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Efficiency of Working of Governments: A Case Study of 27 OECD Countries

Maimoona Javed
Student at School of Economics, BZU Multan, Pakistan
maimoonawajid1690@gmail.com

Abstract

Efficiency for 27 OECD countries is computed and evaluated by taking statistics of seven years from 2008-2014 in this paper. Three input variables education spending, health spending and social spending are taken as percentage of GDP and Output variables include life expectancy at birth, Infant Survival Rate (ISR), 25-34 years old population with tertiary education, unemployment rate and Corruption index. DEA is applied to gauge the technical efficiency of the chosen DMUs under the assumptions of CRS and VRS and then Scale efficiency is estimated. There are 9 countries on the frontier under CRS while France is the least efficient one and total CRS efficiency score is 94%. Under VRS, 15 countries are on the frontier and the least efficient one is Belgium while total efficiency under VRS is 97%. Switzerland is the least efficient country under Scale efficiency and there are 9 countries on the frontier. Total Scale Efficiency is 97%. Then second stage analysis is executed in order to further scrutinize the European and Non-European countries by taking CRS & VRS efficiency scores as dependent variable and the independent variables include GDP per capita growth rate, Government Stability, Income Inequality, Labor Force Participation rate (between 15-64 years), Human development Index (HDI) and one Dummy variable that take 1 for non-European and 0 for European countries. The second stage analysis shows a significant positively related impact of GDP Per Capita Growth Rate and Government Stability over efficiency. There is a negative relation between Income inequality HDI income inequality is statistically significant while HDI is insignificant statistically because it is a combination variable. All the computed results for truncated regression are calculated at 95% confidence interval.

Keywords: *DEA (Data Envelopment analysis), Truncated Regression Analysis, Constant Returns to Scale, Variable Returns to Scale, OECD Countries*

1. Introduction:

Businesses, institutions, and organizations operate with limited resources and a multitude of objectives to accomplish. Every organization puts a lot of effort into improving and growing itself, and this includes concentrating on output measurement. Measurement of output is highly useful and practical for sustaining success, providing guidance on where to allocate resources, and identifying areas that require additional financial and management effort. To achieve this, every organization or business is compared to one another; the most efficient business serves as the benchmark for efficiency, and all decision-making units are evaluated in relation to the most efficient one.

Every nation's primary sector, the public sector is responsible for providing its population with goods and services such as health, education, housing, safety, peace, and prosperity through investments in a wide range of areas. The public sector, sometimes known as the government, is a larger organisation that attracts the interest of citizens, visitors, and scholars alike. The country's

broad public sector's expenditures worry the general population and researchers. The general public definitely concerned with the public spending in terms of their own interests while researchers may concerned with the questions as

1. Are these governments' spending bringing advantageous results?
2. Where does the government spending stands in the grading of the other countries with parallel economic status?
3. How proficiently a government is spending?

Efficient use of resources across a range of areas of public interest is another aspect of government efficiency. The public gains from efficient spending in the right areas at the right times, as well as increased public sector efficiency. An effective public sector is one in which the government is able to sustain a balance between public spending and returns, which is a necessary prerequisite for economic growth.

The study's goals are to assess the effectiveness of industrialised nations' government sectors and determine the causes of variations in efficiency ratings. 27 OECD nations are being examined in order to assess efficiency. The seven-year study period (2008–2014) is covered by the data collected. The examination considers three public sectors: the social, health, and education sectors. There are two variables in the education sector: "Population with tertiary education till 34 years of age" and "General education spending on education sector as percentage of GDP." The two output variables in the health sector are "Life expectancy at birth" and "Infant survival rate," with one input variable being "General health sector spending as percentage of GDP"The input variables are "general social spending as a percentage of GDP," while the output variables are "unemployment rate" and "corruption index." By using truncated regression analysis to count GDP per capita growth rate, income inequality, government stability, labour force participation rate, and human development index, a second stage study is conducted to differentiate the efficiency analysis in European and non-European nations. CRS and VRS Efficiency scores are subjected to truncated regression analysis; the findings are discussed in the paper's afterword.

2. Literature Review:

Hauner and Kyobe (2008) established the determinants of Government Efficiency in IMF working paper. Data on the health and education sectors of 114 different nations were collected between 1980 and 2006. Regression analysis was used to econometrically determine the Public Sector Performance (PSP), Public Sector Efficiency (PSE), and Data Envelopment Analysis (DEA) scores in respect to the economic, regional, and demographic factors. The variables included in the analysis were spending on health and education, per capita income, commodity exporters, inflation, transparency, accountability, corruption control, durable regime, democracy, population density, malaria, and climate statistics. According to the data, there is no discernible relationship between spending and performance in the education sector, and other elements like government accountability and corruption control also play a big part in increasing government efficiency. Using data from 1980 to 2004, Hauner and Kyobe (2010) conducted the same research for the education and health sectors of 114 nations. It was found that 80–90% less money might be spent to attain the same level of health and education efficiency, highlighting the resource waste in the analysis's participating nations. According to statistics, the United States and Germany have the lowest levels of efficiency in the health sector, while African countries have the lowest levels in the education sector.

