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DISSERTATION

ASSESSING PUBLIC SPENDING EFFICIENCY IN 20 OECD COUNTRIES

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TRABALHO FINAL DE MESTRADO

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Abstract

Being allocated a large share of a country's GDP to the public spending, would rise the question of whether these resources are distributed and allocated in an efficient manner that leads the country to go through the growth enhancing economic path or not. This study is mainly going to follow Afonso, Schuknecht, and Tanzi (2005), aiming to look at the public expenditure of 20 OECD countries for the period 2009-2013, from the perspective of efficiency and assess if these developed countries are performing efficiently compared to each other. In order to evaluate the efficiency scores, Public Sector Performance (PSP) and Public Sector Efficiency (PSE) indicators were constructed and Data Envelopment Analysis was conducted. The results of these analyses show that the only country that performed on the efficiency frontier is Switzerland. The average input-oriented efficiency score is equal to 0.732. That is, on average countries could have reduced the level of public expenditure by 26.8% and still achieved the same level of public performance. The average output-oriented efficiency score is 0.769 denoting that on average the sample countries could have increased their performance by 23.1% by employing the same level of public expenditure.

Keywords: Public Spending, Technical Efficiency, Public Sector Performance (PSP), Data Envelopment Analysis (DEA)
JEL codes: C14, C87, H40, H50, Y10

Contents

1. Introduction

Being the main element in the policy-making decisions, governments have a great responsibility to move the countries towards economic growth and to increase the social welfare. Confronting the constant budget constraints and employing the correct policies by governments is one of the crucial issues due to the pressures from globalization and ageing population on the countries budget on both expenditure and revenue sides (Deroose and Kastrop (2008)). As a large share of the GDP is allocated to the public spending, improving the public spending efficiency is an important issue that could help to ensure the sustainability of the public finances (Barrios and Schaechter (2008)). Understanding how far the governments can increase their performance at the same spending levels simply by increasing their spending efficiency could help fiscal policy makers achieving sustained fiscal disciplines (Mandl, Dierx, and Ilzkovitz (2008)) .

This study is going to assess the public spending efficiency in 20 OECD countries during the period 2009-2013. The main reason of doing this work is to recognize how well and efficient these countries are performing from both input and output perspectives. First we constructed the composite indicators on Public Sector Performance (PSP) and computed the Public Sector Efficiency (PSE), and then we implemented a non-parametric approach called Data Envelopment Analysis (DEA) for 6 different models. The first two models are considering the efficiency of the government in a macro level and the other four models assess the efficiency of public expenditure in four different core areas of government performance: administration, education, health and infrastructure.

This work follows Afonso, Schuknecht, and Tanzi (2005) with a slightly smaller country-sample due to the data availability, but with more recent data, and substituting FDH with the DEA approach. The reason that we preferred DEA to FDH is the higher accuracy of the DEA in the results due to the convexity assumption.

DEA results obtained from running model 1 and 2 show that Switzerland by applying the lowest amount of public expenditure could achieve the highest level of performance in this sample and it's the only country that is performing on the efficiency frontier with a significant distance from the other countries. The results of running the DEA for the other models suggest that governments of these countries are performing more efficiently in the health and education systems than in the administration and infrastructure functions.

Our results are highly in line with the results of the previous studies in this subject (e.g. St. Aubyn et al. (2009), Afonso, Schuknecht, and Tanzi (2005), etc.) suggesting that the governments could get a higher level of performance by spending at the same level or that they could obtain the same level of performance by spending less. The average input-oriented efficiency score is equal to 0.732. That is, on average countries could have reduced the level of inputs by 26.8% and achieve the same outputs. The average output-oriented efficiency score is 0.769 denoting that on average the countries could have increased the level of their outputs by 23.1% by employing the same level of inputs.

The next chapter is a literature review. Chapter three introduces the methodology that is used. Chapter four describes the results of the assessment and finally chapter five concludes.

2. Literature Review

The literature on assessing the government spending efficiency has usually obtained the efficiency frontiers either by applying parametric or non-parametric approaches. Stochastic Frontier Analysis (SFA) is a popular parametric approach and Free Disposal Hull (FDH) and Data Envelopment Analysis (DEA) are the two non-parametric approaches that have been used by many researchers in order to obtain an efficiency frontier. It is worth mentioning that there haven't been too many studies in evaluating the public spending efficiency at an aggregate level.

Herrera and Pang (2005), applied FDH and DEA methodologies to compute the input and output efficiency scores of health and education public sectors of 140 countries for the period 1996 to 2002. Their results indicate that countries with higher spending levels obtained lower efficiency scores.

Afonso and St. Aubyn (2005), assessed the efficiency of the public spending for the education and health sectors across 17 and 24 OECD countries in 2000. They applied FDH and DEA approaches in order to compare the results of each method. For the education analysis they used hours per year in school and teachers per 100 students as inputs and PISA scores as output. For the health analysis they used the number of doctors, nurses and beds as inputs and infant survival and life expectancy as outputs. The results related to the comparison of these two techniques infer that some of the countries that were considered as efficient under FDH are no longer efficient according to the DEA results, and that countries could have obtained better results by applying the same level of inputs.

Afonso, Schuknecht, and Tanzi (2005), computed the Efficiency scores for 23 OECD countries for 1990 and 2000 by constructing the PSP indicators and considering the PSP scores as an input measure and public expenditure as percentage of GDP as an output measure by applying the FDH methodology. The results of their studies show that small governments obtained better performance and efficiency scores compared to the larger ones. And larger governments could have obtained the same level of performance by decreasing the level of the public expenditure.

Sutherland et al. (2007), applied both non-parametric (DEA) and parametric (SFA) approaches to assess the public spending efficiency in primary and secondary education among OECD countries. The results of school-level efficiency estimated by them suggest a high correlation between the results of both approaches. Their results show that governments could gain higher efficiency scores by decreasing the expenditure levels and keeping the performance constant.

Afonso and Fernandes (2008), assessed the public spending efficiency of 278 Portuguese municipalities for the year 2001 by applying a non-parametric approach (DEA). They constructed a composite indicator of local government performance and considered it as the output measure and the level of per capita municipal spending as the input measure of the DEA. The results of the DEA implemented by them suggest that most of these municipalities could have achieved the same level of performance by decreasing the level of the public resources application.

St. Aubyn et al. (2009), applied a two stage semi-parametric (DEA and the Tobit regression) and a parametric approach (SFA) in order to evaluate the efficiency and effectiveness of public spending on tertiary education for 26 EU countries plus Japan and the US for two different periods (1998-2001 and 2002-2005). They conclude that to be considered as good performers countries do not necessarily need to increase their spending on higher education but need to spend efficiently.

Afonso, Romero, and Monsalve (2013), computed the Public Sector Efficiency (PSE) and conducted a DEA in order to assess the public expenditure efficiency for 23 Latin American and Caribbean countries for the period 2001-2010. The output measure suggested by them is the Public Sector Performance (PSP) scores computed by constructing the composite indicator of public sector performance. The input measure is the total public spending-to-GDP ratio. They conclude that the PSE scores have an inverse correlation with the size of the governments and also that these governments could achieve the same level of output with less government spending.

Table 1 summarizes all the literature we mentioned above with their results and specific details regarding the methodology and the sample size.

Table 1: Papers on the Evaluation of the Public Spending Efficiency

Authors	Methodology	Country Coverage	Sample Period	Results
Herrera and Pang (2005)	FDH, DEA	140 countries	1996-2002	Applying a higher level of expenditures results in a lower efficiency scores
Afonso and St. Aubyn (2005)	FDH, DEA	OECD Countries	2000	Countries could obtained better results by applying the same amount on Inputs
Afonso, Schuknecht, and Tanzi (2005)	FDH	23 OECD Countries	1990 and 2000	Smaller governments performed better than larger ones Larger governments could increase their performance by decreasing the usage of resources
Sutherland et al. (2007)	DEA	OECD Countries	2003	Governments could get a better efficiency scores by decreasing the spending and keeping the outputs constant
Afonso and Fernandes (2008)	DEA	278 Portuguese municipalities	2001	Most of the municipalities could achieved a higher level of output by applying the same level of input
St. Aubyn et al. (2009)	DEA, SFA	26 EU + Japan + US	1998-2001, 2002-2005	To be a better performer countries do not necessarily need to increase spending but spend efficiently
Afonso, Romero, and Monsalve (2013)	DEA	23 Latin American and Caribbean countries	2001-2010	Inverse correlation between the PSE scores and the size of the governments Government could achieved the same level of output by spending less

3. Methodology and Data

This study's Database is compiled from various sources that are listed in table A1 and table A2 (in the Appendix). Table A1 lists several sub-indicators that are used for constructing the PSP indicators. These PSP indicators are then used as the output measure for the frontier analysis. Table A2 includes the data on various governments' expenditures area, which then could be used as the input measures for the efficiency analysis.

The methodology applied in this study includes three approaches. The first two sections explain how the PSP and PSE are constructed and the third section provides an intuitive approach to the Data Envelopment Analysis (DEA).

3.1. Public Sector Performance (PSP)

In order to compute the Public Sector Performance, we followed Afonso, Schuknecht, and Tanzi (2005). They introduced the two main components of PSP, called opportunity indicators and the traditional Musgravian indicators.

The opportunity indicator that focuses on the role of the government in providing various and accessible opportunities for individuals in the market place contains four sub-indicators. These sub-indicators reflect the governments' performance in four areas, administration, education, health and infrastructure. The administration sub-indicator comprises the same indices as it had in Afonso, Schuknecht, and Tanzi (2005), which consists of: corruption, burden of government regulation (red tape), judiciary independence and shadow economy. Besides that, we added another component called the property rights to the administration sub-indicator (following Scheubel (2015)) due to its' important role

in increasing the welfare and economic growth by providing a reliable environment for individuals and companies to invest. In order to measure the education sub-indicator, we used the secondary school enrolment rate, quality of educational System and PISA scores. For the health sub-indicator, we compiled data on the infant mortality rate and life expectancy. The infrastructure sub-indicator is measured by the quality of overall infrastructure. In order to focus on the structural changes we computed the 5-year (2009-2013) average of all the indices in constructing the opportunity indicators.

The Musgravian Indicators consist of three sub-indicators: distribution, stability and economic performance. In order to measure the PSP of distribution sub-indicator, we used the 5-year average of the Gini Coefficient (2009-2013). For the stability sub-indicator, we used the coefficient of variation of 10-year (2004-2013) GDP growth and standard deviation of 10 years (2004-2013) inflation.

