2018, p. 4).

The OECD's PISA measures the reading, mathematics, and science literacy of 15-year-old students in three years, taking into account the skills they will use daily (OECD, 2016, p. 25). Internationally comparable data on student achievement in PISA are collected with items that can answer the question "What is important for citizens to know and be able to do?" and student questionnaires (Gurria, 2016, p. 22). Questionnaires in TALIS

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are also optionally applied in PISA sampled schools, creating a TALIS-PISA link (Ainley & Carstens, 2018, p. 4). In this way, it enables scientific research to be carried out on common data by establishing a connection between the achievement status of students and teacher qualifications. Efficacy analysis was conducted for 24 different countries using the link between TALIS and PISA in the present study. Indicators of teacher job satisfaction and self-efficacy perception were utilized as input variables in the study, accounting for TALIS data, while PISA mathematics, science, and reading literacy scores were taken into consideration as output variables.

Teachers' Job Satisfaction and Students' Performance

It has been seen that there are many definitions of job satisfaction in the literature. "Job satisfaction is the pleasurable state resulting from the appraisal of one's job as achieving emotional or facilitating the achievement of one's job values" (Locke, 1969, p. 316). Job dissatisfaction is a dissatisfied emotional state that prevents one's job from reaching one's job values or devaluing the job. Job satisfaction and dissatisfaction are a function of the perceived relationship between what one wants from their job and the perception that it offers or requires it (Locke, 1969, p. 316). Two main components in teacher job satisfaction are "job comfort and job fulfillment". The former emphasizes how satisfactory the job conditions are for an individual, while the latter expresses the degree of satisfaction with one's achievements within the meaningful aspects of the job (Evans, 1997, p. 327).

Variables related to job satisfaction such as "teachers who don't believe that the teaching profession is valued in society (%)" and "teachers who are not satisfied with their job (%)" were measured in TALIS 2013. There are many studies on the relationship between job satisfaction and job performance (e.g., Iqbal, Fakhra, Tahir, & Shabbir, 2016; Locke, 1970; Judge, Thoresen, Bono, & Patton, 2001; Pushpakumari, 2008). In addition, it is still a matter of debate whether job satisfaction leads to high performance or whether high performance leads to job satisfaction (Luthans, 2000, p. 167; Judge et al., 2001, p. 378; Pushpakumari, 2008, p. 91).

In their research using ex-post facto research design, Osagie and Akinlosotu (2017, p. 53) revealed that teachers' performance at work affects student success with a dual-causality relationship. High job satisfaction positively affects the school, teachers, and students (Ainley & Carstens, 2018, p. 44). Job satisfaction affects work performance and teachers' affective qualities such as self-efficacy, attitude, and motivation (Caprara, Barbaranelli, Steca, & Malone, 2006; Klassen, Bong, Usher, Chong, Huan, Wong, & Georgiou, 2009). In our research, "Teaching time per week (hours)" is also considered as an input variable. Studies have found that teachers' job satisfaction decreases as the teacher's weekly course hours increase (Yerdelen, Sungur, & Klassen, 2016, p. 147).

Teachers' Self-Efficacy Beliefs and Students' Performance

It has been proven that teacher efficacy is strongly associated with student outcomes, such as achievement, motivation, and self-efficacy beliefs, as well as meaningful educational outcomes such as teachers' persistence, enthusiasm, and instructional behavior (Tschannen-Moran & Hoy, 2001, p. 783). Teacher self-efficacy is expressed as "the belief of teachers in their abilities to organize and carry out the actions necessary to produce the given outcomes" (Bandura, 1997, p. 3; Tschannen-Moran, Hoy, & Hoy, 1998, p. 233). Self-efficacy is a concept that Bandura initially articulated in his 1977 article "Self-Efficacy: Toward a Unifying Theory of Behavioral Change," which is connected to Bandura's social cognitive theory. p. 207; Tschannen-Moran et al., 1998). Two ideas that are easily mistaken are self-efficacy and self-confidence. Self-efficacy and self-confidence are two quite different ideas, claims Bandura (1997, p. 11). While the perception of self-efficacy is the judgment of personal capacity, self-confidence is the judgment of self-worth (Bandura, 1997, p. 11).

Self-efficacy beliefs of teachers affect their performance at work and so student success (Caprara et al., 2006; Perera & John, 2020; Tschannen-Moran & Hoy, 2001; Tschannen-Moran et al., 1998; Zee & Koomen, 2016). Perceived self-efficacy has guiding effects on not only the choice of activities but also the ultimate success through expectations, it can also affect coping efforts. Efficacy expectations determine how much effort people will expend and how long they will persist in facing obstacles and deterrent experiences. The stronger the perceived self-efficacy, the greater the effort (Bandura, 1977, p. 194).

Personal self-efficacy expectations are derived from four primary sources of information: performance achievements, verbal persuasion, vicarious experience, and physiological states (Bandura, 1977, p. 191). Teacher self-efficacy is affected by many factors, such as teaching experience (Wolters & Daugherty, 2007). As self-efficacy increases, job satisfaction and student academic success are also positively affected (Bandura, 1977; Caprara et al., 2006; Perera & John, 2020; Zee & Koomen, 2016). The findings of 40 years of research on teacher self-efficacy were compiled by Zee and Koomen (2016, p. 981) who found that teacher self-efficacy

includes students' academic adjustment, teacher behavior patterns and practices related to classroom quality, and teachers' psychological well-being, including personal achievement, job satisfaction, and commitment. They found that it showed positive associations with the underlying factors. In TALIS, "teachers who believe they can help their students to value learning (%)" and "teachers who believe they can help their students to think critically (%)" indicators were considered as input variables within the scope of the research. Critical thinking is one of the competencies required for success in students' daily life, academic life and business life (Bezanilla, Fernández-Nogueira, Poblete, & Galindo-Domínguez, 2019, p. 1; Franco, Costa, Butler, & Almeida, 2017, p. 707). In this respect, it is important to reveal teachers' self-efficacy perceptions about helping students think critically.

Aim of Recent Research

It aims to determine which of the 24 countries participating in the TALIS 2013 and PISA 2015 is effective according to the BCC and CCR model when the TALIS 2013 indicators are considered inputs and PISA 2015 mathematics, scientific, and reading literacy are considered as outputs in this study. It is aimed to reveal which effective countries should be taken as a reference by which ineffective countries. The research is important because it establishes a connection between the international TALIS and PISA application, performs an efficiency analysis, and reveals the relationship between teacher qualifications and student achievement with data envelopment analysis. There are many free software for data envelopment analysis. When different software was used, the results obtained may differ partially. Therefore, it is important to compare different software in data envelopment analysis. The findings obtained from three free software frequently used in data envelopment analysis were also compared within the scope of the research. In line with the purpose of the research, answers to the following questions were sought:

1. Which countries are effective according to TALIS indicators ("teaching time per week (hours), teachers who don't believe they can help their students to value learning (%), teachers who don't believe they can help their students to think critically (%), teachers who don't believe that the teaching profession that taking is valued in society (%), teachers who are not satisfied with their job (%)") taken as inputs and PISA 2015 mathematics, scientific and reading literacy taken as outputs, based on BCC and CCR model using EMS 1.3, DEAP-XP 2.1 and R-4.1.3 software?

2. Which effective countries should be referenced according to TALIS indicators ("teaching time per week (hours), teachers who don't believe they can help their students to value learning (%), teachers who don't believe they can help their students to think critically (%), teachers who don't believe that the teaching profession that taking is valued in society (%), teachers who are not satisfied with their job (%)") taken as inputs and PISA 2015 mathematics, scientific and reading literacy taken as outputs, based on BCC and CCR model using EMS 1.3, DEAP-XP 2.1 and R-4.1.3 software?

3. How were slack values based on BCC, and CCR model analyzed with EMS 1.3, DEAP-XP 2.1, and R-4.1.3 software?

4. How do the findings differ when using EMS 1.3, DEAP-XP 2.1, and R-4.1.3?

Method

Research Design

This study is based on a survey research and seeks to compare the efficacy of 24 different countries. In survey model research, the researcher seeks to learn about current conditions (Fraenkel, Wallen, & Hyun, 2012).

Sample

Approximately 540 000 students from 72 countries participated in the PISA 2015 assessment, representing 29 million 15-year-old students (Gurria, 2016, p. 3). 20 teachers from approximately 200 schools from each country participating in the TALIS 2013 assessment were included in the sample (Rutkowski et al., 2013, p. 38).