Delis and Kammas (2011) worked for measuring Public sector efficiency by taking statistics from Economic affairs, Public services, Social security and Welfare sectors of the Government with the health and education sector Statistics of.19 OECD countries had taken for duration of 1980-2000

and studied and analyzed for Stochastic DEA. Public spending on Education, Health, Economic affairs, General public services, Social security and Welfare sectors were the input variables. Secondary school enrollment, Quality of education, Life expectancy, Infant mortality rate, Power transmission loses, Corruption, Bureaucratic quality, GINI coefficient, unemployment rate, GDP growth rate, GDP per capita, Standard deviation of GDP growth rate and inflation rate were output variables. Input-oriented DEA is used to measure PSE and approximates pure Governmental Efficiency, impacts of socio-economic environment and luck. Then the influences of luck are separated and results illustrate that luck was less significant and low influential factor than the governance. Last part of the analysis takes a set of variables including Democratic participation as Turnout, cabinet's political measure as Ideology, Share of excess seats in Parliament as Power governance, and a dummy variable holding value of 1 if Coalition Government was in power as Coalition. Estimated results describes that Turnout was highly significant of all, Power governance and Ideology were positively related and significant at 1% level of other estimators while Coalition was always negative and significant at 1% at all levels of other estimators.

Afonso et al (2005) evaluated the efficiency of public sector of 23 OECD countries for duration 1990-2000. The data included the PSP (Public Sector Performance) and PSE (Public Sector Efficiency) indicators. Because of the limitations and restrictions of PSE indicators, FDH (Free Disposal Hull) was used in the investigation too. The study showed that from the input point of view countries were wasting almost 20% of their inputs by utilizing it without any need and by the same level of inputs, 15% more output can be generated. Analysis resulted and states that small governments are more efficient than the large ones.

Afonso et al(2006) constructed the analysis by using PSP and PSE indicators for the measurement for efficiency of spending of local government with help of generating the PSE indicators by six sub-indicators. DEA was used to determine the efficiency of the emerging economies and then investigation was further conducted by Tobit regression analysis and non-fiscal determinants of the efficiency were calculated. DEA results showed that emerging economies can control the waste of resources and get the same output level by spending 45% less than the current spending while with the other aspect of output same input could be produced 67% more of the outputs. Emerging markets of Asia were more efficient than the other emerging markets. The results calculated by Tobit regression analysis proclaimed positive relation between security of property rights, education level of population, aptitude of civil servants and efficiency.

Sijpe and Rayp (2007) significantly analyzed and quantified the government efficiency of 52 Asian and European developing countries and originate the determinants of efficiency by using DEA. Input variable used in the analysis is PPP based central government expenditures per capita while output variables were put into sets of health, education and government performance. Health embedded statistics like infant mortality and immunization against measles. Education embodied statistics about youth literacy rate; secondary school enrollment and government performance takes statistics regarding government effectiveness. The results demonstrates diversity of expenditures in the countries. Some of the Asian countries were efficient in spending on health, education, stability and rule of law. But in most of the Asian countries these parameters needed to be addressed. For this purpose foreign aid demonstrates significant role. European countries menifest the efficient in the above parameters and have high efficiency as compare to Asian countries. China, Malawi and Russia had efficiency score 1.

The role of environmental variables was analyzed by Ruggiero (1993) by using DEA. Teacher's salary, expenditures, pupil personal expenditures, books, computers and adults with college education percentage was taken as input variables. Reading score, math score, social studies score

and dropout rate were output variables. At the end of the analysis out of 556 districts 113 were efficient ones, 443 were inefficient ones and amid 443 inefficient districts 221 were high inefficient and 222 were low inefficient ones.

An efficiency evaluation was prepared by Maxwell et al between OECD and Non-OECD countries. Analysis was carried out by taking government efficiency, bussiness efficiency and infrastructure advancements as input variables and one output variable was incorporated in the analysis that was economic performance. The average index for government performance was 54.4, index for average business performance was 53.2, index for average infrastructure was 53.3 and average economic performance index was 53.5. The mean Total scale Efficiency score for OECD economies was .65 and for Non-OECD economies was .53 and on the basis of TSE Argentina and Indonesia were proficient countries. On the basis of Pure Technical Efficiency (PTE) Non-OECD countries give the impression of being more efficient than the OECD countries. In terms of Scale Efficiency, the position of OECD and Non-OECD countries were made and top 5 OECD countries were Turkey, Poland, Mexico, Greece and Italy. Top 5 Non-OECD countries were Indonesia, Argentina, Brazil, Romania and Philippines.

Wang and Alvi (2011) determined and analyzed the efficiency of Government expenditures and the factors that control and affect the performance of government spending. Data of seven countries from Asia for the duration of 1986 to 2007 is taken. GDP statistics were used as variable that signify the economic development and the statistical analysis depicts that higher the rate of GDP lowers the unemployment and represented a better standard of living. DEA was applied to the statistics and the results showed that the sample countries were wasting their 50% of reserves and resources when they were not contented with the GDP growth only. In the sample Singapore and Japan had highest efficiency scores and falls on the DEA frontier. The most inefficient among the sample countries was Thailand as it wasted 77% of resources while among the efficient countries Japan wasted 34% of resources. Tobit regression analysis results menifests that there was a negative relation between the government inefficiency and the activities of private sector. Corruption also demonstrates a negative role in the efficiency related matters of the country and statistics also showed that higher the rate of corruption and monetary expansion lowered the efficiency.

Saunders (1987) analyzed inclination of government spending of OECD countries by taking data of 20 years from 1960-1980. Author concluded that in duration of national elections the GDP showed a rising trend about 1.3% and GDP was lesser in federal countries as compared to non-federal countries. There was positive relation between old age population ratio and government spending while the young age ratio had a negative relation with government spending. For the implications of the study for Australia the instigator suggested that government spending in Australia showed low trends in the sixties due to less response of governments and community factors towards international trends of government spending. The level of government spending was showing a declining trend than its envisage level and transfer payments were lowest among all OECD countries.

Data and Methodology:

DEA can be fractionated into input and output oriented. The DEA was developed by Charnes et al. (1978) as an input oriented model under the presupposition of Constant Returns to Scale (CRS) known as CCR (Charnes, Cooper, Rhodes). Under the presupposition of Variable Returns to scale (VRS) the model was planned by Banker et al. (1984) known as BCC (Banker, Charnes, Cooper). Coelli et al. (2005) proposed a model with input orientation under the assumptions of CRS.