Table 2: Total Public Sector Performance (PSP) indicator

Total Public Sector Performance			
Opportunity indicators		**Standard ''Musgravian'' Indicators**	
Administrative	Corruption	**Distribution**	Gini index
	Red tape		
	Judicial independence	**Stability**	Coefficient of variation of growth
	Property rights		
	Shadow economy		Standard deviation of Inflation
		Economic performance	GDP per capita (PPP)
Education	Secondary School Enrolment (gross %)		GDP growth
	PISA Scores		Unemployment
	Quality of educational system		
Health	Infant mortality		
	Life expectancy		
Public infrastructure	Infrastructure Quality		

Table 2 presents a list of the variables that we collected data on, in order to construct the PSP indicators. After having collected all data on all of the sub-indicators, we normalized all the measures by dividing the value of a specific country by the average of that measure for all the countries in the sample, in order to provide a convenient platform for comparing the results. The PSPs in each sub-indicator was then constructed by the aggregation of the measures related to each sub-indicator, after assigning equal weights to them.

In order to compute the total Public Sector Performance, we gave equal weights to each sub-indicator of opportunity and Musgravian indicators and aggregated them.

Assume there are p countries with n areas of performance, then we can determine the overall performance of the country i by:

$$PSP_i = \sum_{j=1}^{n} PSP_{ij} \text{ , } i = 1, \dots, p \text{ ; with } PSP_{ij} = f(I_k) \qquad (1)$$

where $f(I_k)$ is a function of k observable socio-economic indicators I_k.

3.2. Public Sector Efficiency

In order to compute the Public Sector Efficiency, we take into account the costs that governments have in order to achieve a certain performance level. So, we now consider the Public Expenditure as the input and relate that expenditure to its' relevant PSP indicator. We consider the government consumption as the input in obtaining the administrative performance, government expenditure in education as the input for the education performance, health expenditure is related to the health indicator of performance and public investment is considered as the input for the infrastructure performance. For the distribution indicator we consider the expenditure on Transfers and subsidies as the cost affecting

the income distribution. The stability and economic performance are related to the total expenditure. Then we weigh each area of government expenditure to its' relative output and compute the Public Sector Efficiency for each indicator and also the total PSE of each country as follows:

$$PSE_i = \sum_{j=1}^{n} \frac{PSP_{ij}}{EXP_{ij}}, i = 1, \dots, n. \qquad (2)$$

where EXP_{ij} denotes the government expenditure of the country i in the area j.Table A3 presents data on different categories of public expenditure (% of GDP) for the sample countries that are the computed 10-year average for the period 2004-2013.

3.3. Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) is an approach that assesses the relative performance and efficiency of a set of Decision-Making Units (DMUs) by using the linear programming methods in order to construct a production frontier. This method assumes the convexity of the production frontier. DEA's inceptions were first introduced by Farrell (1957) and the term DEA was used and became popular for the first time by Charnes, Cooper, and Rhodes (1978).

DEA can be conducted for the input and output-oriented analysis by assuming that the technology is constant or variable return to scale (CRS or VRS). The constant return to scale DEA model doesn't consider the constraint of convexity and also under this assumption, the efficiency scores achieved from the both input- and output-oriented specifications are equal.

Suppose there are I Decision-Making Units (DMU), each DMU uses N inputs to produce M outputs. If X is the $N \times I$ input matrix and Y is the $M \times I$ output matrix for all the I DMUs, then x_i is an input column vector and y_i is an output column vector for the i-th DMU. So for a given DMU the DEA model according to Charnes, Cooper, and Rhodes (1978) is as follow:

$$\begin{aligned} & Max_{\emptyset,\lambda}\emptyset \\ \text{Subject to } & -\emptyset y_i + Y\lambda \geq 0 \\ & x_i - X\lambda \geq 0 \\ & n1'\lambda = 1 \\ & \lambda \geq 0 \end{aligned} \qquad (3)$$

where $\emptyset$ is a scalar and $1/\emptyset$ is the output-oriented efficiency score and satisfies $0 < 1/\emptyset \leq 1$. According to Farrel (1957), if the efficiency score of a DMU is equal to 1, then the firm is performing on the efficiency frontier and considered as a technically efficient firm.

λ ($I \times 1$) is a vector of constants that measures the weights for identifying the location of the inefficient firms. The constraint $n1'\lambda = 1$ is the convexity restriction imposed on the variable returns to scale DEA model.

Figure 1: Example of the DEA frontiers

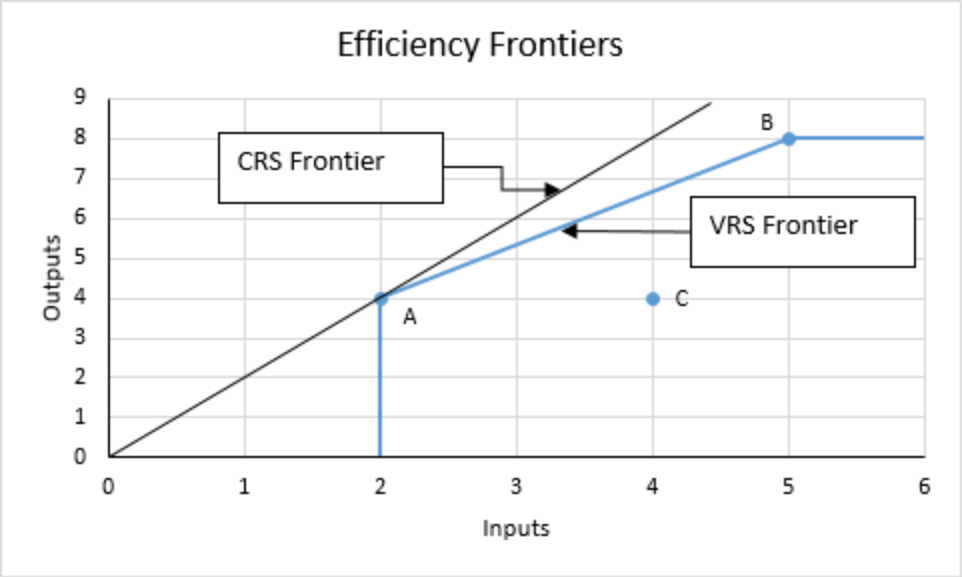


Figure 1 plots an example of the CRS and VRS DEA frontiers for three different firms. As illustrated, firms A and B are located on the VRS efficiency frontiers so they are considered as efficient DMUs. Firm A is considered efficient under CRS and VRS but firm B is not performing efficiently under CRS. Firm C is considered inefficient because it could have achieved a higher level of outputs by employing a lower level of inputs (Coelli et al. (2005)).

4. Empirical analysis

The results are presented in 3 different sections. Section 4.1 presents the results from constructing and evaluating the PSP indicator and scores. Section 4.2 provides the PSE values and finally, section 4.3 represents the efficiency scores and results of the conducted DEA models.

4.1. Public Sector Performance (PSP)

As we explained in the methodology section, we constructed the composite indicator on the public sector performance by applying different variables for both Opportunity and Musgravian indicators. Table 4 depicts the results of the PSP computations where countries with the PSP scores higher than 1 are considered as good performers. The PSP scores range from 0.56 to 1.30 suggesting that Switzerland is the best performer and Greece is the worst performer in the sample countries. The top 4 best performers are Switzerland, Luxembourg, Norway and Canada. The worse performers according to the results are Greece, Italy, Portugal and Spain.

Comparing the PSP results of each individual sub-indicator for different countries, we can observe that Switzerland and Luxembourg are the best performers in the administration area. Finland and the Netherlands are performing the best in education. In the provision of health almost all of the countries are performing well. Switzerland and Finland are the best performers in public infrastructure. We can also notice that in terms of income distribution, Norway and Finland are performing the best, in terms of stability Switzerland and Canada rank the best and Luxembourg has the best economic performance in the sample.

Table 4: Public Sector Performance (PSP) Indicators, 2009-2013

Country	Opportunity Indicators					Musgravian Indicators				Total Public Sector Performance	
	Administra-tion	Education	Health	Infrastruc-ture	PSP Opportunity	Distribution	Stability	Economic Performance	PSP Musgravian	**Equal weights**	Different weights
Austria	1,11	0,97	1,00	1,09	1,04	1,03	1,27	1,24	1,18	**1,11**	1,13
Belgium	0,88	1,08	1,00	1,01	0,99	1,05	1,17	0,98	1,07	**1,03**	1,04
Canada	1,09	1,05	1,00	1,02	1,04	0,97	1,75	1,18	1,30	**1,17**	1,21
Denmark	1,07	1,06	0,99	1,04	1,04	1,03	0,84	0,88	0,92	**0,98**	0,96
Finland	1,16	1,11	1,00	1,11	1,09	1,06	0,69	0,90	0,88	**0,99**	0,95
France	0,95	0,98	1,00	1,10	1,01	0,99	1,23	0,85	1,02	**1,02**	1,02
Germany	1,02	1,01	1,00	1,07	1,02	1,01	1,11	0,96	1,03	**1,02**	1,03
Greece	0,61	0,85	1,00	0,78	0,81	0,95	0,01	-0,03	0,31	**0,56**	0,48
Ireland	1,04	1,08	1,00	0,84	0,99	1,00	0,63	1,06	0,90	**0,94**	0,93
Italy	0,63	0,88	1,01	0,74	0,81	0,97	0,46	0,45	0,63	**0,72**	0,69
Japan	1,09	0,98	1,01	1,04	1,03	0,95	1,00	0,98	0,98	**1,00**	0,99
Luxem-bourg	1,18	0,95	1,00	1,04	1,04	1,02	1,13	1,85	1,33	**1,19**	1,23
Nether-lands	1,13	1,10	1,00	1,06	1,07	1,06	1,21	1,09	1,12	**1,09**	1,10
Norway	1,04	1,02	1,00	0,90	0,99	1,10	1,43	1,56	1,36	**1,18**	1,24
Portugal	0,77	0,94	0,99	1,05	0,94	0,94	0,29	0,37	0,53	**0,73**	0,67
Spain	0,76	0,95	1,00	1,01	0,93	0,95	0,70	0,66	0,77	**0,85**	0,82
Sweden	1,08	1,00	1,00	1,03	1,03	1,08	0,96	1,17	1,07	**1,05**	1,06
Switzer-land	1,24	1,06	1,01	1,15	1,12	1,01	1,75	1,69	1,48	**1,30**	1,36
United Kingdom	1,08	0,99	1,00	0,94	1,00	0,97	1,09	0,97	1,01	**1,01**	1,01
United States	1,10	0,94	0,99	0,99	1,00	0,87	1,28	1,21	1,12	**1,06**	1,08
Average	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	**1,00**	1,00
Maximum	1,24	1,11	1,01	1,15	1,12	1,10	1,75	1,85	1,48	**1,30**	1,36
Minimum	0,61	0,85	0,99	0,74	0,81	0,87	0,01	-0,03	0,31	**0,56**	0,48

In order to check the robustness of the results and to check if different sub-indicators have different impacts on the final results of the PSP scores, we assigned a higher weight (2/3) to the Musgravian indicators and a lower weight (1/3) to the Opportunity indicators

(instead of assigning equal weights to each indicator) by assuming that the Musgravian indicators have higher impacts on the overall performance of the public sector of a country.