24 out of 72 participating countries and economies participated in the PISA 2015 and TALIS 2013 assessments. These countries are Australia, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Iceland, Israel, Italy, Japan, Korea, Latvia, Mexico, Netherlands, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, United Kingdom.

Data Collection

Research data were accessed from the website of OECD statistics ("https://stats.oecd.org/") in 2018. The source of the input and output variables used in the research was given in Table 1.

Table 1. Input and output variables

Variables	Explanation	References
I1	Teaching time per week (hours)	TALIS 2013
I2	Teachers who don't believe they can help their students to value learning (%)	TALIS 2013/ Teachers' self-efficacy
I3	Teachers who don't believe they can help their students to think critically (%)	TALIS 2013/ Teachers' self-efficacy
I4	Teachers who don't believe that the teaching profession is valued in society (%)	TALIS 2013/ Teachers' satisfaction with their jobs
I5	Teachers who are not satisfied with their job (%)	TALIS 2013/ Teachers' satisfaction with their jobs
O1	PISA 2015 Math Average Score	PISA 2015
O2	PISA 2015 Science Avarage Score	PISA 2015
O3	PISA 2015 Reading Average Score	PISA 2015

Note: 'O' represents output, and 'I' represents input variables

Data Analysis

Data envelopment analysis (DEA) has been developed as one of the strong quantitative, analytical tools for measuring and evaluating performance by Charnes, Cooper and Rhodes. Data envelopment analysis (DEA) evaluates the performance of a set of similar entities called decision-making units (DMUs), which convert multiple inputs into multiple outputs with a "data-oriented" approach (Cooper, Seiford, & Zhu, 2004, p. 1). There are two main models in data envelopment analysis: CCR model (Charnes, Cooper and Rhodes, 1978) and BCC model (Banker, Charnes & Cooper, 1984). In this research, we used data envelopment analysis with both models.

Data envelopment analysis (DEA) measures the total technical efficiency of the decision-making units with the assumption of the constant return to scale (CRS) in CCR model. Banker, Charnes, and Cooper modified this assumption with a variable return to scale (VRS) in BCC model (Banker, Charnes, and Cooper, 1984). CCR and BCC models have two types called the input and output-oriented models. We used the input-oriented CCR model which is the most appropriate input composition to produce a certain output composition most effectively in this research. An inefficient decision-making unit (DMUs) can be made more efficient by representation by DEA with a proportional reduction of inputs (Cooper, Seiford, & Zhu, 2004, p. 15).

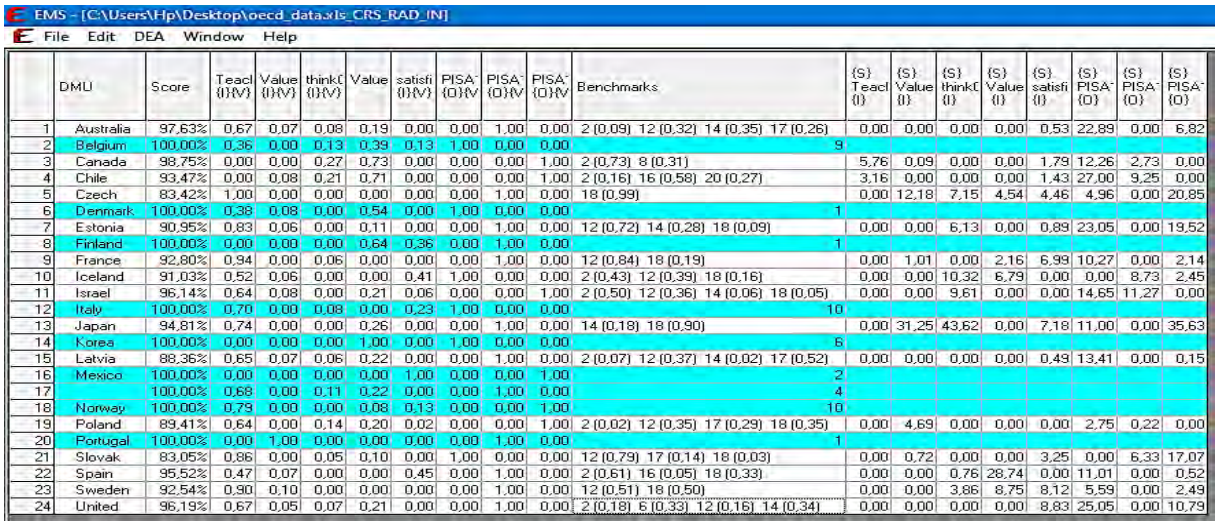
The research was carried out by following 8 steps. In the first step, as the number of DMUs decreases and the number of inputs and outputs increases, the accuracy level of data envelopment analysis will decrease (Khezrimotlagh, Cook, & Zhu, 2021, p. 529), 24 decision-making units were selected as a suitable number of DMUs. In the second step, using the literature review, 5 input and 3 output variables were selected. In the third step, by paying attention to the accessibility and reliability of the data, it worked with OECD's data that the OECD tested its reliability. As the fourth step focuses on increasing efficiency by reducing the inputs without changing the output level, it was decided to analyze the data with CCR under constant return to scale and BCC under variable return to scale assumption, considering both assumptions from input-oriented models. In the fifth step, the effectiveness of 24 countries was examined using three different software. In the sixth step, reference groups were interpreted for ineffective countries. In the seventh step, we found which country can be referenced for ineffective DMUs. According to the three software packages utilized in the research, the methods for the inquiry were chosen, and the slack values in the inputs and outputs were investigated. The results were then interpreted.

EMS 1.3, DEAP-XP 2.1, and R-4.1.3 (R Core Team, 2021) software were used to analyze the data. "deaR" package was used in R-4.1.3 (R Core Team, 2021) software. Information about the softwares used in data

analysis and data analysis steps were explained below.

Efficiency Measurement System (EMS) 1.3

EMS is a free user-friendly data envelopment analysis software designed for Windows 9x/NT. The last version of EMS was 1.3. Determining the input and output data is critical for data envelopment analysis. EMS software performs analysis on MS Excel or text format files. EMS can perform data envelopment analysis on 5000 DMUs with approximately 40 inputs and outputs (Scheel, 2000). Graphics are not provided in this software. Figure 1 shows the outputs of the data envelopment analysis performed in the CCR model with EMS 1.3.



EMS - [C:\Users\Hp\Desktop\oecd_data.xls_CRS_RAD_IN]