The proposed model was

$$\textbf{Min}_{\theta,}\ \beta\ \theta$$

Subject to

$$-y_i + Y\beta \geq 0,$$
$$\theta x_i - X\beta \geq 0,$$
$$\beta \geq 0$$

Where

θ is a scalar and the value of θ disclose the efficiency scores f the i^{th} DMU. It accomplish the state that shows $\theta \leq 1$ and the DMUs that have value of θ exactly equal to 1 are the efficient ones. In other case the DMU will be considered incompetent one.

β	a vector of constants
X_i	input vector of i^{th}DMU
y_i	output vector of i^{th}DMU
Y	output matrix of I DMU
X	input matrix of I DMU

Coelli et al. (2005) demonstrated in his model that the assumptions of CRS are appropriate and suitable for the condition where all DMUs are working at the level of optimality. The real world situations showed that the DMUs are normally not able to work at the optimal level because of the market competition and other financial constraints. In order to decipher the problem of CRS the assumptions of VRS are incorporated in the analysis. The efficiency measurement of the DMUs under the assumptions of VRS gives the scores of technical efficiency and also is known as pure technical efficiency. The model is converted into VRS by adding convexity constraint into the CRS assumptions oriented model.

$$\textbf{Min}_{\theta,}\ \beta\ \theta$$

Subject to

$$-y_i + Y\beta \geq 0,$$
$$\theta x_i - X\beta \geq 0,$$
$$I1'\ \beta = 1$$
$$\beta \geq 0$$

Where I1 is an 1×1 vector of ones. The difference amid the values of the CRS and VRS is known as scale inefficiency. Scale efficiency evaluation for each DMU can be obtained by the share of technical efficiency scores attained by the CRS assumptions and the technical efficiency scores attain by using the supposition of VRS.

$$\theta_s = \theta_{CRS} / \theta_{VRS}$$

Where

θ_s is Scale efficiency

θ_{CRS} is Technical efficiency of the model with constant returns to scale

θ_{VRS} is Technical efficiency of the model with variable returns to scale

The model for the non increasing returns to scale is specified below

$$\textbf{Min}_{\theta,}\ \beta\ \theta$$

Subject to

$$-y_i + Y\beta \geq 0,$$

$$\theta x_i - X\beta \geq 0,$$
$$I1'\beta \leq 1$$
$$\beta \geq 0$$

Data and variables description: statistics for 27 OECD countries have taken and is scrutinize by taking public sector performance variables into account. Three major sectors are included in the analysis. These sectors include

- Health sector
- Education sector
- Social sector

Health Sector: Health sector encompasses one input and two output variables. Input variable is General health spending as percentage of GDP while output variables take account of Infant survival Rate and Life Expectancy at Birth. Infant survival rate can be defined as the number of demise of children under the age of one year per live births of 1000. Infant survival rate is calculated by the following formula

$$\textbf{Infant survival rate} = \frac{1000 - IMR}{IMR}$$

Life expectancy at birth can be described as the how extended a new born will suppose to live with the assumption that the current death rate remains unchanged.

Education Sector: Education sector contains one input and one output variable. General education spending behaves in the analysis as percentage of GDP is input variable while output variable is the population with tertiary education at the age 25-34 years age. The statistics comprise all the higher degree holders, researchers and skilled professionals.

Social sector: In the social sector there is one input and one output variable. General social sector spending as percentage of GDP is taken as input while Unemployment Rate and Corruption Index are taken as output variables in the current study . Unemployment rate is taken as the percentage gauge of total labor force. Corruption index is taken as output variable and to see the level of bribery, fraud and dishonesty in the different sectors of government. The values are taken from 1-6. The value of corruption index closer to 6 is considered less corrupt while the values closer to 1 show more corruption in the countries.

Second Stage Analysis: Second stage analysis takes GDP Per Capita Growth rate, Income Inequality**,** Government Stability**,** Human Development Index and Dummy (takes 1 for Non European and 0 for European countries) as variables.

Second stage analysis is applied to the CRS and VRS Efficiency scores to get the influence of certain variables on efficiency of the selected DMUs. As the efficiency scores falls between zero and one and perform as dependent variable in second stage analysis, truncated regression analysis is used as technique. Input, output and second stage variables with their sources and monetary units are described in the table below

Input variables	**Source**	**Monetary unit**
• General public sector spending on health sector	OECD database of health statistics	Percentage of GDP
• General public sector spending on education sector	OECD database of education statistics	Percentage of GDP

• General public sector spending on social sector	OECD database of social sector spending statistics	Percentage of GDP

Table: 5.2. Description of Input variables

Output variables	**Source**	**Monetary Unit**
• Life expectancy at birth	OECD database of health statistics	Demise of children under the age of one year per 1000 live births
• Infant Survival rate	OECD database of health statistics	Survival of children under the age of one year per 1000 live births
• Population with tertiary education	OECD database of education statistics	The percentage of population who completed the tertiary education. Doctoral degree holders are excluded.
• Unemployment rate	OECD database of main economic indicators	Percentage of total labor force that is unemployed.
• Corruption Index	International Country Risk Guide	Index takes values between 0-6. Closer to 6 is considered better.

5.3: Description of output variables

Second stage variable	**Source**	**Monetary Unit**
• GDP per Capita growth rate	IMF databases	GDP divided by population gives GDP per capita as result
• Income inequality	IMF databases	Percentage of income distribution
• Government stability	International Country Risk Guide	Takes values between0-11
• Human development index	IMF databases	Takes values between 0-1

5.4: Description of second stage variables

Results and Discussions: Input oriented CRS and VRS Efficiency scores are evaluated by using DEA and then Scale Efficiency is estimated out of CRS and VRS scores.