The results of the robustness analysis are very similar to the PSP scores computed by assigning equal weights to each indicator. The countries that obtained a PSP score higher than average when assigning the equal weight to each indicator also achieved higher than average performance results by assigning different weights to Opportunity and Musgravian indicators. Similar results were also attained for the countries with a lower than average PSP scores.

Figure 2: Comparison of our PSP results with the results obtained by Afonso, Schuknecht, and Tanzi (2005)

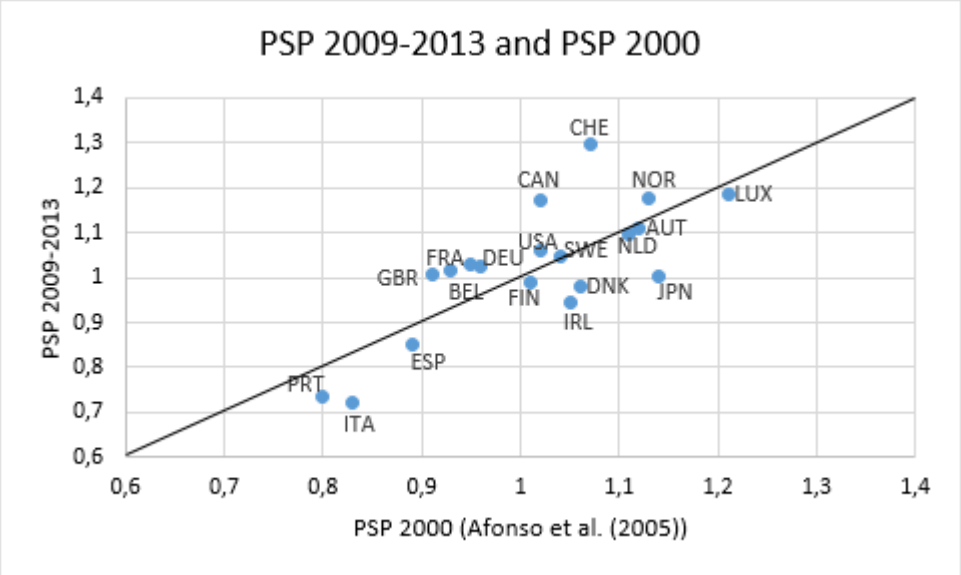


Figure 2 depicts the results of the Comparison of our PSP results with the results obtained by Afonso, Schuknecht, and Tanzi (2005) for 23 OECD countries for 2000. As we can see,

Switzerland, Canada, Norway, United States, Germany, Belgium, France and the United Kingdom have improved their performance during these years.

4.2. Public Sector Efficiency (PSE)

The following table shows the PSE scores that we computed by dividing the PSP scores of each country for different sub-indicators by the level of the relevant expenditure category. As we can see in Table 5, the PSE scores are ranging from 0.63 to 1.69. Switzerland is considered as the most efficient country among the 20 countries obtaining the PSE score of 1.69. On the other hand, Greece is considered as the least efficient country, obtaining a PSE score equal to 0.63. The other efficient countries followed by Switzerland are Luxembourg, Canada, Japan, Norway and Germany.

By considering the results of the computations of PSP and PSE at the same time, we can find that countries such as France and Sweden that are considered as good performers are not among the group of countries that are considered as efficient. Ireland on the other hand is not considered as a very good performer but performs relatively efficiently. Figure 3 illustrates these results by defining four quadrants in which these countries are situated.

Comparing the PSE results with the results obtained from the earlier work of Afonso, Schuknecht, and Tanzi (2005) on the OECD countries, we observe that Switzerland, Luxembourg, Canada, Norway, Ireland, Austria, Germany, Belgium, Sweden and France have increased the level of their Public Sector Efficiency while the other countries obtained lower PSE scores.

Table 5: Public Sector Efficiency (PSE) Indicators, 2009-2013

Country	Opportunity Indicators					Musgravian Indicators				Total Public Sector Efficiency	
	Administra-tion	Education	Health	Infrastruc-ture	PSE Opportunity	Distribution	Stability	Economic Performance	PSE Musgravian	**Equal weights**	Different Weights
Austria	1,15	0,94	0,94	1,25	1,07	0,81	1,14	1,11	1,02	**1,05**	1,04
Belgium	0,77	0,94	0,94	1,56	1,05	0,89	1,03	0,87	0,93	**1,00**	0,97
Canada	1,06	1,11	1,02	1,13	1,08	1,36	2,02	1,36	1,58	**1,30**	1,41
Den-mark	0,83	0,69	0,84	1,13	0,87	0,89	0,72	0,75	0,79	**0,84**	0,82
Finland	1,02	0,94	1,18	1,01	1,04	0,95	0,61	0,79	0,78	**0,93**	0,87
France	0,82	0,93	0,86	0,94	0,89	0,79	1,04	0,71	0,85	**0,87**	0,86
Germa-ny	1,10	1,15	0,88	1,72	1,21	0,91	1,13	0,98	1,01	**1,12**	1,08
Greece	0,60	1,18	1,18	0,63	0,90	0,85	0,01	-0,03	0,28	**0,63**	0,49
Ireland	1,20	1,09	1,24	0,85	1,09	1,25	0,69	1,17	1,04	**1,07**	1,06
Italy	0,65	1,06	1,06	0,87	0,91	0,81	0,43	0,43	0,56	**0,76**	0,68
Japan	1,14	1,42	0,97	1,07	1,15	1,12	1,18	1,16	1,15	**1,15**	1,15
Luxem-bourg	1,45	1,41	1,20	0,87	1,23	0,98	1,23	2,02	1,41	**1,31**	1,35
Nether-lands	0,92	1,10	0,84	0,93	0,95	1,40	1,23	1,11	1,25	**1,08**	1,15
Norway	1,04	0,79	0,97	0,79	0,90	1,18	1,53	1,67	1,46	**1,14**	1,27
Portugal	0,77	0,98	1,07	0,99	0,95	0,91	0,28	0,35	0,51	**0,76**	0,66
Spain	0,81	1,13	1,15	0,87	0,99	1,03	0,75	0,71	0,83	**0,92**	0,88
Sweden	0,87	0,81	0,94	0,82	0,86	1,09	0,86	1,04	1,00	**0,92**	0,95
Switzer-land	2,31	1,09	1,09	1,33	1,46	1,20	2,44	2,37	2,00	**1,69**	1,82
United Kingdom	1,05	0,98	1,00	1,18	1,05	1,09	1,11	0,98	1,06	**1,06**	1,06
United States	1,40	0,94	0,94	0,89	1,04	1,01	1,51	1,42	1,31	**1,16**	1,22
Average	1,05	1,03	1,01	1,04	1,03	1,03	1,05	1,05	1,04	**1,04**	1,04
Maxi-mum	2,31	1,42	1,24	1,72	1,46	1,40	2,44	2,37	2,00	**1,69**	1,82
Mini-mum	0,60	0,69	0,84	0,63	0,86	0,79	0,01	-0,03	0,28	**0,63**	0,49

Figure 3: Public Sector Performance and Public Sector Efficiency (2009-2013)

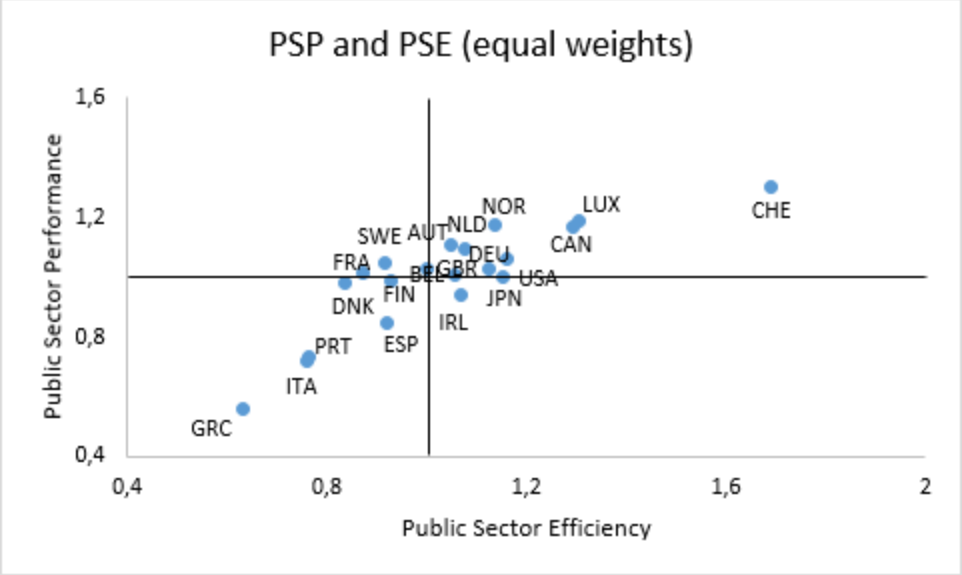
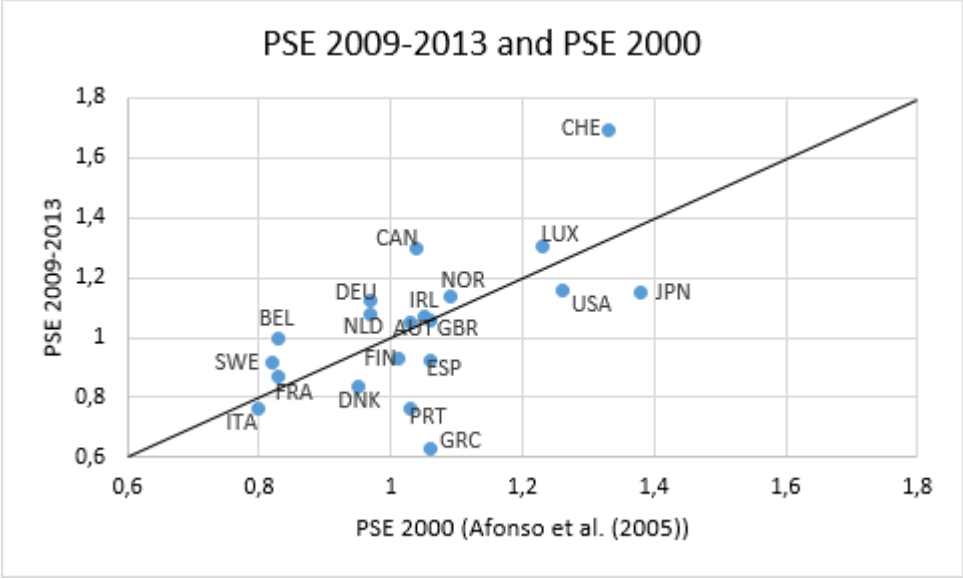