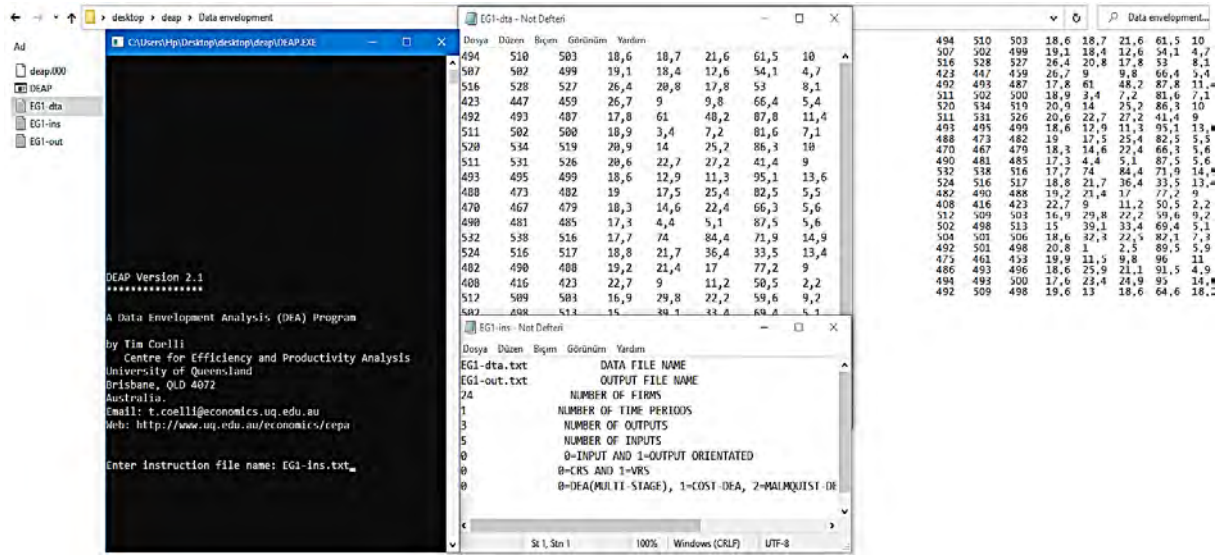
File Edit DEA Window Help

	DMU	Score	Teacl {I}{V}	Value {I}{V}	thinkD {I}{V}	Value	satisfi {I}{V}	PISA {O}{V	PISA {O}{V	PISA {O}{V	Benchmarks	{S} Teacl {I}	{S} Value {I}	{S} thinkD {I}	{S} Value {I}	{S} satisfi {I}	{S} PISA {O}	{S} PISA {O}	{S} PISA {O}
1	Australia	97,63%	0,67	0,07	0,08	0,19	0,00	0,00	1,00	0,00	2 (0,09) 12 (0,32) 14 (0,35) 17 (0,26)	0,00	0,00	0,00	0,00	0,53	22,89	0,00	6,82
2	Belgium	100,00%	0,36	0,00	0,13	0,39	0,13	1,00	0,00	0,00	9								
3	Canada	98,75%	0,00	0,00	0,27	0,73	0,00	0,00	0,00	1,00	2 (0,73) 8 (0,31)	5,76	0,09	0,00	0,00	1,79	12,26	2,73	0,00
4	Chile	93,47%	0,00	0,08	0,21	0,71	0,00	0,00	0,00	1,00	2 (0,16) 16 (0,58) 20 (0,27)	3,16	0,00	0,00	0,00	1,43	27,00	9,25	0,00
5	Czech	83,42%	1,00	0,00	0,00	0,00	0,00	0,00	1,00	0,00	18 (0,99)	0,00	12,18	7,15	4,54	4,46	4,96	0,00	20,85
6	Denmark	100,00%	0,38	0,08	0,00	0,54	0,00	1,00	0,00	0,00	1								
7	Estonia	90,95%	0,83	0,06	0,00	0,11	0,00	0,00	1,00	0,00	12 (0,72) 14 (0,28) 18 (0,09)	0,00	0,00	6,13	0,00	0,89	23,05	0,00	19,52
8	Finland	100,00%	0,00	0,00	0,00	0,64	0,36	0,00	1,00	0,00	1								
9	France	92,80%	0,94	0,00	0,06	0,00	0,00	0,00	1,00	0,00	12 (0,84) 18 (0,19)	0,00	1,01	0,00	2,16	6,99	10,27	0,00	2,14
10	Iceland	91,03%	0,52	0,06	0,00	0,00	0,41	1,00	0,00	0,00	2 (0,43) 12 (0,39) 18 (0,16)	0,00	0,00	10,32	6,79	0,00	0,00	8,73	2,45
11	Israel	96,14%	0,64	0,08	0,00	0,21	0,06	0,00	0,00	1,00	2 (0,50) 12 (0,36) 14 (0,06) 18 (0,05)	0,00	0,00	9,61	0,00	0,00	14,65	11,27	0,00
12	Italy	100,00%	0,70	0,00	0,09	0,00	0,23	1,00	0,00	0,00	10								
13	Japan	94,81%	0,74	0,00	0,00	0,26	0,00	0,00	1,00	0,00	14 (0,18) 18 (0,90)	0,00	31,25	43,62	0,00	7,18	11,00	0,00	35,63
14	Korea	100,00%	0,00	0,00	0,00	1,00	0,00	1,00	0,00	0,00	6								
15	Latvia	88,36%	0,65	0,07	0,06	0,22	0,00	0,00	1,00	0,00	2 (0,07) 12 (0,37) 14 (0,02) 17 (0,52)	0,00	0,00	0,00	0,00	0,49	13,41	0,00	0,15
16	Mexico	100,00%	0,00	0,00	0,00	0,00	1,00	0,00	0,00	1,00	2								
17		100,00%	0,68	0,00	0,11	0,22	0,00	0,00	1,00	0,00	4								
18	Norway	100,00%	0,79	0,00	0,00	0,08	0,13	0,00	0,00	1,00	10								
19	Poland	89,41%	0,64	0,00	0,14	0,20	0,02	0,00	0,00	1,00	2 (0,02) 12 (0,35) 17 (0,29) 18 (0,35)	0,00	4,69	0,00	0,00	0,00	2,75	0,22	0,00
20	Portugal	100,00%	0,00	1,00	0,00	0,00	0,00	0,00	1,00	0,00	1								
21	Slovak	83,05%	0,86	0,00	0,05	0,10	0,00	1,00	0,00	0,00	12 (0,79) 17 (0,14) 18 (0,03)	0,00	0,72	0,00	0,00	3,25	0,00	6,33	17,07
22	Spain	95,52%	0,47	0,07	0,00	0,00	0,45	0,00	1,00	0,00	2 (0,61) 16 (0,05) 18 (0,33)	0,00	0,00	0,76	28,74	0,00	11,01	0,00	0,52
23	Sweden	92,54%	0,90	0,10	0,00	0,00	0,00	0,00	1,00	0,00	12 (0,51) 18 (0,50)	0,00	0,00	3,86	8,75	8,12	5,59	0,00	2,49
24	United	96,19%	0,67	0,05	0,07	0,21	0,00	0,00	1,00	0,00	2 (0,18) 6 (0,33) 12 (0,16) 14 (0,34)	0,00	0,00	0,00	0,00	8,83	25,05	0,00	10,79

Figure 1. Screenshot for DEA in EMS Software

Data Envelopment Analysis Program (DEAP) 2.1

DEAP 2.1 is one of the free software used in data envelopment analysis. Data file, output file, and several DMUs, periods, output, and inputs must be specified in the DEAP 2.1 txt format instruction file. Regarding the model used, information about being input-output oriented and suitable for CCR or BCC model should be specified in the instruction file, and the software should be opened. A data file should be constructed with the name written in the instruction file (See Figure 2, EG1-dta.txt). The generated file name should be written in the instruction file name section of the software. A screenshot of the analysis with the sample CCR model was given in the figure. A limitation of this software is that graphics are not provided. Figure 2 shows the instruction and data files of the data envelopment analysis performed in the CCR model with the DEAP 2.1.



desktop › deap › Data envelopment

deap.000
DEAP
EG1-dta
EG1-ins
EG1-out

C:\Users\Hp\Desktop\desktop\deap\DEAP.EXE

DEAP Version 2.1

A Data Envelopment Analysis (DEA) Program

by Tim Coelli
Centre for Efficiency and Productivity Analysis
University of Queensland
Brisbane, QLD 4072
Australia.
Email: t.coelli@economics.uq.edu.au
Web: http://www.uq.edu.au/economics/cepa

Enter instruction file name: EG1-ins.txt

EG1-dta - Not Defteri

EG1-ins - Not Defteri

EG1-dta.txt DATA FILE NAME
EG1-out.txt OUTPUT FILE NAME
24 NUMBER OF FIRMS
1 NUMBER OF TIME PERIODS
3 NUMBER OF OUTPUTS
5 NUMBER OF INPUTS
0 0=INPUT AND 1=OUTPUT ORIENTATED
0 0=CRS AND 1=VRS
0 0=DEA(MULTI-STAGE), 1=COST-DEA, 2=MALMQUIST-DE

Figure 2. Screenshot for DEA in DEAP Software

R 4.1.3

R is free open-source software. 4.1.3 version has been used since the most up-to-date version of R software is 4.1.3. In this research, data envelopment analysis was performed with the "deaR" package in R software. While performing data analysis, the package used with the "install.packages("deaR")" command was installed firstly. Then the "dear" package was activated with the "library("deaR")" command. The "setwd" command was used to work in a folder. "data<-read.table("oecd.csv",header = T, sep = ";")" command introduced oecd.csv data file. Input and output variables were introduced with the command "data_example <- read_data(data, inputs = 2:6, outputs = 7:9)". Results for input-oriented CCR model, "result <- model_basic(data_example, orientation = "io", rts ="crs")" command used and "result <- model_basic(data_example, orientation = "io", rts ="vrs")" command used for input-oriented BCC model. The commands "rts(result)", "efficiencies(result)", "slacks(result)", "summary(result, export excel = TRUE)", "plot(result)", "eff(result)", "targets(result)" were used to obtain the findings and graphics. Many visualizations related to data envelopment analysis can be obtained in R. In the figure 3, the analysis codes of the CCR model and the screenshot of the R-4.1.3 software were shared.