Input Oriented CRS Efficiency of 27 OECD countries: Input Oriented Efficiency is determined and results are shown in the Table 6.1. Descriptive Statistics Analysis for years 2008-14 is given in Table 6.2 and the DMU wise statistical analysis is depicted in table 6.3. Frequency distribution of Input Oriented CRS Efficiency scores is given table 6.4. The comparison between Mean and Minimum efficiency is shown by graph in Figure 6.1

Table 6.1: Input oriented CRS efficiency scores

Countries	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Australia	0.98	1.00	1.00	1.00	1.00	1.00	1.00
Belgium	0.76	0.87	0.86	0.84	0.87	0.85	0.86
Chile	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Czech Republic	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Denmark	1.00	0.81	0.81	0.85	0.88	0.89	0.91
Estonia	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Finland	1.00	1.00	1.00	1.00	0.99	1.00	1.00
France	0.84	0.87	0.80	0.82	0.83	0.79	0.77
Germany	1.00	0.96	0.98	0.97	1.00	0.99	0.98
Hungary	0.84	0.90	0.92	0.95	1.00	1.00	0.98
Iceland	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ireland	0.80	1.00	0.81	0.88	0.87	0.91	0.95
Israel	0.94	1.00	1.00	1.00	0.99	0.97	0.97
Italy	0.86	0.88	0.93	1.00	0.98	0.95	0.97
Japan	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Korea	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Latvia	0.99	1.00	1.00	1.00	1.00	1.00	1.00
Mexico	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Norway	1.00	0.99	0.98	0.97	1.00	1.00	1.00
Netherlands	0.94	0.91	0.83	0.83	0.87	0.86	0.88
Poland	0.91	0.94	0.94	0.99	0.97	0.95	1.00
Slovenia	0.98	0.93	0.88	0.86	1.00	0.87	1.00
Spain	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Sweden	0.98	0.97	0.99	0.84	0.90	0.91	0.96
Switzerland	0.83	0.86	0.80	0.78	0.83	0.83	0.84
Turkey	1.00	1.00	1.00	1.00	1.00	1.00	1.00
United States	0.77	0.91	0.81	0.84	0.87	0.85	0.83

(Source: Author's own calculations)

Table 6.2: Descriptive Statistical Analysis of Input Oriented CRS Efficiency scores (Year wise Analysis)

Input Oriented CRS Efficiency	2008	2009	2010	2011	2012	2013	2014
Mean Efficiency	0.94	0.96	0.94	0.94	0.96	0.95	0.96
Minimum Efficiency	0.76	0.81	0.80	0.78	0.83	0.79	0.77
Median	0.99	1.00	0.99	1.00	1.00	1.00	1.00
Standard Deviation	0.08	0.06	0.08	0.08	0.06	0.07	0.07
Maximum Efficiency	1.00	1.00	1.00	1.00	1.00	1.00	1.00
No. of efficient units	13	14	13	14	13	14	15

(Source: Author's own calculations)

Figure 6.1: Comparison of Mean and Minimum efficiency scores under CRS

Mean and Minimum efficiency comparison is depicted in Figure 6.1. Mean efficiency is almost inelastic for whole of the period but the minimum efficiency lies between 0.764-0.829. The mean efficiency scores are less diversified.

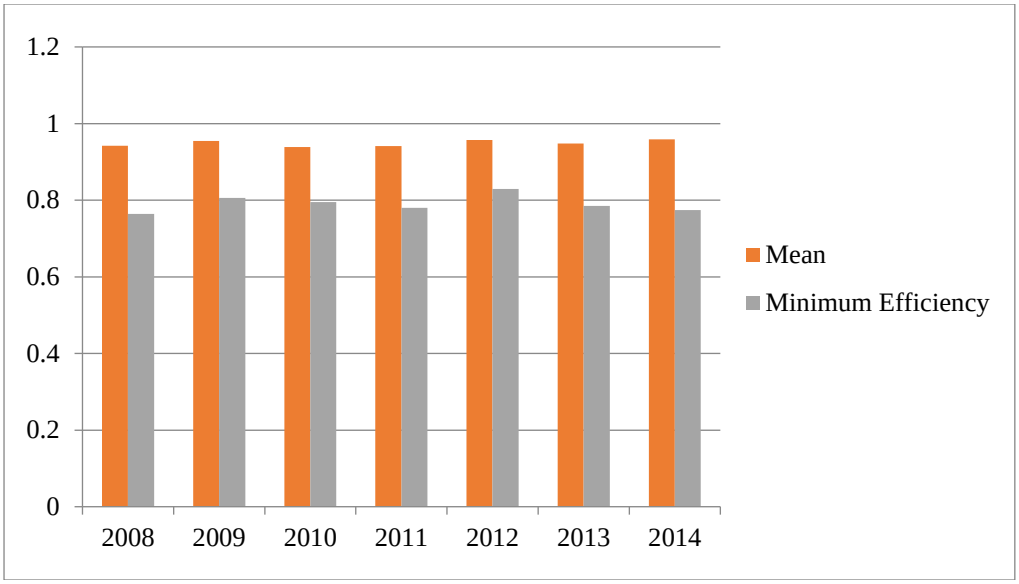

Table 6.3: Descriptive Statistical Analysis of Input Oriented CRS Efficiency scores (DMU wise Analysis)