Figure 4: Comparison of our PSE results with the results obtained by Afonso, Schuknecht, and Tanzi (2005)



4.3. Data Envelopment Analysis (DEA)

We performed DEA for six different models assuming both constant and variable returns to scale. The summary of the results of these models is reported in Table 8. Model 1 assumes 1 input (the governments' normalized total spending) and 1 output (total PSP scores). The results obtained from analysing model 1 are illustrated in Table 6. According to these results, Switzerland is the only country that attains the efficiency score of 1, so it is considered to be the most efficient country of the sample in terms of the public expenditure. The least efficient country in the input-oriented analysis is France by attaining the efficiency score of 0.605 meaning that France could have actually obtained the same level of outputs by reducing the amounts of inputs by 39.5%. Considering the results of the output-oriented analysis, Greece is attaining the efficiency score of 0.431, which leads the country to be the least efficient among the other countries. This indicates that Greece could have increased the outputs level by 56.9% and by consuming the same level of the inputs.

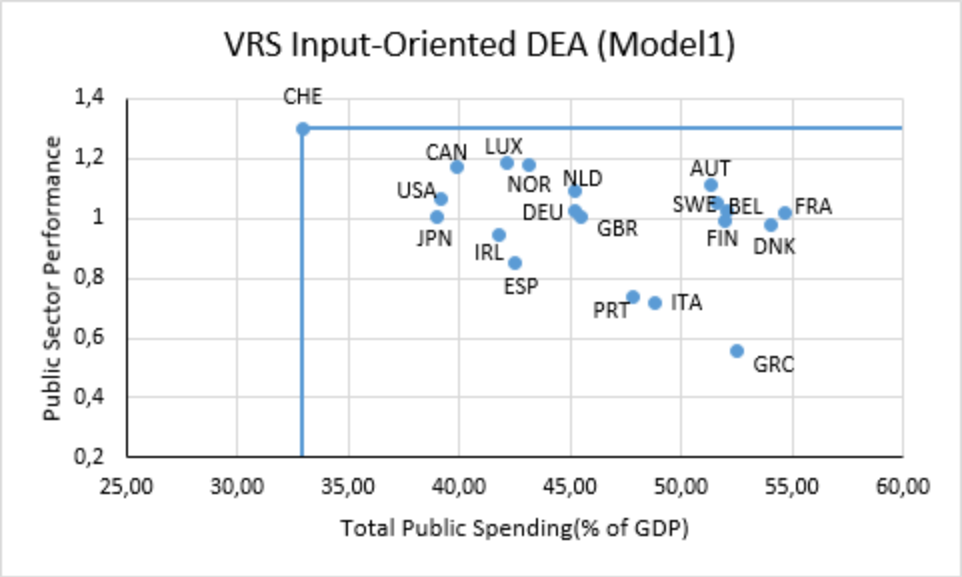
The average input-oriented efficiency score is equal to 0.732. That is, on average countries could have reduced the level of inputs by 26.8% and still achieve the same level of outputs. The average output-oriented efficiency score is 0.769 denoting that on average the sample countries could have increased the level of their outputs by 23.1% by employing the same level of inputs.

Table 6: DEA results (Model 1), 2009-2013

Model 1 - 1 Input (Normalized Total Spending), 1 Output (Total PSP scores)								
COUNTRY		CRS	INPUT ORIENTED			OUTPUT ORIENTED		
			VRS	PEERS	RANK	VRS	PEERS	RANK
Austria	AUT	0,554	0,649	CHE	14	0,854	CHE	5
Belgium	BEL	0,505	0,637	CHE	16	0,792	CHE	9
Canada	CAN	0,745	0,828	CHE	4	0,9	CHE	4
Denmark	DNK	0,464	0,615	CHE	19	0,754	CHE	15
Finland	FIN	0,485	0,637	CHE	16	0,762	CHE	14
France	FRA	0,475	0,605	CHE	20	0,785	CHE	10
Germany	DEU	0,576	0,735	CHE	9	0,785	CHE	10
Greece	GRC	0,272	0,632	CHE	18	0,431	CHE	20
Ireland	IRL	0,572	0,791	CHE	5	0,723	CHE	16
Italy	ITA	0,376	0,679	CHE	13	0,554	CHE	19
Japan	JPN	0,652	0,847	CHE	2	0,769	CHE	13
Luxembourg	LUX	0,724	0,791	CHE	5	0,915	CHE	2
Netherlands	NLD	0,616	0,735	CHE	9	0,838	CHE	6
Norway	NOR	0,695	0,766	CHE	8	0,908	CHE	3
Portugal	PRT	0,389	0,692	CHE	12	0,562	CHE	18
Spain	ESP	0,512	0,783	CHE	7	0,654	CHE	17
Sweden	SWE	0,519	0,643	CHE	15	0,808	CHE	8
Switzerland	CHE	1	1	CHE	1	1	CHE	1
United Kingdom	GBR	0,565	0,727	CHE	11	0,777	CHE	12
United states	USA	0,691	0,847	CHE	2	0,815	CHE	7
Average		0,569	0,732			0,769		
Minimum		0,272	0,605			0,431		

Figure 5 shows Model 1's variable returns to scale efficiency frontier. As we can observe Switzerland is the most efficient country and the only country that is performing on the efficiency frontier while the other countries are performing below this frontier.

Figure 5: Production Possibility Frontier (Model 1)



Model 2 assumes 2 outputs, the Opportunity PSP scores and the other one is the Musgravian PSP scores and 1 input, the governments' normalized total spending. According to the results, Switzerland is the only efficient country and France (in the input-oriented analysis) and Greece (in the output-oriented analysis) are again obtaining the least efficiency score among all the countries. The results of this model are quite similar to the results we obtained from implementing DEA on Model 1. The production possibility frontier of this model is illustrated in Figure A1 in the Appendix. Due to the existence of two outputs and one input we could only plot the production possibility frontier assuming that there exist constant returns to scale.

Table 7: DEA results, (Model 2) 2009-2013

Model 2 - 1 Input (Normalized Total Spending), 2 Output (Opportunity and Musgravian PSP scores)								
COUNTRY		CRS	INPUT ORIENTED			OUTPUT ORIENTED		
			VRS	PEERS	RANK	VRS	PEERS	RANK
Austria	AUT	0,602	0,649	CHE	14	0,929	CHE	4
Belgium	BEL	0,563	0,637	CHE	16	0,884	CHE	15
Canada	CAN	0,768	0,828	CHE	4	0,929	CHE	4
Denmark	DNK	0,571	0,615	CHE	19	0,929	CHE	4
Finland	FIN	0,62	0,637	CHE	16	0,973	CHE	2
France	FRA	0,546	0,605	CHE	20	0,902	CHE	12
Germany	DEU	0,669	0,735	CHE	9	0,911	CHE	11
Greece	GRC	0,457	0,632	CHE	18	0,723	CHE	19
Ireland	IRL	0,699	0,791	CHE	5	0,884	CHE	15
Italy	ITA	0,491	0,679	CHE	13	0,723	CHE	19
Japan	JPN	0,779	0,847	CHE	2	0,92	CHE	8
Luxembourg	LUX	0,735	0,791	CHE	5	0,929	CHE	4
Netherlands	NLD	0,702	0,735	CHE	9	0,955	CHE	3
Norway	NOR	0,704	0,766	CHE	8	0,919	CHE	10
Portugal	PRT	0,581	0,692	CHE	12	0,839	CHE	17
Spain	ESP	0,65	0,783	CHE	7	0,83	CHE	18
Sweden	SWE	0,591	0,643	CHE	15	0,92	CHE	8
Switzerland	CHE	1	1	CHE	1	1	CHE	1
United Kingdom	GBR	0,649	0,727	CHE	11	0,893	CHE	13
United states	USA	0,756	0,847	CHE	2	0,893	CHE	13
Average		0,657	0,732			0,894		
Minimum		0,457	0,605			0,723		

DEA was also conducted for the other four models. These models try to evaluate the efficiency of each country in different areas of governments' performance. Table 8 shows the summary of the results of these evaluations. Results of the Model 3 which focuses on the administrative performance suggest that governments on average could have reduced the level of their consumption by 44% and still got the same level of administrative performance. The only country that had an efficient administration is Switzerland.

Model 4 results suggest that the same education performance could have been achieved by lowering the level of expenditure on education. The results show that Finland, Japan, Luxembourg and the Netherlands are performing on the efficiency frontier.

Model 5 considers the efficiency of the public health system. The results of the DEA implemented on this model show that there exist four countries on the frontier that are considered to be efficient. These countries are Ireland, Japan, Luxembourg and Switzerland. On average the sample countries could decreased the health expenditure by 16.1% and attained the same level of health performance or they could had increased their performance by 0.8% with the same level of health expenditure. This shows that these countries on average are performing most efficiently in the health sector when compare to the other sectors.

The results of implementing DEA on Model 6 that considers the efficiency of public infrastructure shows that Germany and Switzerland are the most efficient countries in the sample in terms of public infrastructure, and on average all these governments could have reached to the same level of infrastructure outputs by decreasing the public investment by 32.7%.