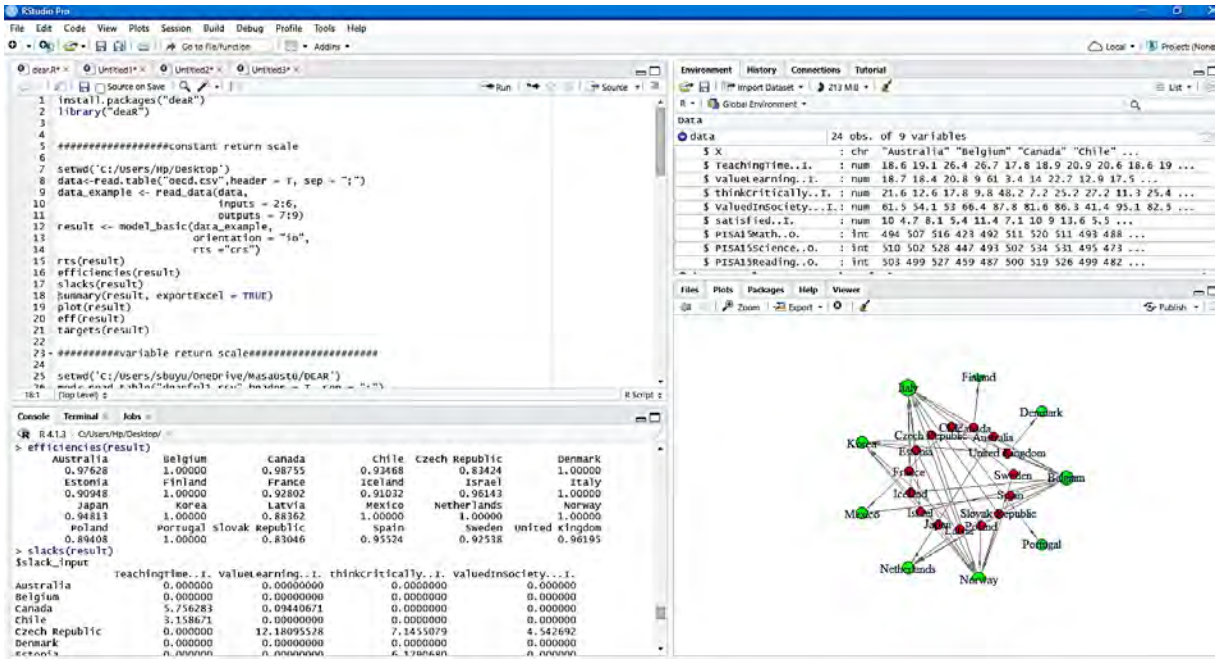


Figure 3. Screenshot for DEA in R Software

Results

In this section, data envelopment analysis findings according to CCR and BCC input-oriented model based on EMS 1.3 DEAP-XP 2.1 and R-4.1.3 software were given, when "teaching time per week (hours), teachers who don't believe they can help their students to value learning (%), teachers who don't believe they can help their students to think critically (%), teachers who don't believe that the teaching profession is valued in society (%), teachers who are not satisfied with their job (%)" variables were taken as input variables and PISA 2015 Math PISA 2015 Science and PISA 2015 Reading literacy variables were taken as output variables. The efficiency ratings of 24 countries were looked at in Table 2.

When the efficiency analysis findings for 24 DMUs were examined according to OECD data, countries with 1/1.000 and 100.00% efficiency points were considered efficient countries in Table 2. The findings obtained from all three software were given in the output format of the software. Belgium, Denmark, Finland, Italy, Korea, Mexico, Netherlands, Norway, and Portugal were found to be effective countries according to the CCR model, when EMS 1.3, DEAP-XP 2.1and R-4.1.3 software were used. Belgium, Canada, Denmark, Estonia, Finland, Italy, Japan, Korea, Mexico, Netherlands, Norway, and Portugal were effective countries according to the BCC model, when EMS 1.3, DEAP-XP 2.1, and R-4.1.3 software were used. In Figure 4, the number of effective and ineffective countries and the efficient distribution of ineffective countries were given by CCR Model when using EMS 1.3, DEAP-XP 2.1, and R-4.0.

Table 2. Efficiency rates of 24 countries by three different softwares

Number	DMUs	CCR (EMS)	CCR (DEAP)	CCR (R)	BCC (EMS)	BCC (DEAP)	BCC (R)	Scale (DEAP)
1	Australia	97.63%	0.976	0.97628	98.29%	0.983	0.98285	0.993
2	Belgium	100.00%	1.000	1	100.00%	1.000	1	1.000
3	Canada	98.75%	0.988	0.98755	100.00%	1.000	1	0.988
4	Chile	93.47%	0.935	0.93468	93.73%	0.937	0.9373	0.997
5	Czech Republic	83.42%	0.834	0.83424	84.27%	0.843	0.8427	0.990
6	Denmark	100.00%	1.000	1	100.00%	1.000	1	1.000
7	Estonia	90.95%	0.909	0.90948	100.00%	1.000	1	0.909
8	Finland	100.00%	1.000	1	100.00%	1.000	1	1.000
9	France	92.80%	0.928	0.92802	96.55%	0.966	0.96551	0.961
10	Iceland	91.03%	0.910	0.91032	91.60%	0.916	0.916	0.994
11	Israel	96.14%	0.961	0.96143	99.49%	0.995	0.99486	0.966
12	Italy	100.00%	1.000	1	100.00%	1.000	1	1.000
13	Japan	94.81%	0.948	0.94813	100.00%	1.000	1	0.948
14	Korea	100.00%	1.000	1	100.00%	1.000	1	1.000
15	Latvia	88.36%	0.884	0.88362	89.81%	0.898	0.89806	0.984
16	Mexico	100.00%	1.000	1	100.00%	1.000	1	1.000
17	Netherlands	100.00%	1.000	1	100.00%	1.000	1	1.000
18	Norway	100.00%	1.000	1	100.00%	1.000	1	1.000
19	Poland	89.41%	0.894	0.89408	91.08%	0.911	0.91081	0.982
20	Portugal	100.00%	1.000	1	100.00%	1.000	1	1.000
21	Slovak Republic	83.05%	0.830	0.83046	86.30%	0.863	0.86298	0.962
22	Spain	95.52%	0.955	0.95524	95.67%	0.957	0.95671	0.998
23	Sweden	92.54%	0.925	0.92538	93.15%	0.932	0.93153	0.993
24	United Kingdom	96.19%	0.962	0.96195	96.56%	0.966	0.96557	0.996

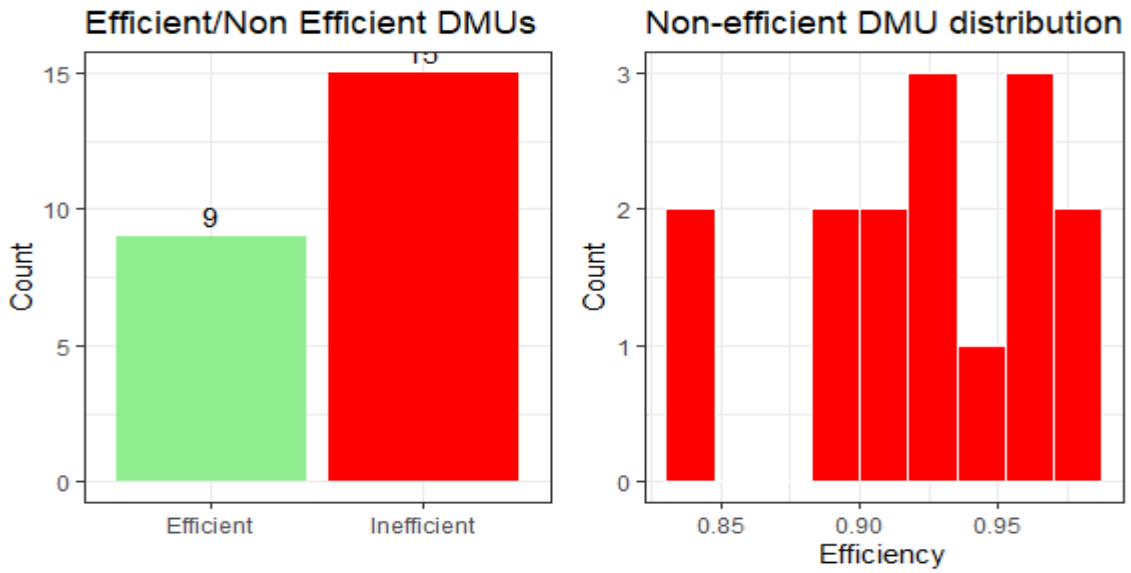


Figure 4. Number of efficient and ineffective countries and efficiency distributions of ineffective countries by CCR model

When Figure 4 was examined, it was seen that 9 countries were efficient, and 15 countries were not efficient according to the CCR model. Looking at the distribution of the efficiency of the ineffective countries, it was seen that 2 countries had an efficiency score of less than 0.85. The number of ineffective countries with an efficiency rate higher than 0.95 was five. According to the CCR model, the country with an efficiency score below 85% was the Czech Republic with an efficiency score of 83.42%.