Countries	Mean	Median	Standard Deviation	Minimum Efficiency	Maximum efficiency	No. of times on the Frontier
Australia	1.00	1.00	0.01	0.98	1.00	6
Belgium	0.84	0.86	0.04	0.76	0.87	0
Chile	1.00	1.00	0.00	1.00	1.00	7
Czech Republic	1.00	1.00	0.00	1.00	1.00	7
Denmark	0.88	0.88	0.07	0.81	1.00	1
Estonia	1.00	1.00	0.00	1.00	1.00	7
Finland	1.00	1.00	0.01	0.99	1.00	6
France	0.82	0.82	0.04	0.77	0.87	0
Germany	0.98	0.98	0.02	0.96	1.00	1
Hungary	0.94	0.95	0.06	0.84	1.00	2
Iceland	1.00	1.00	0.00	1.00	1.00	7
Ireland	0.89	0.88	0.07	0.80	1.00	1
Israel	0.98	0.99	0.02	0.94	1.00	3
Italy	0.94	0.95	0.05	0.86	1.00	1
Japan	1.00	1.00	0.00	1.00	1.00	7
Korea	1.00	1.00	0.00	1.00	1.00	7
Latvia	1.00	1.00	0.01	0.99	1.00	6
Mexico	1.00	1.00	0.00	1.00	1.00	7
Norway	0.99	1.00	0.01	0.97	1.00	4
Netherlands	0.88	0.87	0.04	0.83	0.94	0
Poland	0.96	0.95	0.03	0.91	1.00	1
Slovenia	0.93	0.93	0.06	0.86	1.00	1
Spain	1.00	1.00	0.00	1.00	1.00	7
Sweden	0.93	0.96	0.06	0.84	0.99	0
Switzerland	0.82	0.83	0.03	0.78	0.86	0

Turkey	1.00	1.00	0.00	1.00	1.00	7
United States	0.84	0.84	0.04	0.77	0.91	0

(Source: Author's own calculations)

Table 6.4: Frequency distribution of Input Oriented CRS Efficiency Scores (2008-2014)

Efficiency range	2008	2009	2010	2011	2012	2013	2014
1	13.0	14.0	13.0	14.0	13.0	14.0	15.0
0.90-0.99	7.0	8.0	6.0	4.0	6.0	6.0	7.0
0.80-0.89	5.0	5.0	7.0	8.0	8.0	6.0	4.0
0.70-0.79	2.0	0.0	1.0	1.0	0.0	1.0	1.0
Total	27.0	27.0	27.0	27.0	27.0	27.0	27.0

(Source: Author's own calculations)

6.2: Input Oriented VRS Efficiency of 27 OECD countries

Input Oriented CRS efficiency scores are given in table 6.5. Descriptive statistical analysis is for 2008-2014 is depicted in table 6.6. Country wise descriptive analysis is given in Table 6.7. The figure 6.2 shows the graph between mean and minimum efficiency scores. Table 6.8 shows the frequency distribution of VRS scores of efficiency.

Table 6.5: Input oriented VRS efficiency scores

Countries	2008	2009	2010	2011	2012	2013	2014
Australia	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Belgium	0.77	0.87	0.86	0.84	0.88	0.87	0.88
Chile	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Czech Republic	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Denmark	1.00	0.81	0.81	0.85	0.91	0.94	0.93
Estonia	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Finland	1.00	1.00	1.00	1.00	1.00	1.00	1.00
France	1.00	1.00	0.86	0.84	0.85	0.80	0.80
Germany	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hungary	0.854	0.92	0.95	1.00	1.00	1.00	1.00
Iceland	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ireland	0.87	1.00	1.00	1.00	1.00	1.00	1.00
Israel	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Italy	0.91	0.92	0.96	1.00	1.00	0.97	1.00
Japan	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Korea	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Latvia	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mexico	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Norway	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Netherlands	1.00	0.99	0.94	0.89	0.98	0.95	0.97
Poland	0.91	0.94	0.94	0.99	0.98	0.97	1.00
Slovenia	1.00	0.93	0.90	0.88	1.00	0.87	1.00
Spain	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Sweden	1.00	1.00	1.00	0.85	1.00	1.00	1.00
Switzerland	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Turkey	1.00	1.00	1.00	1.00	1.00	1.00	1.00
United States	0.91	0.96	0.86	0.87	0.88	0.86	0.84

(Source: Author's own calculations)

6.6: Descriptive Statistical Analysis of Input Oriented VRS Efficiency scores (Year wise Analysis)

Input Oriented VRS Efficiency	2008	2009	2010	2011	2012	2013	2014
Mean Efficiency	0.97	0.98	0.97	0.96	0.98	0.97	0.98
Minimum Efficiency	0.77	0.81	0.81	0.84	0.85	0.80	0.80
Median	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Standard Deviation	0.06	0.05	0.06	0.06	0.04	0.06	0.05
Maximum Efficiency	1.00	1.00	1.00	1.00	1.00	1.00	1.00
No of efficient units	20	19	18	18	20	19	21

(Source: Author's own calculations)

Figure 6.2: Comparison of Mean and Minimum efficiency scores under VRS

The graphical comparison of mean and minimum efficiency is given in figure 6.2. Mean efficiency is less elastic than the minimum efficiency.