These results also suggest that governments are performing more efficiently in the health and education sections than in administrative and infrastructure sections despite the fact that they apply a higher level of expenditure in administrative functions.

Due to the significant distance between the Switzerland's efficiency score and the other countries especially the least efficient ones, we decided to conduct the DEA once again

without considering Switzerland in the sample in order to acquire a more precise image of the differences in the efficiency scores.

Table 8: Summary results of different DEA models

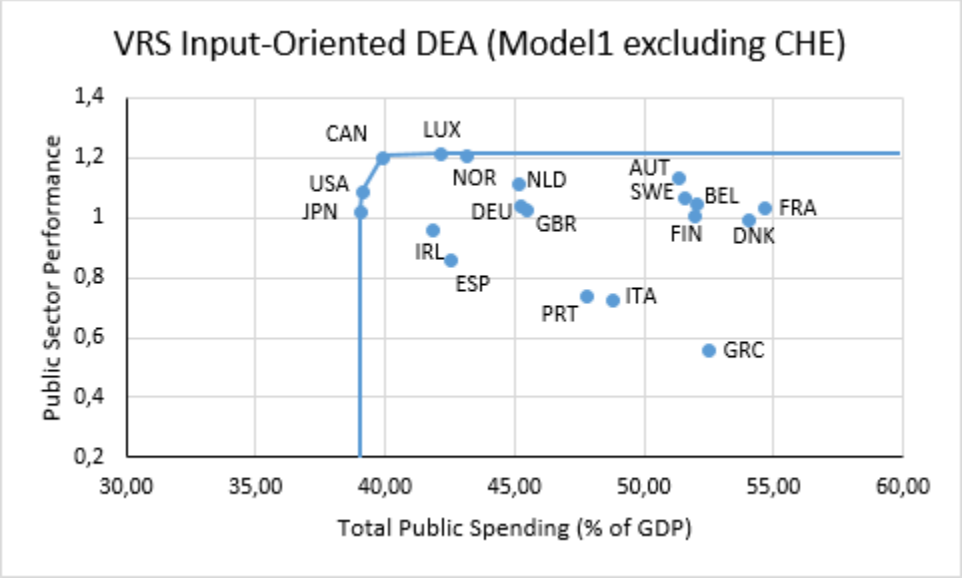
		Model 1	Model 2	Model3	Model 4	Model 5	Model 6
Inputs		Total public expenditure	Total public expenditure	Government Consumption	Education Expenditure	Health Expenditure	Public investment
Outputs		PSP	PSP Opportunity PSP Musgravian	PSP Administration	PSP Education	PSP Health	PSP infrastructure
Countries on the frontier		CHE	CHE	CHE	FIN, JPN, LUX, NLD	IRL, JPN, LUX, CHE	DEU, CHE
Average scores	**Input**	0,732	0,732	0,56	0,812	0,839	0,673
	output	0,769	0,894	0,808	0,933	0,992	0,876
Minimum score	**Input**	0,605	0,605	0,422	0,586	0,684	0,493
	Output	0,431	0,723	0,492	0,854	0,972	0,644
Total countries		20	20	20	20	20	20
Efficient countries		1	1	1	4	4	2

Table 9 shows the results of the recalculations of DEA for Model 1, excluding Switzerland from the sample. These results denote the increase in the average efficiency scores of the countries for both input and output oriented analysis. Model 1 as depicted in Figure 7, suggests that Canada, Japan, Luxembourg and the United States are performing on the efficiency frontier. Again, France and Greece are obtaining respectively the least input and output oriented efficiency scores in both models. The countries on average could have decreased the level of the public expenditure by 14.6% and still performed efficiently.

Table 9: DEA results (Model 1) excluding Switzerland, 2009-2013

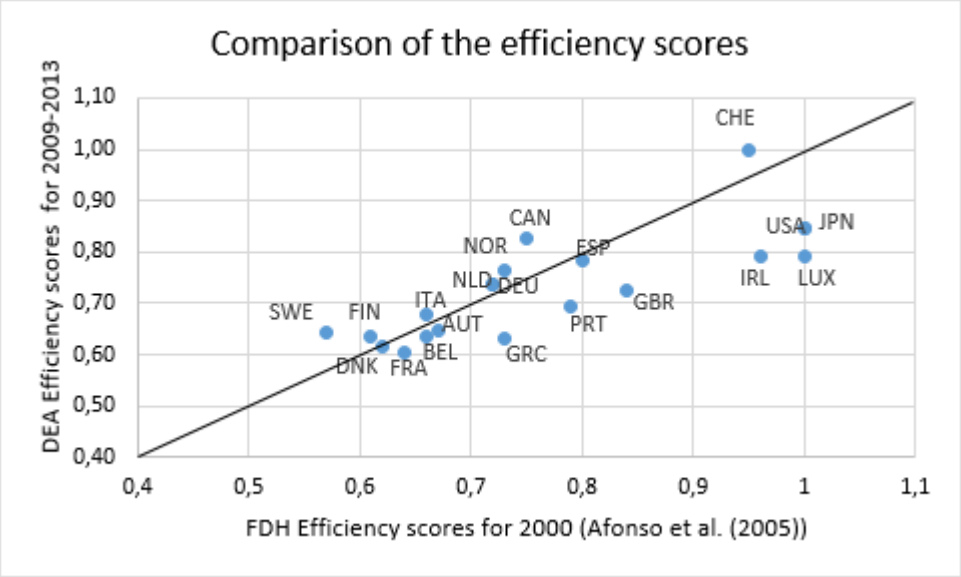
Model 1- 1 Input (Normalized Total Spending), 1 Output (Total PSP scores)								
COUNTRY	Code	CRT	INPUT ORIENTED			OUTPUT ORIENTED		
			VRT	PEERS	RANK	VRT	PEERS	RANK
Austria	AUT	0,736	0,769	CAN,USA	13	0,936	LUX	6
Belgium	BEL	0,671	0,751	USA,JPN	15	0,866	LUX	9
Canada	CAN	1	1	CAN	1	1	CAN	1
Denmark	DNK	0,612	0,722	JPN	18	0,819	LUX	14
Finland	FIN	0,643	0,751	JPN	15	0,828	LUX	13
France	FRA	0,631	0,715	USA,JPN	19	0,854	LUX	11
Germany	DEU	0,767	0,864	JPN,USA	9	0,859	LUX	10
Greece	GRC	0,353	0,744	JPN	17	0,46	LUX	19
Ireland	IRL	0,764	0,933	JPN	6	0,793	LUX,CAN	15
Italy	ITA	0,494	0,8	JPN	12	0,597	LUX	18
Japan	JPN	0,869	1	JPN	1	1	JPN	1
Luxembourg	LUX	0,958	1	LUX	1	1	LUX	1
Netherlands	NLD	0,82	0,87	CAN,USA	8	0,918	LUX	7
Norway	NOR	0,93	0,949	LUX,CAN	5	0,994	LUX	5
Portugal	PRT	0,515	0,816	JPN	11	0,61	LUX	17
Spain	ESP	0,674	0,917	JPN	7	0,711	LUX	16
Sweden	SWE	0,691	0,759	USA,JPN	14	0,882	LUX	8
United Kingdom	GBR	0,75	0,859	USA,JPN	10	0,845	LUX	12
United states	USA	0,925	1	USA	1	1	USA	1
MEAN		0,726	0,854			0,841		
MINIMUM		0,353	0,715			0,46		

Figure 6: Production Possibility Frontier (Model 1) excluding Switzerland



Although Afonso, Schuknecht, and Tanzi (2005) applied a FDH approach in order to assess the public spending efficiency and considered a bigger country-sample than what we did, we take the opportunity to compare our results from DEA, with more recent data, with the results they achieved from implementing FDH. By looking at Figure 8, we observe an improvement in the efficiency scores of Canada, Finland, Germany, Italy, Netherlands, Norway, Sweden and Switzerland during that 10-year period.

Figure 7: Comparison of the Efficiency scores of 2000 (obtained by Afonso, Schuknecht, and Tanzi (2005)) And 2009-2013



5. Conclusions

We assessed the public spending efficiency for 20 OECD countries for the period 2009-2013 by applying a non-parametric approach called Data Envelopment Analysis (DEA). In order to do so first, we constructed the composite indicators of Public Sector Performance (PSP) and Public Sector Efficiency (PSE) and then implemented the DEA approach for 6 different models by considering the level of the public spending as the input and the PSP scores as the output of our analysis.

The derived PSP scores suggest that Switzerland is the best performer among all the other countries in the sample followed by Luxembourg, Norway and Canada. The bottom performers on the other hands are Greece, Italy, Portugal and Spain. France, Denmark, Belgium, Finland, Sweden and Austria also could have performed the same by decreasing the level of their total expenditure. Comparing these results with the results from Afonso, Schuknecht, and Tanzi (2005) we can say that Switzerland, Canada, United Kingdom, France, Belgium, Germany, Norway and United States had improved their performance during this period of 10 years.

PSE results indicate that Switzerland is the most efficient country followed by Luxembourg Canada, Japan, Norway and Germany. On the other hand Greece is considered as the least efficient country. These results also propose that being a good performer doesn't necessarily mean that the country is spending in an efficient manner. We can mention at France and Sweden those of which are relatively good performers but not efficient countries. Switzerland, Canada, Germany and Belgium showed an improvement in the scores of their

public performance efficiency when comparing the results with the PSE results obtained by Afonso, Schuknecht, and Tanzi (2005).

The results of the implemented DEA for model 1 that assesses the efficiency of the public spending as a whole, show that the only country in this sample that is performing on the efficiency frontier is Switzerland and all the other countries on average could decreased the expenditure level by 26.8% and still attained the same level of performance.

According to what we observed by considering Switzerland as an outlier and excluding it from the sample and recalculating the DEA scores, countries could got the same level of outputs by decreasing the level of the public spending by 14.6%.

In summary, our results suggest that countries with a higher level of expenditures perform less efficiently than countries that have a lower level of public spending. However, following Mandl, Dierx, and Ilzkovitz (2008) we recommend individual analyses for each country to complement our analysis due to the different traditions and cultures in institutional settings, aspects of political economy, etc. and also applying a parametric analysis for checking the robustness of the results could be strongly helpful for achieving sound fiscal policies.