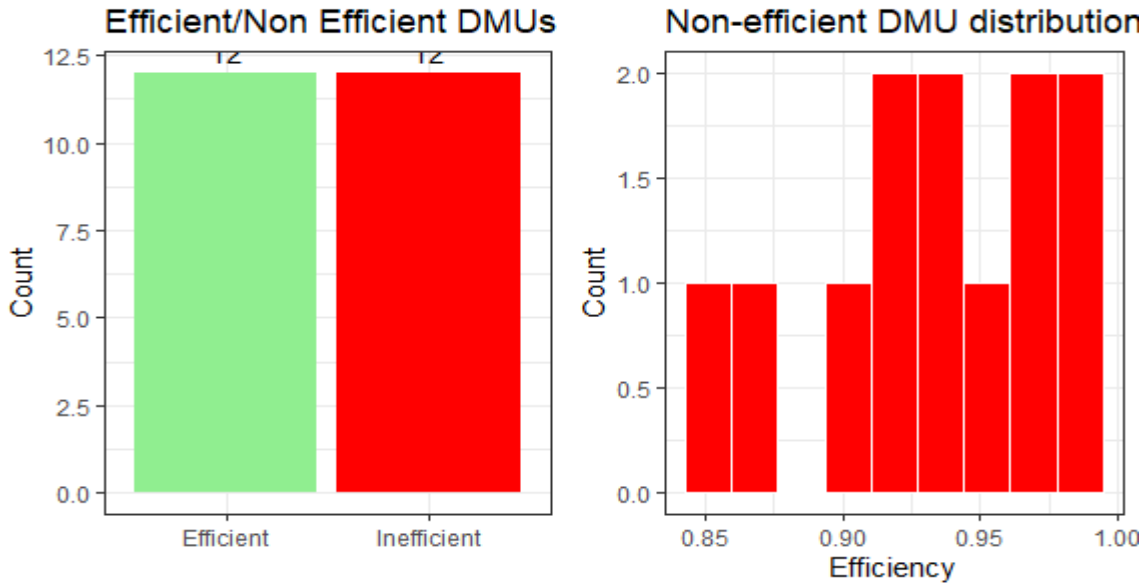


Figure 5. Number of efficient and ineffective countries and efficiency distributions of ineffective countries by BCC model

When Figure 5 was examined, it was seen that 12 countries were efficient, and 12 countries were not efficient according to the BCC model. When the distribution of the efficiency of the ineffective countries was examined, it was seen that one country had an efficiency score less than 0.85. The number of ineffective countries with efficiency rates higher than 0.95 was five. The Czech Republic had an efficiency score of 84.27 percent, which, according to the CCR model, was the country with the lowest efficiency score. The efficiency scores for EMS 1.3, DEAP-XP 2.1, and R-4.1.3 software was identical according to the CCR and BCC models. When the efficiency scores of the CCR and BCC models were compared, it was seen that the average efficiency scores obtained from the BCC model were higher than the CCR model.

Table 3 listed the benchmarks obtained with the CCR and BCC models run with the program's EMS 1.3, DEAP-XP 2.1, and R-4.1.3.

Table 3. Benchmarks by CCR and BCC Models in all three softwares

Number	DMUs	CCR Benchmarks			BCC Benchmarks		
		(EMS)	(DEAP)	(R-4.1.3)	(EMS)	(DEAP)	(R-4.1.3)
1	Australia	2 (0.09) 12 (0.32) 14 (0.35) 17 (0.26)	14(0.346) 17(0.257) 2(0.090) 12(0.323)	2 (0.0903) 12 (0.3226) 14 (0.3459) 17 (0.2573)	6 (0.33) 7 (0.03) 8 (0.03) 14 (0.26) 17 (0.35)	6(0.325) 14(0.258) 8(0.027) 17(0.354) 7(0.035)	6 (0.3252) 7 (0.0347) 8 (0.0273) 14 (0.2583) 17 (0.3545)
2	Belgium	9	9	9	6	6	6
3	Canada	2 (0.73) 8 (0.31)	8(0.307) 2(0.733)	2 (0.7326) 8 (0.3069)	0		0
4	Chile	2 (0.16) 16 (0.58) 20 (0.27)	16(0.577) 2(0.160) 20(0.271)	2 (0.1601) 16 (0.5772) 20 (0.271)	2 (0.18) 6 (0.07) 16 (0.52) 20 (0.23)	6(0.073) 2(0.176) 16(0.524) 20(0.226)	2 (0.1762) 6 (0.0734) 16 (0.5243) 20 (0.2262)
5	Czech Republic	18 (0.99)	18(0.990)	18 (0.99)	18 (1.00)	18(1.000)	18 (1.00)
6	Denmark	1	1	1	6	6	6
7	Estonia	12 (0.72) 14 (0.28) 18 (0.09)	14(0.277) 18(0.091) 12(0.719)	12 (0.7188) 14 (0.2771) 18 (0.091)	1		1
8	Finland	1	1	1	2	2	2
9	France	12 (0.84) 18 (0.19)	12(0.836) 18(0.186)	12 (0.8362) 18 (0.1863)	6 (0.64) 12 (0.20)	18(0.158) 6(0.639)	6 (0.6385) 12 (0.2035)

					18 (0.16)	12(0.204)	18 (0.1579)
10	Iceland	2 (0.43) 12 (0.39) 18 (0.16)	2(0.426) 12(0.388) 18(0.163)	2 (0.4262) 12 (0.3877) 18 (0.1632)	2 (0.13) 12 (0.51) 16 (0.09) 18 (0.27)	18(0.270) 16(0.091) 2(0.130) 12(0.508)	2 (0.1304) 12 (0.5081) 16 (0.091) 18 (0.2705)
11	Israel	2 (0.50) 12 (0.36) 14 (0.06) 18 (0.05)	14(0.058) 2(0.503) 18(0.050) 12(0.356)	2 (0.5027) 12 (0.3556) 14 (0.0577) 18 (0.0504)	2 (0.52) 12 (0.37) 14 (0.06) 18 (0.05)	14(0.060) 2(0.520) 18(0.052) 12(0.368)	2 (0.5202) 12 (0.368) 14 (0.0597) 18 (0.0522)
12	Italy	10	10	10	8	8	8
13	Japan	14 (0.18) 18 (0.90)	18(0.897) 14(0.177)	14 (0.1771) 18 (0.8968)	0	0	0
14	Korea	6	6	6	4	4	4
15	Latvia	2 (0.07) 12 (0.37) 14 (0.02)	2(0.071) 14(0.017) 27(0.523)	2 (0.0712) 12 (0.3727) 14 (0.0165)	2 (0.07) 12 (0.38) 14 (0.02)	14(0.017) 17(0.532) 2(0.072)	2 (0.0724) 12 (0.3787) 14 (0.0168)
16	Mexico	17 (0.52) 2	12(0.373) 2	17 (0.5235) 2	17 (0.53) 3	12(0.379) 3	17 (0.532) 3
17	Netherlands	4	4	4	5	5	5
18	Norway	10	10	10	8	8	8
19	Poland	2 (0.02) 12 (0.35) 17 (0.29)	2(0.021) 12(0.352) 17(0.292)	2 (0.0212) 12 (0.352) 17 (0.2924)	6 (0.44) 12 (0.00) 17 (0.12)	12(0.004) 17(0.121) 18(0.439)	6 (0.4364) 12 (0.0043) 17 (0.1207)
20	Portugal	18 (0.35) 1	18(0.346) 1	18 (0.3462) 1	18 (0.44) 1	6(0.436) 1	18 (0.4386) 1
21	Slovak Republic	12 (0.79) 17 (0.14) 18 (0.03)	17(0.142) 18(0.028) 12(0.792)	12 (0.7919) 17 (0.1422) 18 (0.0282)	12 (0.82) 17 (0.15) 18 (0.03)	18(0.029) 12(0.823) 17(0.148)	12 (0.8229) 17 (0.1477) 18 (0.0294)
22	Spain	2 (0.61) 16 (0.05) 18 (0.33)	2(0.611) 16(0.048) 18(0.334)	2 (0.6106) 16 (0.048) 18 (0.3344)	2 (0.51) 12 (0.04) 16 (0.08) 18 (0.37)	2(0.513) 16(0.078) 12(0.039) 18(0.370)	2 (0.5134) 12 (0.0388) 16 (0.078) 18 (0.3698)
23	Sweden	12 (0.51) 18 (0.50)	12(0.511) 18(0.496)	12 (0.5111) 18 (0.4963)	6 (0.16) 12 (0.33) 18 (0.51)	6(0.162) 18(0.506) 12(0.332)	6 (0.1618) 12 (0.3322) 18 (0.506)
24	United Kingdom	2 (0.18) 6 (0.33) 12 (0.16) 14 (0.34)	14(0.342) 6(0.332) 12(0.160) 2(0.176)	2 (0.1761) 6 (0.3321) 12 (0.1605) 14 (0.3424)	2 (0.05) 6 (0.53) 8 (0.10) 14 (0.25) 17 (0.07)	17(0.067) 2(0.050) 14(0.255) 8(0.102) 6(0.526)	2 (0.0504) 6 (0.5258) 8 (0.1022) 14 (0.2549) 17 (0.0666)