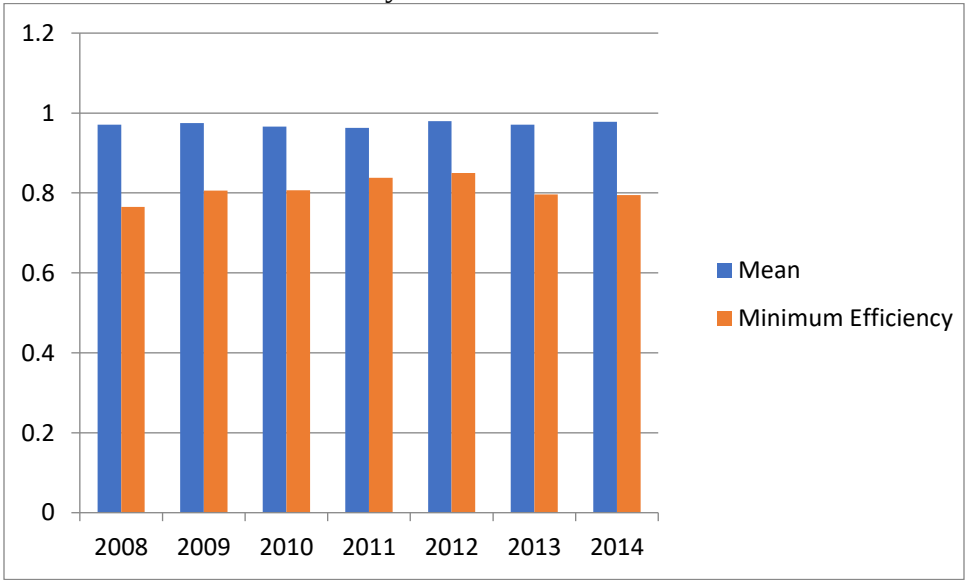

Table 6.7: Descriptive Statistical Analysis of Input Oriented VRS Efficiency scores (DMU wise Analysis)

Countries	Mean	Median	Standard Deviation	Minimum Efficiency	Maximum efficiency	No. of times on the Frontier
Australia	1.00	1.00	0.00	1.00	1.00	7
Belgium	0.85	0.87	0.04	0.77	0.88	0
Chile	1.00	1.00	0.00	1.00	1.00	7
Czech Republic	1.00	1.00	0.00	1.00	1.00	7
Denmark	0.89	0.91	0.07	0.81	1.00	1
Estonia	1.00	1.00	0.00	1.00	1.00	7
Finland	1.00	1.00	0.00	1.00	1.00	7
France	0.88	0.85	0.09	0.98	1.00	2

Germany	1.00	1.00	0.00	1.00	1.00	7
Hungary	0.96	1.00	0.06	0.85	1.00	3
Iceland	1.00	1.00	0.00	1.00	1.00	7
Ireland	0.98	1.00	0.05	0.87	1.00	6
Israel	1.00	1.00	0.00	1.00	1.00	7
Italy	0.97	0.97	0.04	0.91	1.00	2
Japan	1.00	1.00	0.00	1.00	1.00	7
Korea	1.00	1.00	0.00	1.00	1.00	7
Latvia	1.00	1.00	0.00	1.00	1.00	7
Mexico	1.00	1.00	0.00	1.00	1.00	7
Norway	1.00	1.00	0.00	1.00	1.00	7
Netherlands	0.96	0.97	0.03	0.89	1.00	1
Poland	0.96	0.97	0.03	0.91	1.00	1
Slovenia	0.94	0.93	0.06	0.87	1.00	3
Spain	1.00	1.00	0.00	1.00	1.00	7
Sweden	0.98	1.00	0.06	0.85	1.00	6
Switzerland	1.00	1.00	0.01	1.00	1.00	6
Turkey	1.00	1.00	0.00	1.00	1.00	7
United States	0.89	0.87	0.04	0.84	0.96	0

(Source: Author's own calculations)

Table 6.8: Frequency distribution of Input Oriented VRS Efficiency Scores (2008-2014)

Efficiency range	2008	2009	2010	2011	2012	2013	2014
1	21.0	19.0	18.0	18.0	20.0	19.0	21.0
0.90-0.99	3.0	6.0	5.0	2.0	4.0	4.0	3.0
0.80-0.89	2.0	2.0	4.0	7.0	3.0	3.0	2.0
0.70-0.79	1.0	0.0	0.0	0.0	0.0	1.0	1.0
Total	27	27	27	27	27	27	27

(Source: Author's own calculations)

6.3: Scale Efficiency of 27 OECD countries

Scale efficiency is calculated by dividing CRS efficiency score with VRS efficiency scores. scale efficiency scores are calculated and shown in table 6.9. Descriptive statistical analysis for each year is given in Table 6.10. Table 6.11 shows Descriptive Statistical Analysis according to each DMU separately. Table 6.12 shows frequency distribution of Scale Efficiency scores.

Table: 6.9. Scale Efficiency (2008-2014) scores

Countries	2008	2009	2010	2011	2012	2013	2014
Australia	0.98	1.00	1.00	1.00	1.00	1.00	1.00
Belgium	1.00	1.00	1.00	1.00	0.99	0.97	0.98
Chile	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Czech Republic	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Denmark	1.00	1.00	1.00	0.99	0.97	0.94	0.98
Estonia	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Finland	1.00	1.00	1.00	1.00	0.99	1.00	1.00
France	0.84	0.87	0.93	0.97	0.98	0.99	0.97

Germany	1.00	0.96	0.98	0.97	1.00	0.99	0.98
Hungary	0.99	0.98	0.97	0.95	1.00	1.00	0.98
Iceland	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ireland	0.92	1.00	0.81	0.88	0.87	0.91	0.95
Israel	0.94	1.00	1.00	1.00	0.99	0.97	0.97
Italy	0.95	0.95	0.97	1.00	0.98	0.98	0.98
Japan	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Korea	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Latvia	0.99	1.00	1.00	1.00	1.00	1.00	1.00
Mexico	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Norway	1.00	0.99	0.98	0.97	1.00	1.00	1.00
Netherlands	0.94	0.92	0.88	0.94	0.89	0.91	0.91
Poland	1.00	1.00	1.00	1.00	0.99	0.99	1.00
Slovenia	0.98	1.00	0.98	0.98	1.00	1.00	1.00
Spain	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Sweden	0.98	0.97	0.99	0.98	0.90	0.91	0.96
Switzerland	0.83	0.86	0.80	0.78	0.83	0.83	0.84
Turkey	1.00	1.00	1.00	1.00	1.00	1.00	1.00
United States	0.84	0.95	0.95	0.97	0.99	0.98	0.98