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Appendix

Table A1: Detailed list of output components

Sub Index	Variable	Source	Series
Opportunity Indicators			
Administration	Corruption	Transparency International's Corruption Perceptions Index (CPI) (2009-2013)	Average (5y) corruption on a scale from 10 (Perceived to have low levels of corruption) to 0 (highly corrupt)
	Red Tape	World Economic Forum: The Global competitiveness Report (2010-2015)	Average (5y) Burden of government Regulation on a scale from 7 (not burdensome at all) to 1 (extremely burdensome),(2009-2013)
	Judicial Independence	World Economic Forum: The Global competitiveness Report (2010-2015)	Average (5y) judicial independence on a scale from 7 (entirely independent) to 1 (heavily influenced),(2009-2013)
	Property Rights	World Economic Forum: The Global competitiveness Report (2010-2015)	Average (5y) property rights on a scale from 7 (very strong) to 1 (very weak), (2009-2013)
	Shadow Economy	Friedrich Schneider (2015)	%of official GDP. Reciprocal value 1/x. Average (5y) shadow economy (2009-2013)
Education	School Enrollment Secondary, gross (%)	World Bank, World Development Indicators (2009-2013)	Average (5y) Ratio of total enrollment in secondary education, (2009-2013)
	Quality of Educational System	World Economic Forum: The Global competitiveness Report (2010-2015)	Average (5y) quality of educational system on a scale from 7 (very well) to 1 (not well at all), (2009-2013)
	PISA scores	PISA Report, (2012)	Simple average of mathematics, reading and science scores
Health	Infant Mortality	World Bank, World Development Indicators (2009-2013)	Per 1000 lives birth in a given year. We used the Infant Survival Rate in our computations which is equal to: (1000-IMR)/1000. Average (5y) ISR
	Life Expectancy	World Bank World Development Indicators (2009-2013)	Average (5y) life expectancy at birth, Total (years)
Public Infrastructure	Infrastructure Quality	World Economic Forum: The Global Competitiveness Report (2010-2015)	Average (5y) infrastructure quality on a scale from 7 (extensive and efficient) to 1 (extremely underdeveloped), (2009-2013)
Standard Musgravian Indicators			
Distribution	Gini Index	Eurostat, OECD (2009-2013)	Average (5y) Gini Index on a scale from 100 (Perfect Inequality) to 0 (perfect equality), (2009-2013) Transformed to 100-Gini for better comparison

Stabilization	Coefficient of Variation of Growth	C.V= Standard Deviation/Mean	Based on GDP at constant prices (percent change) Reciprocal value 1/x
	Standard Deviation of Inflation	IMF World Economic Outlook (WEO database) 2015	Inflation, average consumer prices (percent change). Reciprocal value 1/x of the standard deviation
Economic Performance	GDP per capita	IMF World Economic Outlook (WEO database) 2015	GDP based on PPP per capita GDP, current International dollar
	GDP Growth	IMF World Economic Outlook (WEO database) 2015	Average (10y) GDP, constant prices (percent change)
	Unemployment	IMF World Economic Outlook (WEO database) 2015	Average (10y) unemployment rate, percent of total labor force Reciprocal value 1/x

Table A2: Detailed list of input components (Expenditure Categories)

Sub Index	Variable	Source	Series
Administration	Government Consumption	The World Bank (2004-2013)	Average (10y) general government final consumption expenditure (% of GDP) at current prices
Education	Public Education	UIS Statistics (2004-2013)	Average (10y) expenditure on education (% of GDP)
Health	Public Health	OECD database (2004-2013)	Average (10y) expenditure on health % of GDP
Public Infrastructure	Public Investment	European Commission, AMECO (2004-2013)	Average (10y) General government gross fixed capital formation (% of GDP) at current prices
Distribution	Expenditure on Social Protection	European Commission, AMECO (2004-2013)	Average (10y) aggregation of the social transfers other than in kind (% of GDP) and Subsidies (% of GDP) at current prices
Stabilization\ Economic Performance	Government Total Expenditure	European Commission, AMECO (2004-2013)	Average (10y) of Total Expenditure (% Of GDP)

Table A3: Public Expenditure (% of GDP) 2004-2013

Country	Government Consumption	Education	Health	Public Investment	Transfers and Subsidies	Total Spending
Austria	19,53	5,43	7,45	2,97	20,20	51,31
Belgium	23,09	6,09	7,38	2,22	18,75	52,04
Canada	20,68	4,96	6,88	3,09	11,40	39,91
Denmark	25,92	8,10	8,28	3,17	18,48	54,07
Finland	22,77	6,27	5,93	3,77	17,86	51,97
France	23,21	5,55	8,21	4,02	20,01	54,63
Germany	18,61	4,61	7,97	2,13	17,62	45,21
Greece	20,48	3,83	5,94	4,24	17,68	52,48
Ireland	17,53	5,25	5,67	3,38	12,71	41,81
Italy	19,62	4,34	6,67	2,89	19,07	48,80
Japan	19,25	3,63	7,35	3,33	13,41	39,02
Luxembourg	16,32	3,55	5,87	4,11	16,64	42,12
Netherlands	24,79	5,30	8,31	3,91	12,01	45,19
Norway	20,25	6,83	7,19	3,91	14,78	43,14
Portugal	20,14	5,09	6,49	3,64	16,36	47,82
Spain	18,89	4,45	6,13	3,99	14,64	42,54
Sweden	25,19	6,53	7,52	4,32	15,76	51,57
Switzerland	10,83	5,14	6,48	2,96	13,35	32,95
United Kingdom	20,70	5,34	7,02	2,73	14,14	45,44
United States	15,79	5,28	7,36	3,81	13,76	39,16
Average	20,18	5,28	7,01	3,43	15,93	46,06
Maximum	25,92	8,10	8,31	4,32	20,20	54,63
Minimum	10,83	3,55	5,67	2,13	11,40	32,95

Sources: The World Bank, European Commission (AMECO), OECD database, UIS Statistics

Table A4: Public Sector Performance (PSP) Indicators without Switzerland, 2009-2013

Country	Opportunity Indicators					Musgravian Indicators				Total Public Sector Performance	
	Admin-istration	Education	Health	Infrastruc-ture	PSP Opportuni-ty	Distribu-tion	Stability	Economic Perfor-mance	PSP Mus-gravian	**Equal weights**	Different weights
Austria	1,13	0,97	1,00	1,09	1,05	1,03	1,33	1,29	1,22	**1,13**	1,16
Belgium	0,89	1,08	1,00	1,02	1,00	1,05	1,23	1,02	1,10	**1,05**	1,07
Canada	1,10	1,05	1,00	1,02	1,04	0,97	1,84	1,24	1,35	**1,20**	1,25
Denmark	1,08	1,06	0,99	1,05	1,05	1,03	0,86	0,91	0,94	**0,99**	0,97
Finland	1,17	1,12	1,00	1,12	1,10	1,06	0,72	0,93	0,90	**1,00**	0,97
France	0,96	0,98	1,01	1,11	1,01	1,00	1,28	0,88	1,05	**1,03**	1,04
Germany	1,03	1,01	1,00	1,08	1,03	1,01	1,15	0,99	1,05	**1,04**	1,04
Greece	0,61	0,86	1,00	0,79	0,81	0,95	-0,01	-0,04	0,30	**0,56**	0,47
Ireland	1,05	1,09	1,00	0,85	1,00	1,00	0,66	1,10	0,92	**0,96**	0,94
Italy	0,64	0,88	1,01	0,74	0,82	0,97	0,45	0,46	0,63	**0,72**	0,69
Japan	1,10	0,98	1,01	1,05	1,04	0,95	1,03	1,02	1,00	**1,02**	1,01
Luxem-bourg	1,19	0,95	1,00	1,05	1,05	1,02	1,18	1,91	1,37	**1,21**	1,26
Netherlands	1,15	1,10	1,00	1,07	1,08	1,06	1,25	1,13	1,14	**1,11**	1,12
Norway	1,06	1,03	1,00	0,90	1,00	1,10	1,51	1,62	1,41	**1,20**	1,27
Portugal	0,78	0,94	0,99	1,06	0,94	0,94	0,28	0,38	0,53	**0,74**	0,67
Spain	0,77	0,95	1,01	1,02	0,94	0,95	0,72	0,68	0,78	**0,86**	0,83
Sweden	1,10	1,00	1,01	1,04	1,04	1,08	1,01	1,22	1,10	**1,07**	1,08
United Kingdom	1,09	0,99	1,00	0,95	1,01	0,97	1,14	1,00	1,04	**1,02**	1,03
United States	1,11	0,95	0,99	1,00	1,01	0,87	1,36	1,26	1,16	**1,09**	1,11
Average	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	**1,00**	1,00
Maximum	1,19	1,12	1,01	1,12	1,10	1,10	1,84	1,91	1,41	**1,21**	1,27
Minimum	0,61	0,86	0,99	0,74	0,81	0,87	-0,01	-0,04	0,30	**0,56**	0,47

Table A5: DEA results, (Model 3) 2009-2013

Model 3 - 1 Input (Normalized Government Consumption), 1 Output (Administration PSP scores)

COUNTRY		CRS	INPUT ORIENTED			OUTPUT ORIENTED		
			VRS	PEERS	RANK	VRS	PEERS	RANK
Austria	AUT	0,498	0,557	CHE	8	0,895	CHE	5
Belgium	BEL	0,336	0,474	CHE	16	0,71	CHE	16
Canada	CAN	0,465	0,529	CHE	13	0,879	CHE	7
Denmark	DNK	0,364	0,422	CHE	20	0,863	CHE	11
Finland	FIN	0,447	0,478	CHE	15	0,935	CHE	3
France	FRA	0,36	0,47	CHE	17	0,766	CHE	15
Germany	DEU	0,483	0,587	CHE	5	0,823	CHE	14
Greece	GRC	0,263	0,535	CHE	12	0,492	CHE	20
Ireland	IRL	0,521	0,621	CHE	4	0,839	CHE	12
Italy	ITA	0,283	0,557	CHE	8	0,508	CHE	19
Japan	JPN	0,5	0,568	CHE	7	0,879	CHE	7
Luxembourg	LUX	0,634	0,667	CHE	3	0,952	CHE	2
Netherlands	NLD	0,4	0,439	CHE	18	0,911	CHE	4
Norway	NOR	0,453	0,54	CHE	10	0,839	CHE	12
Portugal	PRT	0,335	0,54	CHE	10	0,621	CHE	17
Spain	ESP	0,352	0,574	CHE	6	0,613	CHE	18
Sweden	SWE	0,376	0,432	CHE	19	0,871	CHE	9
Switzerland	CHE	1	1	CHE	1	1	CHE	1
United Kingdom	GBR	0,457	0,524	CHE	14	0,871	CHE	9
United states	USA	0,614	0,692	CHE	2	0,887	CHE	6
Average		0,457	0,56			0,808		
Minimum		0,263	0,422			0,492		