When Table 3 was examined, it was given how many efficient countries should be referenced, which countries ineffective countries should take as reference, and to what extent. When the benchmarks were examined, Canada was not an effective country according to the CCR model. According to the software EMS, DEAP-XP 2.1 and R-4.1.3, Belgium should be referenced by Canada with the 2nd DMU order at a rate of 0.73 and Finland with the 8th DMU order at a rate of 0.31 when the CCR model was chosen. According to the three software, Canada was the effective country in the BCC model. Canada was not one of the countries that should refer to any country that was not effective according to the three software. The benchmarks in Table 3 show that R-4.1.3, DEAP-XP 2.1, and EMS software gave the same results. The graph of how many times inefficient countries should reference efficient countries was given in Figure 6 for the CCR model and in Figure 7 for the BCC model.

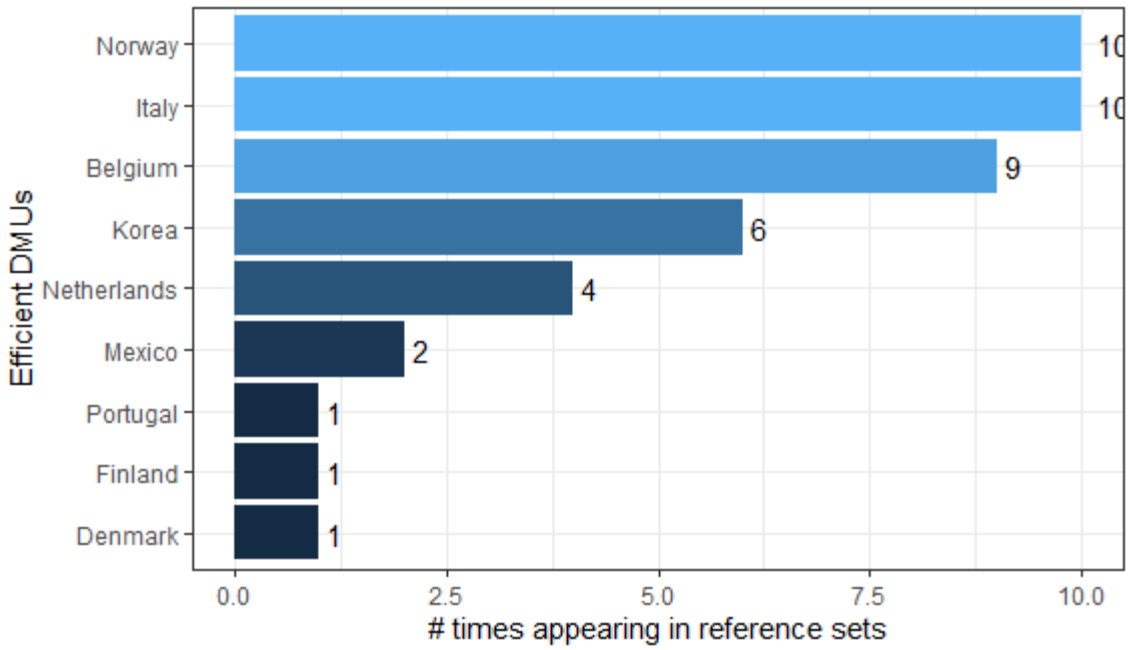


Figure 6. Reference numbers of effective countries by CCR model

When Figure 6 was examined, it was seen that when EMS 1.3, DEAP-XP 2.1, and R-4.1.3 software were used according to the CCR model, Norway and Italy should be taken as references by 10 ineffective countries, and these two countries were the most referenced. Denmark, Finland, and Portugal should only be referenced by one ineffective country.

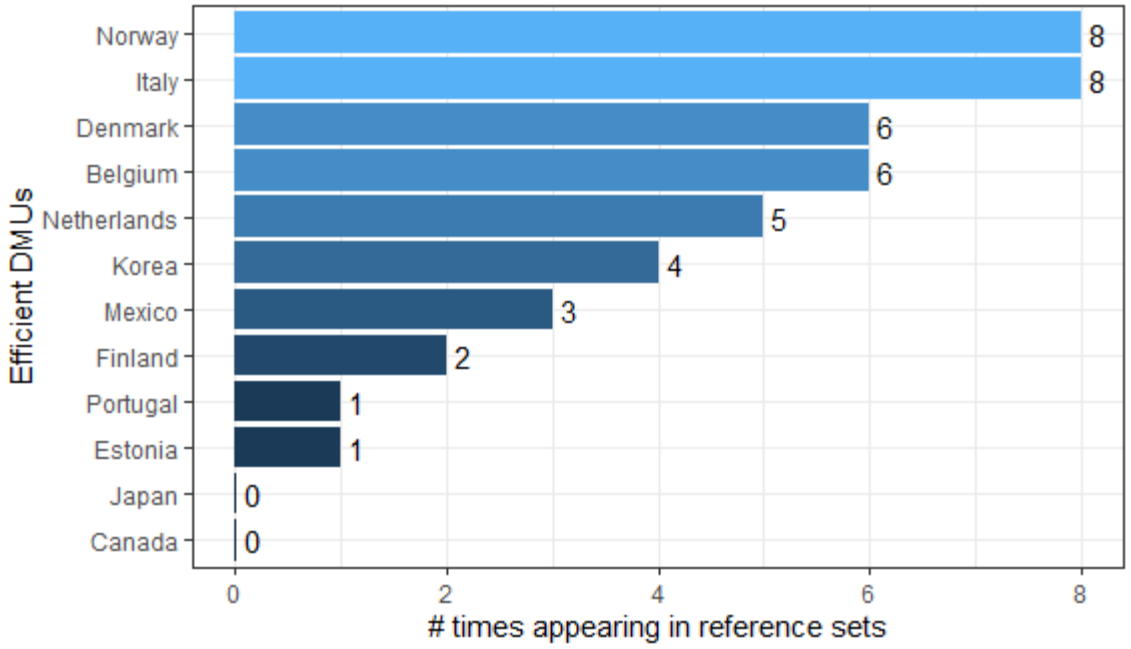


Figure 7. Number of references to effective countries by BCC model

When Figure 7 was examined, it was seen that when EMS 1.3, DEAP-XP 2.1, and R-4.1.3 software were used according to the BCC model, Norway and Italy should be taken as reference by 8 ineffective countries and these two countries were most referenced. Although Japan and Canada were effective countries, they were not referenced by any ineffective countries. EMS 1.3, DEAP-XP 2.1, and R-4.1.3 software produced completely parallel outputs for reference countries and reference quantities. In addition, according to the CCR and BCC models, the reference rate and the number of effective countries may differ partially.

In Figure 8 and Figure 9, Network Diagram for 24 Countries According to the CCR model and the Network Diagram for 24 Countries According to BCC Model were given.

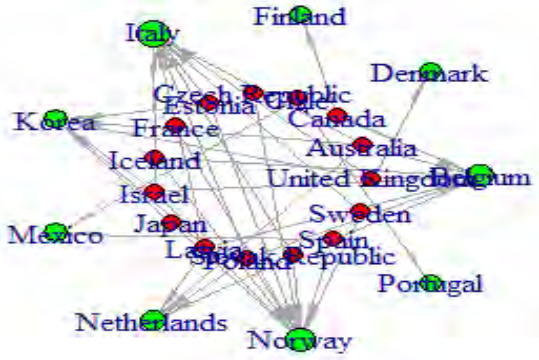


Figure 8. Network diagram for 24 countries according to CCR model

When the diagram in Figure 8 was examined, those shown in green were efficient countries, while those shown in red were inefficient countries. The efficient countries referenced by the inefficient countries were shown with arrows in the diagram. In the diagram, for example, while 10 countries refer to Italy (Australia, Estonia, France, Iceland, Israel, Latvia, Poland, Slovak Republic, Sweeden, United Kingdom), one country (Canada) should take reference Finland.