(Source: Author's own calculations)

Table 6.10: Descriptive Statistical Analysis of Scale Efficiency (Year wise Analysis)

Scale Efficiency	2008	2009	2010	2011	2012	2013	2014
Mean Efficiency	0.97	0.98	0.97	0.98	0.98	0.98	0.98
Minimum Efficiency	0.83	0.86	0.80	0.78	0.83	0.83	0.84
Median	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Standard Deviation	0.05	0.04	0.05	0.05	0.05	0.04	0.04
Maximum Efficiency	1.00	1.00	1.00	1.00	1.00	1.00	1.00
No of efficient units	13	16	13	15	13	14	15

(Source: Author's own calculations)

Figure 6.3: Comparison of Mean and Minimum efficiency scores of Scale Efficiency

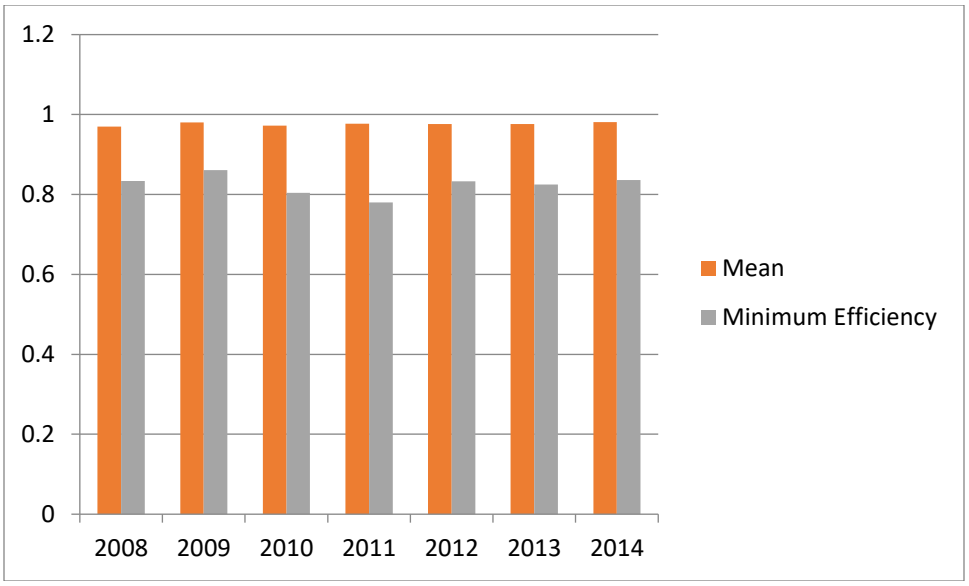

Table 6.11: Descriptive Statistical Analysis of Scale Efficiency scores (DMU wise Analysis)

Countries	Mean	Median	Standard Deviation	Minimum Efficiency	Maximum efficiency	No. of times on the Frontier
Australia	1.00	1.00	0.01	0.98	1.00	6
Belgium	0.99	1.00	0.01	0.97	1.00	2
Chile	1.00	1.00	0.00	1.00	1.00	7
Czech Republic	1.00	1.00	0.00	1.00	1.00	7
Denmark	0.98	0.99	0.02	0.94	1.00	2
Estonia	1.00	1.00	0.00	1.00	1.00	7
Finland	1.00	1.00	0.00	0.99	1.00	6
France	0.94	0.97	0.06	0.84	0.99	0
Germany	0.98	0.98	0.02	0.96	1.00	1
Hungary	0.98	0.98	0.02	0.95	1.00	2
Iceland	1.00	1.00	0.00	1.00	1.00	7
Ireland	0.91	0.91	0.06	0.81	1.00	1
Israel	0.98	0.99	0.02	0.94	1.00	3
Italy	0.97	0.98	0.02	0.95	1.00	1
Japan	1.00	1.00	0.00	1.00	1.00	7
Korea	1.00	1.00	0.00	1.00	1.00	7
Latvia	1.00	1.00	0.00	0.99	1.00	6
Mexico	1.00	1.00	0.00	1.00	1.00	7
Norway	0.99	1.00	0.01	0.97	1.00	4
Netherlands	0.91	0.91	0.02	0.88	0.94	0
Poland	1.00	1.00	0.01	0.99	1.00	1
Slovenia	0.99	1.00	0.01	0.98	1.00	2
Spain	1.00	1.00	0.00	1.00	1.00	7
Sweden	0.96	0.97	0.04	0.90	0.99	0
Switzerland	0.83	0.83	0.03	0.78	0.86	0

Turkey	1.00	1.00	0.00	1.00	1.00	7
United States	0.95	0.97	0.05	0.84	0.99	0

(Source: Author's own calculations)

Table 6.12: Frequency Distribution of Scale Efficiency scores (2008-2014)

Efficiency range	2008	2009	2010	2011	2012	2013	2014
1	13.0	16.0	14.0	15.0	13.0	14.0	15.0
0.90-0.99	11.0	10.0	10.0	10.0	10.0	12.0	11.0
0.80-0.89	3.0	1.0	3.0	1.0	4.0	1.0	1.0
0.70-0.79	0.0	0.0	0.0	1.0	0.0	0.0	0.0
Total	27	27	27	27	27	27	27

(Source: Author's own calculations)

6.4: Second stage Analysis

CRS efficiency scores: Second stage analysis can be conducted by OLS and Simple Regression Analysis but here in the proposed paper author applied Truncated Regression because efficiency scores falls between 0 and 1. There can be many other factors that are influencing the efficiency scores but here in this paper second stage analysis includes five variables along with one dummy variable. GDP per capita growth rate (GDP-PC-GR), Income Inequality (Inc-Inq), Government Stability (Govt-Stab), Human Development Index (HDI) and Dummy variable that takes 1 for Non-European and 0 for European countries. There are seven Non-European and 20 European countries among all 27 DMUs included in the analysis. For second stage Truncated Regression Analysis CRS Efficiency scores are taken as dependent variable and five independent variables are taken. Results are shown in table: 6.13.