Table A6: DEA results, (Model 4) 2009-2013

Model 4 - 1 Input(Normalized Education Expenditure)-1 Output (Education PSP scores)								
COUNTRY		CRS	INPUT ORIENTED			OUTPUT ORIENTED		
			VRS	PEERS	RANK	VRS	PEERS	RANK
Austria	AUT	0,663	0,663	JPN	16	0,881	FIN	16
Belgium	BEL	0,661	0,825	NLD	10	0,975	FIN	6
Canada	CAN	0,786	0,926	NLD	7	0,975	NLD	6
Denmark	DNK	0,488	0,586	NLD	20	0,955	FIN	10
Finland	FIN	0,657	1	FIN	1	1	FIN	1
France	FRA	0,657	0,657	JPN	17	0,889	FIN	15
Germany	DEU	0,817	0,882	NLD	9	0,962	NLD	9
Greece	GRC	0,831	0,931	LUX	6	0,857	NLD	18
Ireland	IRL	0,76	0,948	NLD	5	0,982	NLD	5
Italy	ITA	0,756	0,817	LUX	11	0,854	NLD	20
Japan	JPN	1	1	JPN	1	1	JPN	1
Luxembourg	LUX	0,998	1	LUX	1	1	LUX	1
Netherlands	NLD	0,774	1	NLD	1	1	NLD	1
Norway	NOR	0,557	0,615	NLD	18	0,919	FIN	11
Portugal	PRT	0,689	0,698	LUX	14	0,867	NLD	17
Spain	ESP	0,796	0,798	LUX	12	0,915	NLD	12
Sweden	SWE	0,568	0,598	NLD	19	0,901	FIN	13
Switzerland	CHE	0,769	0,924	NLD	8	0,974	NLD	8
United Kingdom	GBR	0,69	0,709	NLD	13	0,9	FIN	14
United states	USA	0,662	0,67	LUX	15	0,855	NLD	19
Average		0,729	0,812			0,933		
Minimum		0,488	0,586			0,854		

Table A7: DEA results, (Model 5) 2009-2013

Model 5 - 1 Input (Normalized Health Expenditure)- 1 Output (Health PSP scores)								
COUNTRY		CRS	INPUT ORIENTED			OUTPUT ORIENTED		
			VRS	PEERS	RANK	VRS	PEERS	RANK
Austria	AUT	0,76	0,76	IRL	16	0,986	JPN	14
Belgium	BEL	0,764	0,767	IRL	15	0,982	JPN	17
Canada	CAN	0,823	0,827	LUX/IRL	10	0,988	CHE/JPN	11
Denmark	DNK	0,679	0,684	IRL	20	0,979	JPN	19
Finland	FIN	0,954	0,956	IRL	6	0,994	CHE/LUX	7
France	FRA	0,694	0,741	CHE/LUX	17	0,992	JPN	9
Germany	DEU	0,71	0,711	IRL	18	0,985	JPN	16
Greece	GRC	0,952	0,954	IRL	7	0,994	LUX/CHE	7
Ireland	IRL	1	1	IRL	1	1	IRL	1
Italy	ITA	0,856	0,932	LUX/CHE	8	0,996	JPN/CHE	6
Japan	JPN	0,782	1	JPN	1	1	JPN	1
Luxembourg	LUX	0,968	1	LUX	1	1	LUX	1
Netherlands	NLD	0,682	0,69	LUX/IRL	19	0,987	JPN	13
Norway	NOR	0,789	0,802	LUX/IRL	13	0,988	CHE/JPN	11
Portugal	PRT	0,866	0,873	IRL	9	0,982	CHE/JPN	17
Spain	ESP	0,929	0,993	LUX/CHE	5	0,999	CHE/LUX	5
Sweden	SWE	0,757	0,805	LUX/CHE	12	0,991	JPN	10
Switzerland	CHE	0,884	1	CHE	1	1	CHE	1
United Kingdom	GBR	0,806	0,807	IRL	11	0,986	JPN/CHE	14
United states	USA	0,76	0,77	IRL	14	0,972	JPN	20
Average		0,821	0,839			0,992		
Minimum		0,679	0,684			0,972		

Table A8: DEA results, (Model 6) 2009-2013

Model 6 - 1 Input (Public Investment), 1 Output (Infrastructure PSP Scores)								
COUNTRY	Code	CRS	INPUT ORIENTED			OUTPUT ORIENTED		
			VRS	PEERS	RANK	VRS	PEERS	RANK
Austria	AUT	0,729	0,775	CHE/DEU	5	0,943	CHE	5
Belgium	BEL	0,907	0,959	DEU	3	0,937	CHE/DEU	6
Canada	CAN	0,657	0,69	DEU	7	0,883	CHE	13
Denmark	DNK	0,657	0,672	DEU	9	0,907	CHE	9
Finland	FIN	0,589	0,684	CHE/DEU	8	0,967	CHE	3
France	FRA	0,547	0,616	CHE/DEU	12	0,958	CHE	4
Germany	DEU	1	1	DEU	1	1	DEU	1
Greece	GRC	0,368	0,503	DEU	19	0,679	CHE	19
Ireland	IRL	0,496	0,63	DEU	11	0,73	CHE	18
Italy	ITA	0,508	0,737	DEU	6	0,644	CHE/DEU	20
Japan	JPN	0,623	0,64	DEU	10	0,904	CHE	10
Luxembourg	LUX	0,503	0,518	DEU	18	0,901	CHE	11
Netherlands	NLD	0,539	0,545	DEU	15	0,919	CHE	7
Norway	NOR	0,457	0,545	DEU	15	0,778	CHE	17
Portugal	PRT	0,576	0,585	DEU	13	0,913	CHE	8
Spain	ESP	0,506	0,534	DEU	17	0,88	CHE	14
Sweden	SWE	0,474	0,493	DEU	20	0,892	CHE	12
Switzerland	CHE	0,775	1	CHE	1	1	CHE	1
United Kingdom	GBR	0,687	0,78	DEU	4	0,833	CHE/DEU	16
United states	USA	0,517	0,559	DEU	14	0,859	CHE	15
Average		0,606	0,673			0,876		
Minimum		0,368	0,493			0,644		

Table A9: DEA results, (Model 2) excluding Switzerland 2009-2013

Model 2 - 1 Input (Normalized Total Spending), 2 Output (Opportunity and Musgravian PSP scores)								
COUNTRY	Code	CRS	INPUT ORIENTED			OUTPUT ORIENTED		
			VRS	PEERS	RANK	VRS	PEERS	RANK
Austria	AUT	0,773	0,796	JPN,CAN,NLD	14	0,984	NLD,LUX	8
Belgium	BEL	0,726	0,753	CAN,JPN	16	0,931	NLD,LUX	15
Canada	CAN	1	1	CAN	1	1	CAN	1
Denmark	DNK	0,722	0,746	NLD,JPN	17	0,96	NLD,FIN	10
Finland	FIN	0,791	1	FIN	1	1	FIN	1
France	FRA	0,693	0,712	CAN,JPN	19	0,934	NLD,FIN	14
Germany	DEU	0,851	0,859	CAN,JPN	10	0,954	NLD	11
Greece	GRC	0,577	0,741	JPN	18	0,736	FIN	19
Ireland	IRL	0,897	0,933	JPN	8	0,946	NLD,JPN	12
Italy	ITA	0,629	0,798	JPN	13	0,752	NLD,FIN	18
Japan	JPN	1	1	JPN	1	1	JPN	1
Luxembourg	LUX	0,958	1	LUX	1	1	LUX	1
Netherlands	NLD	0,895	1	NLD	1	1	NLD	1
Norway	NOR	0,965	1	NOR	1	1	NOR	1
Portugal	PRT	0,735	0,814	JPN	12	0,865	NLD,FIN	17
Spain	ESP	0,824	0,912	JPN	9	0,884	NLD,JPN	16
Sweden	SWE	0,76	0,76	CAN,JPN	15	0,963	LUX,NLD	9
United Kingdom	GBR	0,835	0,858	JPN,CAN	11	0,935	NLD	13
United states	USA	0,972	0,999	JPN,CAN	7	0,987	JPN,CAN	7
Average		0,821	0,878			0,938		
Minimum		0,577	0,712			0,736		

Table A10: DEA results, (Model 3 excluding Switzerland) 2009-2013

Model 3 - 1 Input (Normalized Government Consumption), 1 Output (Administration PSP scores)								
COUNTRY	Code	CRS	INPUT ORIENTED			OUTPUT ORIENTED		
			VRS	PEERS	RANK	VRS	PEERS	RANK
Austria	AUT	0,789	0,813	LUX,USA	7	0,944	LUX	5
Belgium	BEL	0,525	0,684	USA	15	0,743	LUX	15
Canada	CAN	0,728	0,764	USA	12	0,923	LUX	7
Denmark	DNK	0,57	0,609	USA	19	0,905	LUX	10
Finland	FIN	0,703	0,71	LUX,USA	14	0,98	LUX	3
France	FRA	0,566	0,68	USA	16	0,805	LUX	14
Germany	DEU	0,757	0,848	USA	4	0,864	LUX	13
Greece	GRC	0,41	0,771	USA	11	0,515	LUX	19
Ireland	IRL	0,823	0,901	USA	3	0,884	LUX	12
Italy	ITA	0,445	0,805	USA	8	0,535	LUX	18
Japan	JPN	0,784	0,82	USA	6	0,925	LUX	6
Luxembourg	LUX	1	1	LUX	1	1	LUX	1
Netherlands	NLD	0,633	0,646	LUX,USA	17	0,961	LUX	4
Norway	NOR	0,713	0,78	USA	10	0,885	LUX	11
Portugal	PRT	0,528	0,784	USA	9	0,651	LUX	16
Spain	ESP	0,556	0,836	USA	5	0,644	LUX	17
Sweden	SWE	0,596	0,627	USA	18	0,92	LUX	8
United Kingdom	GBR	0,723	0,763	USA	13	0,917	LUX	9
United states	USA	0,964	1	USA	1	1	USA	1
Average		0,674	0,781			0,842		
Minimum		0,41	0,609			0,515		