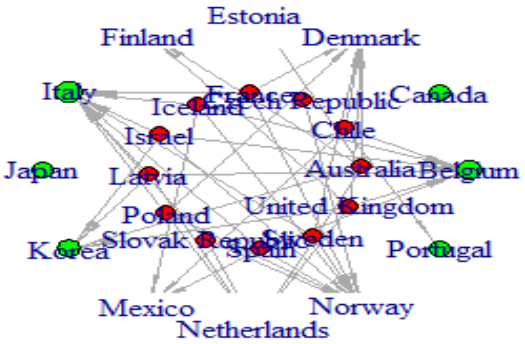


Figure 9. Network diagram for 24 countries according to BCC model

When the diagram in Figure 9 was examined, the countries in the outer part of the diagram were the countries that should be taken as reference, while the countries in the inner part were ineffective. While eight countries should take Italy as a reference (France, Iceland, Israel, Latvia, Poland, Slovak Republic, Spain, and Sweeden), no country should take Canada as a reference.

In Table 4, Table 5, Table 6, Table 7, Table 8, and Table 9, it was seen how much an increase in output could occur if inefficient countries reduce their input values to be efficient. In Table 4, Table 5, Table 6, Table 7, Table 8, and Table 9, it was seen how much an increase in output will occur if inefficient countries reduce their input values to be efficient. When EMS 1.3 software was used for this, the slack values for the CCR model were given in Table 4.

Table 4. Slack values obtained from EMS 1.3 Software for CCR model

Slack Values	Inputs					Outputs		
DMUs	I1	I2	I3	I4	I5	O1	O2	O3
Australia	0	0	0	0	0.53	22.89	0	6.82
Canada	5.76	0.09	0	0	1.79	12.26	2.73	0
Chile	3.16	0	0	0	1.43	27	9.25	0
Czech Republic	0	12.18	7.15	4.54	4.46	4.96	0	20.85
Estonia	0	0	6.13	0	0.89	23.05	0	19.52
France	0	1.01	0	2.16	6.99	10.27	0	2.14
Iceland	0	0	10.32	6.79	0	0	8.73	2.45
Israel	0	0	9.61	0	0	14.65	11.27	0
Japan	0	31.25	43.62	0	7.18	11	0	35.63
Latvia	0	0	0	0	0.49	13.41	0	0.15
Poland	0	4.69	0	0	0	2.75	0.22	0
Slovak Republic	0	0.72	0	0	3.25	0	6.33	17.07
Spain	0	0	0.76	28.74	0	11.01	0	0.52
Sweden	0	0	3.86	8.75	8.12	5.59	0	2.49
United Kingdom	0	0	0	0	8.83	25.05	0	10.79

The interpretation of the slack values in Table 4 was as follows. For example, Australia was an ineffective country according to the CCR model. Australia's reduction of only the fifth input variable "teachers who are not satisfied with their job (%)" by 0.53 unit resulted in a 22.89 unit increase in the first output variable (Mathematics literacy) and a 6.82 unit increase in the third output variable (reading literacy).

Slack values for the CCR model were given in Table 5 when DEAP-XP 2.1 and R-4.1.3 software was used.

Table 5. Slack values obtained from DEAP-XP 2.1 and R-4.1.3 Software for CCR model

Slack Values	Inputs					Outputs		
DMUs	I1	I2	I3	I4	I5	O1	O2	O3
Australia	0.000	0.000	0.000	0.000	0.529	22.895	0.000	6.821
Canada	5.756	0.094	0.000	0.000	1.794	12.258	2.732	0.000
Chile	3.159	0.000	0.000	0.000	1.426	26.997	9.252	0.000
Czech Republic	0.000	12.181	7.146	4.543	4.461	4.960	0.000	20.849
Estonia	0.000	0.000	6.129	0.000	0.893	23.049	0.000	19.517
France	0.000	1.008	0.000	2.156	6.988	10.271	0.000	2.139
Iceland	0.000	0.000	10.323	6.792	0.000	0.000	8.727	2.448
Israel	0.000	0.000	9.606	0.000	0.000	14.649	11.272	0.000
Japan	0.000	31.254	43.622	0.000	7.180	11.004	0.000	35.629
Latvia	0.000	0.000	0.000	0.000	0.493	13.413	0.000	0.152
Poland	0.000	4.690	0.000	0.000	0.000	2.753	0.217	0.000
Slovak Republic	0.000	0.725	0.000	0.000	3.248	0.000	6.334	17.072
Spain	0.000	0.000	0.757	28.742	0.000	11.006	0.000	0.520
Sweden	0.000	0.000	3.859	8.746	8.117	5.585	0.000	2.489
United Kingdom	0.000	0.000	0.000	0.000	8.835	25.053	0.000	10.792

The interpretation of the slack values in Table 5 was as follows. For example, Australia was an ineffective country according to the CCR model. Reducing just Australia's fifth input variable "teachers who are not satisfied with their job (%)" by 0.529 resulted in a 22.895 unit increase in the first output variable (Mathematics literacy) and 6.821 unit increase in the third output variable (Reading literacy).

The slack values for the BCC model were given in Table 6 when using the EMS software.

Table 6. Slack values obtained from EMS 1.3 Software for BCC model

Slack Values	Inputs					Outputs		
DMUs	I1	I2	I3	I4	I5	O1	O2	O3
Australia	0	0	0	0	0.2	21.02	0	3.82
Chile	3.67	0	0	0	1.22	28.99	9.68	0
Czech Republic	0	12.3	7.22	4.59	4.51	10	5	26
France	0	3.21	0	10.95	6.65	12.3	2.09	0
Iceland	0	0	8.98	0.69	0	0	9.42	6.76
Israel	0	0	9.94	0	0	31.5	27.9	16.65
Latvia	0	0	0	0	0.5	21.51	8.01	8.13
Poland	0	7.17	0	1.16	0.18	3.08	0	0
Slovak Republic	0	0.75	0	0	3.38	18.6	24.64	35.48
Spain	0	0	0.29	26.77	0	10.77	0	1.71
Sweden	0	0	3.43	11.11	8.01	5.47	0	1.6
United Kingdom	0	0	0	0	8.65	22.18	0	9.14

The interpretation of the slack values in Table 6 was as follows. For example, Australia was an ineffective country according to the BCC model. Australia's reduction of just the fifth input variable "teachers who are not satisfied with their job (%)" by 0.2 units resulted in 21.02 unit increase in the first output variable (Mathematics literacy) and a 3.82 unit increase in the third output variable (Reading literacy).

When using DEAP-XP 2.1 and R-4.1.3 software, slack values for BCC model were given in Table 7.

Table 7. Slack values obtained from DEAP-XP 2.1 and R-4.1.3 Software for BCC model

Slack Values	Inputs					Outputs		
DMUs	I1	I2	I3	I4	I5	O1	O2	O3
Australia	0.000	0.000	0.000	0.000	0.204	21.025	0.000	3.823
Chile	3.669	0.000	0.000	0.000	1.225	28.995	9.684	0.000
Czech Republic	0.000	12.304	7.218	4.589	4.507	10.000	5.000	26.000
France	0.000	3.214	0.000	10.946	6.652	12.304	2.094	0.000
Iceland	0.000	0.000	8.979	0.688	0.000	0.000	9.421	6.757
Israel	0.000	0.000	9.940	0.000	0.000	31.498	27.899	16.653
Latvia	0.000	0.000	0.000	0.000	0.501	21.507	8.006	8.128
Poland	0.000	7.170	0.000	1.158	0.179	3.083	0.000	0.000
Slovak Republic	0.000	0.753	0.000	0.000	3.376	18.603	24.636	35.481
Spain	0.000	0.000	0.295	26.766	0.000	10.772	0.000	1.708
Sweden	0.000	0.000	3.434	11.109	8.011	5.470	0.000	1.596
United Kingdom	0.000	0.000	0.000	0.000	8.654	22.179	0.000	9.141

The interpretation of the slack values in Table 7 was as follows. For example, Australia was an ineffective country according to the BCC model. Reducing just Australia's fifth input variable "teachers who are not satisfied with their job (%)" by 0.204 unit resulted in a 21.025 unit increase in the first output variable (Mathematics literacy) and 3.823 unit increase in the third output variable (Reading literacy). The slack values obtained from the R-4.1.3 software and the slack values obtained from the EMS 1.3 software and DEAP-XP 2.1 software were the same. More than two digits were obtained after the comma only in R-4.1.3 and DEAP-XP 2.1 software, while in EMS 1.3 software only two digits were given after the comma. In addition, the findings of the slack values obtained from the CCR and BCC models differed partially.