Table: 6.13. Results for 2nd Stage Truncated Regression Analysis

CRS Efficiency scores	Coefficient	Standard Error	Z
GDP Per Capita Growth Rate	0.004570	0.004421	1.03
Income Inequality	-0.006863	0.004211	-1.63
Government Stability	0.00940	0.009796	0.96
Human Development index	-0.99370	0.428155	-2.32
Dummy variable	0.071519	0.055470	1.29
Constant	1.88416	0.431014	4.37
Sigma	0.82599	0.010719	7.71

Source: (Author's own calculations)

Truncated Regression Analysis is carried out at 95% of confidence interval. Coefficient for GDP Per Capita is .0045703 which depicts a positive relation with the efficiency scores and the values enlighten the level of change in GDP Per Capita for one unit change in efficiency score. Coefficient for income inequality confirms a negative value which means income inequality and efficiency are negatively related and value depicts the level of change in efficiency caused by income inequality that moves in conflicting direction. Government stability coefficient takes positive value and is positively related with efficiency. Coefficient for Government stability manifests the level of change in efficiency due to change in government stability. To increase one unit in efficiency score Government stability must show a rise of .009397. Human Development index is showing negative value for coefficient which does not seem sensible. Human development index must have positive impact on efficiency but the results of Truncated Regression showing an opposite impact. The reason at the back this unique conduct might be because of twofold insertion of health and education statistics in the analysis as the health and education statistics are once used as input

variables in DEA while they are also included in the construction of Human Development index. Z value for HDI is also below the critical level and is -2.32 which makes HDI statistically insignificant.

Standard Error for the Truncated Regression Analysis presents the data set for income inequality is least spread while the data set for HDI is the most spread among all variables. All Z values are statistically significant except HDI. Z values are acquired by dividing values of coefficients by the values of standard error. Acceptable range of Z value for 95% confidence interval lies between -1.96 to +1.96. GDP Per Capita and Government stability have positive Z scores that mean they are statistically significant and are positively related with efficiency. Income inequality has -1.63 Z scores and is statistically significant. It is negatively related with efficiency means efficiency and income inequality will move in opposite direction. Dummy variable is also statistically significant and takes Z value 1.29. HDI is lower than the critical level of significance and is insignificant as it is showing a contradictory relation with efficiency. HDI is a combination variable that comprised Health and Education statistics while established and these both sectors are also taken s inputs in DEA in this paper. This may be the reason behind strange behavior of HDI.

Dummy variable shows its significance by given Z value in the acceptable range. It means there is a difference among the efficiency scores of European and Non-European countries and the impact of it is strong.

Conclusion & Limitations of the Study:

There are 27 DMUs hypothesized and input oriented efficiency scores under CRS and VRS are obtained. Input oriented CRS efficiency scores show total efficiency of OECD countries for the period of seven years 2008-2014 is 94%. There are 9 DMUs that are on the frontier. Chile, Czech Republic, Estonia, Iceland, Japan, Korea, Mexico, Spain and Turkey are the countries which are most efficient ones throughout the period of investigation. Minimum efficiency scorers' countries are Belgium in year 2008, Denmark in 2009, and France in year 2010. In 2011 Switzerland is least efficient and France is the least efficient for years 2012-2014. On the whole under input oriented CRS France is the least efficient country.

Under input oriented VRS presumptions the efficiency calculations show 15 countries on frontier. These countries contain Australia, Chile, Czech Republic, Estonia, Finland, Germany, Iceland, Israel, Japan, Korea, Latvia, Mexico, Norway, Spain and Turkey. Belgium is the least proficient and resourceful country under VRS. Total efficiency of the whole period of analysis is 97%.

For scale efficiency the outcomes show that there are 9 countries on the frontier and are considered most efficient by scoring efficiency score of 1. These 9 countries include Chile, Czech Republic, Estonia, Iceland, Japan, Korea, Mexico, Spain and Turkey. Switzerland is the lowest efficiency scorer of the whole of the period. The total efficiency of whole period of investigation is 97%. Truncated Regression Analysis is applied to the efficiency scores with five explanatory variables. Efficiency scores are taken as dependent variable and independent variables include GDP Per Capita, Income Inequality, Government stability, Human Development Index and One Dummy variable. Dummy takes 0 for European and 1 for Non-European countries. Second stage examination depicts that all results and outcomes are statistically significant except Human Development Index. Human Development Index is showing a negative and contradictory relation with efficiency in the analysis. GDP Per Capita is optimistically related with efficiency and efficiency increases as GDP Per Capita Growth rate increases. Income inequality is negatively related to Efficiency scores which means as income distribution becomes more unequal efficiency scores starts falling. Government stability is positively related and will increase efficiency as it improves. Human development index is showing a strange value that might caused by binary

counting as it constitutes Health and education figures in it when is developed and the analysis is taking these statistics twice. Once as an input variable in DEA while twice as independent variable included in Human Development Index for 2nd Stage Truncated Regression Analysis. Z value for HDI is also below the critical level and is insignificant. Z values of Truncated Regression Analysis are statistically significant except HDI.

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