Conclusion

According to this study, the variables are "teachers who don't believe they can help their students to value learning (%)," "teachers who don't believe they can help their students to think critically (%)," and "teachers who don't believe they can help their students to value learning" are related to teachers' self-efficacy. Data envelopment analysis was used to determine the input and output variables for the variables "teachers who don't believe that the teaching profession is valued in society (%)" and "teachers who are not satisfied with their job (%)" related to job satisfaction of teachers among TALIS 2013 indicators and science, reading, and mathematical literacy scores. Efficiency analysis of 24 countries was carried out with three different software.

As a result of the research, according to the CCR model, effective countries were Belgium, Denmark, Finland, Italy, Korea, Mexico, Netherlands, Norway, and Portugal, when EMS 1.3, DEAP-XP 2.1, and R-4.1.3 software were used. According to the CCR model, the number of effective countries was nine, when three software were used. As a result of the research, according to the BCC model, when EMS 1.3, DEAP-XP 2.1, and R-4.1.3 software were used, the effective countries were Belgium, Canada, Denmark, Estonia, Finland, Italy, Japan, Korea, Mexico, Netherlands, Norway, and Portugal. When EMS 1.3, DEAP-XP 2.1, and R-4.1.3 were used, the number of effective countries was twelve, according to the BCC model. Norway and Italy were the countries that should be referenced most by ineffective countries to increase their efficiency scores in EMS 1.3, DEAP-XP 2.1, and R-4.1.3 software. When slack values were examined, R, DEAP-XP 2.1, and EMS 1.3 gave the same results. The results were exactly the same in R-4.1.3, DEAP-XP 2.1, and EMS 1.3 software. Efficiency analysis of 24 countries was conducted when teachers' self-efficacy perception and job satisfaction were taken as input variables and students' mathematics, science, and reading literacy performance in PISA were taken as output variables. As a result of the research, it was found that some countries need to decrease some input variables to increase their efficiency scores. In other words, it was necessary to increase the success scores in PISA 2015 and decrease the percentages of individuals who have negative/reverse coded expressions, especially in the self-efficacy perception and job satisfaction measurements. When the studies in the literature were analyzed, there were studies on positive correlations between job satisfaction and self-efficacy perception (e.g., Ainley & Carstens, 2018; Caprara et al., 2006; Perera & John, 2020; Tschannen-Moran & Hoy, 2001; Tschannen-Moran et al., 1998; Zee & Koomen, 2016). In order to increase the efficiency score of ineffective countries, studies should be carried out to increase positive teacher job satisfaction and self-efficacy perception.

Teachers having a lot of weekly teaching time can cause time problems in the design of the courses and administrative duties. This time constraint affects the quality of teaching (Benner & Partelow, 2017). Effective countries such as Finland have lower teaching time than in other countries (see Paronen & Lappi, 2018). It should not be deduced that if the teaching time is long, the success will be high. The important thing is to conduct the lessons effectively. In this research, Canada and Chile should make improvements in the "Teaching time per week (hours)" input variable in CCR model, only Chile should make improvements according to the BCC model. When the Slack values were examined, the improvements that need to be made and the positive differences in the output variables were exactly the same in all three softwares.

Our lives and our success in life are influenced by the perception of self-efficacy, which Albert Bandura (1977) studied within the context of social cognitive theory. According to an educational study (Egido Gálvez, López-Martín, Manso, & Valle, 2018), one of the most significant factors influencing student motivation and success is how teachers see their talents. Pintrich, Smith, Garcia, and Mckeachie (1993) found that high self-efficacy belief effectively fulfilled tasks successfully. In the study, reverse-coded "teachers who don't believe they can help their students to value learning (%)" and "teachers who don't believe they can help their students to think critically (%)" input variables were discussed. Canada, Czech Republic, France, Japan, Poland, and Slovak Republic should make improvements in terms of "teachers who don't believe they can help their students to value learning (%)" variable. Especially Czech Republic, Estonia, Iceland, Israel, Japan, Spain, and Sweden should make improvements in terms of "teachers who don't believe they can help their students to think critically (%)" input variable. In particular, Japan is the country that needs to make the highest improvement in the second and third input variables (variables related to self-efficacy), and it should increase teachers' self-efficacy beliefs. In addition, when slack values were examined in terms of self-efficacy perception, exactly the same results emerged in all three software.

High job satisfaction among teachers is associated with obtaining high students' achievement. To reveal this relationship, it is important to conduct research by linking the OECD's TALIS and PISA results (Dicke et al., 2020). Sealy, Perry, and DeNicola (2016), in their research with PISA and TALIS data, found that there is a relationship between job satisfaction and student achievement in some countries. Similarly, in this study, data envelopment analysis was carried out based on the finding that as job satisfaction increases, student success increases. Czech Republic, France, Iceland, Poland, Spain, and Sweden should make improvements in terms of the "teachers who don't believe that the teaching profession is valued in society (%)" variable. Australia, Chile, Czech Republic, France, Latvia, Poland, Slovak Republic, Sweden, and United Kingdom should make improvements in terms of the "teachers who are not satisfied with their job (%)" variable.

Luthans (2000) mentioned four ways to increase job satisfaction. The first was to increase job satisfaction, the second was to ensure fair pay, advancement, and benefits, the third was to place people in jobs that suited their skills and interests, and the fourth was to increase job satisfaction by making the job suitable for the individual rather than, as with the third item, finding suitable candidates for the job. According to this concept, underperforming nations can raise their input values by looking at the working conditions for educators.

Variables related to the perception of self-efficacy were discussed in this study. To increase the self-efficacy of teachers, well-equipped and self-aware teachers should be trained.

An important result of the research was that the findings were the same when free R-4.1.3, DEAP-XP 2.1, and EMS 1.3 software were used. Researchers were recommended to analyze the data using the "deaR" package in R-4.1.3 in data envelopment analysis, as shown in figures, tables, and more results. It can be said that DEAP-XP 2.1 software was more complex for analysis by taking companies or firms as DMUs with the logic of efficiency of businesses. When using DEAP-XP 2.1 software, researchers should display decimal numbers with dots instead of commas in the input file. Otherwise, the software gives erroneous results. EMS 1.3 software, on the other hand, has a user-friendly interface but does not allow graphics and figures. R-4.1.3 software, on the other hand, not only analyzes data for old methods such as VRS and CRS, but also analyzes data by considering many models such as Fuzzy DEA, Non-radial DEA model, and the situation such as dealing with undesirable outputs in DEA. Finally, R-4.1.3 gave more information, figures, and output, followed by DEAP XP-2.1 and EMS 1.3 software, respectively.

Recommendations

The findings from the CCR model based on the constant return assumption and the BCC model based on the variable return assumption differed partially in this research. When educational research was examined, some studies use both and only one. It is recommended that which model is used in data envelopment analysis and whether this model is input or output oriented should be reported in research. Researchers were advised to specify which software they were analyzing the data within their research.

There are several limitations to this study. Five inputs, three outputs, and 24 DMUs were utilized for the research. Various input variables can be used to illustrate the link between TALIS and PISA. Data envelopment analysis, a nonparametric method, was used in this work to evaluate the data. Research can be conducted by combining TALIS and PISA data using different parametric methods. Different countries were considered as DMUs in this research. For example, data envelopment analysis can be done by working with country data and considering regions or school types as DMUs. To consider more input and output numbers, it is necessary to increase the number of DMUs. By increasing the number of DMUs and increasing the number of inputs and outputs, similar studies can be carried out with advanced data envelopment analysis techniques.

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There is no conflict of interest to disclose.

Author(s) Contribution Rate
SB wrote all sections including “abstract, introduction, method, findings, conclusion”. SB had roles in the conceptualization, resources, data analysis, reporting, drafting, reviewing and editing.

Conflicts of Interest
There is no conflict of interest.

Ethical Approval
Ethical approval is not required. Because data from OECD was used in this research.

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