Table A11: DEA results, (Model 4 excluding Switzerland) 2009-2013

Model 4 - 1Input(Normalized Education Expenditure)-1 Output (Education PSP scores)								
COUNTRY	Code	CRS	INPUT ORIENTED			OUTPUT ORIENTED		
			VRS	PEERS	RANK	VRS	PEERS	RANK
Austria	AUT	0,663	0,663	JPN,LUX	15	0,879	NLD,FIN	15
Belgium	BEL	0,661	0,825	NLD,JPN	9	0,968	FIN,NLD	7
Canada	CAN	0,786	0,926	NLD,JPN	7	0,975	NLD,JPN	6
Denmark	DNK	0,488	0,586	NLD,JPN	19	0,946	FIN	9
Finland	FIN	0,663	1	FIN	1	1	FIN	1
France	FRA	0,657	0,657	JPN	16	0,887	NLD,FIN	14
Germany	DEU	0,817	0,882	NLD,JPN	8	0,962	NLD,JPN	8
Greece	GRC	0,841	0,931	LUX	6	0,867	NLD,JPN	16
Ireland	IRL	0,775	0,984	NLD,JPN	5	0,994	NLD,JPN	5
Italy	ITA	0,756	0,817	LUX	10	0,854	NLD,JPN	19
Japan	JPN	1	1	JPN	1	1	JPN	1
Luxembourg	LUX	0,998	1	LUX	1	1	LUX	1
Netherlands	NLD	0,774	1	NLD	1	1	NLD	1
Norway	NOR	0,562	0,635	NLD,JPN	17	0,92	FIN	10
Portugal	PRT	0,689	0,698	LUX	13	0,867	NLD,JPN	16
Spain	ESP	0,796	0,798	LUX	11	0,915	NLD,JPN	11
Sweden	SWE	0,568	0,598	NLD,JPN	18	0,893	FIN	13
United Kingdom	GBR	0,69	0,709	NLD,JPN	12	0,899	NLD,FIN	12
United states	USA	0,669	0,67	LUX	14	0,864	NLD	18
Average		0,729	0,809			0,931		
Minimum		0,488	0,586			0,854		

Table A12: DEA results, (Model 5 excluding Switzerland) 2009-2013

Model 5 - 1Input (Normalized Health Expenditure)- 1 Output (Health PSP scores)								
COUNTRY	Code	CRS	INPUT ORIENTED			OUTPUT ORIENTED		
			VRS	PEERS	RANK	VRS	PEERS	RANK
Austria	AUT	0,76	0,76	IRL	15	0,986	JPN	14
Belgium	BEL	0,764	0,767	IRL	14	0,982	JPN	17
Canada	CAN	0,823	0,828	LUX,IRL	9	0,99	ESP,JPN	10
Denmark	DNK	0,679	0,684	IRL	19	0,979	JPN	18
Finland	FIN	0,954	0,956	IRL	5	0,994	LUX,ESP	7
France	FRA	0,694	0,747	ESP	16	0,992	JPN	8
Germany	DEU	0,71	0,711	IRL	17	0,985	JPN	15
Greece	GRC	0,953	0,954	IRL	7	0,995	ESP,LUX	6
Ireland	IRL	1	1	IRL	1	1	IRL	1
Italy	ITA	0,856	0,956	ESP,JPN	5	0,998	ESP,JPN	5
Japan	JPN	0,782	1	JPN	1	1	JPN	1
Luxembourg	LUX	0,968	1	LUX	1	1	LUX	1
Netherlands	NLD	0,682	0,69	LUX,IRL	18	0,987	JPN	12
Norway	NOR	0,789	0,803	LUX,IRL	12	0,989	JPN,ESP	11
Portugal	PRT	0,866	0,873	IRL	8	0,985	ESP,JPN	15
Spain	ESP	0,929	1	ESP	1	1	ESP	1
Sweden	SWE	0,757	0,81	LUX,ESP	10	0,991	JPN	9
United Kingdom	GBR	0,806	0,808	IRL	11	0,987	ESP,JPN	12
United states	USA	0,76	0,77	IRL	13	0,972	JPN	19
Average		0,817	0,848			0,990		
Minimum		0,679	0,684			0,972		

Table A13: DEA results, (Model 6 excluding Switzerland) 2009-2013

Model 6 - 1 Input (Public Investment), 1 Output (Infrastructure PSP Scores)								
COUNTRY	Code	CRS	INPUT ORIENTED			OUTPUT ORIENTED		
			VRS	PEERS	RANK	VRS	PEERS	RANK
Austria	AUT	0,728	0,858	FIN,DEU	4	0,991	FIN,DEU	3
Belgium	BEL	0,915	0,969	DEU	3	0,943	FIN,DEU	9
Canada	CAN	0,658	0,697	DEU	8	0,925	FIN,DEU	11
Denmark	DNK	0,655	0,674	DEU	9	0,95	FIN,DEU	6
Finland	FIN	0,59	1	FIN	1	1	FIN	1
France	FRA	0,549	0,838	FIN,DEU	5	0,991	FIN	3
Germany	DEU	1	1	DEU	1	1	DEU	1
Greece	GRC	0,369	0,504	DEU	18	0,705	FIN	18
Ireland	IRL	0,498	0,633	DEU	11	0,765	FIN,DEU	17
Italy	ITA	0,506	0,738	DEU	7	0,674	FIN,DEU	19
Japan	JPN	0,628	0,646	DEU	10	0,947	FIN,DEU	8
Luxembourg	LUX	0,507	0,521	DEU	17	0,937	FIN	10
Netherlands	NLD	0,544	0,549	DEU	14	0,955	FIN	5
Norway	NOR	0,457	0,549	DEU	14	0,804	FIN	16
Portugal	PRT	0,58	0,59	DEU	12	0,949	FIN,DEU	7
Spain	ESP	0,505	0,534	DEU	16	0,911	FIN	13
Sweden	SWE	0,473	0,496	DEU	19	0,92	FIN	12
United Kingdom	GBR	0,69	0,785	DEU	6	0,868	FIN,DEU	15
United states	USA	0,522	0,564	DEU	13	0,893	FIN	14
Average		0,599	0,692			0,901		
Minimum		0,369	0,496			0,674		

Table A14: Public Sector Efficiency (PSE) Indicators excluding Switzerland, 2009-2013

Country	Opportunity Indicators					Musgravian Indicators				Total Public Sector Efficiency	
	Administra-tion	Education	Health	Infrastruc-ture	PSE Opportunity	Distribution	Stability	Economic Perfor-mance	PSE Musgravian	**Equal weights**	Different Weights
Austria	1,19	0,95	0,94	1,27	1,09	0,82	1,22	1,17	1,07	**1,08**	1,08
Belgium	0,79	0,94	0,94	1,58	1,07	0,90	1,11	0,91	0,97	**1,03**	1,00
Canada	1,10	1,12	1,02	1,15	1,10	1,37	2,16	1,45	1,66	**1,34**	1,47
Denmark	0,86	0,69	0,84	1,15	0,89	0,90	0,75	0,79	0,81	**0,85**	0,84
Finland	1,06	0,94	1,18	1,03	1,05	0,95	0,64	0,84	0,81	**0,95**	0,89
France	0,85	0,93	0,86	0,96	0,90	0,80	1,10	0,75	0,88	**0,89**	0,89
Germany	1,14	1,16	0,88	1,75	1,23	0,92	1,19	1,03	1,05	**1,15**	1,11
Greece	0,62	1,18	1,18	0,64	0,91	0,86	-0,01	-0,04	0,27	**0,63**	0,48
Ireland	1,24	1,09	1,24	0,87	1,11	1,27	0,73	1,23	1,08	**1,10**	1,09
Italy	0,67	1,07	1,06	0,89	0,92	0,82	0,43	0,44	0,57	**0,77**	0,68
Japan	1,18	1,42	0,97	1,09	1,17	1,13	1,23	1,22	1,20	**1,18**	1,19
Luxembourg	1,51	1,42	1,20	0,88	1,25	0,98	1,31	2,13	1,47	**1,35**	1,40
Netherlands	0,96	1,10	0,84	0,94	0,96	1,42	1,29	1,17	1,29	**1,10**	1,18
Norway	1,08	0,80	0,97	0,80	0,91	1,19	1,64	1,76	1,53	**1,18**	1,32
Portugal	0,80	0,98	1,07	1,01	0,96	0,92	0,28	0,37	0,52	**0,77**	0,67
Spain	0,84	1,13	1,15	0,88	1,00	1,04	0,79	0,75	0,86	**0,94**	0,91
Sweden	0,90	0,81	0,94	0,83	0,87	1,10	0,92	1,10	1,04	**0,94**	0,98
United Kingdom	1,09	0,98	1,00	1,20	1,07	1,10	1,17	1,03	1,10	**1,08**	1,09
United States	1,46	0,95	0,94	0,90	1,06	1,02	1,62	1,50	1,38	**1,20**	1,27
Average	1,02	1,04	1,01	1,04	1,03	1,03	1,03	1,03	1,03	**1,03**	1,03
Maximum	1,51	1,42	1,24	1,75	1,25	1,42	2,16	2,13	1,66	**1,35**	1,47
Minimum	0,62	0,69	0,84	0,64	0,87	0,80	-0,01	-0,04	0,27	**0,63**	0,48

Table A15: Summary results of different DEA models excluding Switzerland

		Model 1	Model 2	Model3	Model 4	Model 5	Model 6
Inputs		Total public expendi-ture	Total public expendi-ture	Government Consumption	Education Expendi-ture	Health Expendi-ture	Public investment
Outputs		PSP	PSP Oppor-tunity PSP Mus-gravian	PSP Administra-tion	PSP Educa-tion	PSP Health	PSP infrastruc-ture
Countries on the frontier		CAN, JPN, LUX, USA	CAN, FIN, JPN, LUX, NLD, NOR	LUX, USA	FIN, JPN, LUX, NLD	IRL, JPN, LUX, ESP	FIN, DEU
Average scores	**Input**	0,854	0,878	0,781	0,809	0,848	0,692
	out-put	0,841	0,938	0,842	0,931	0,990	0,901
Mini-mum scores	**Input**	0,715	0,712	0,609	0,586	0,684	0,496
	Out-put	0,46	0,736	0,515	0,854	0,972	0,674
Total countries		19	19	19	19	19	19
Efficient countries		4	6	2	4	4	2

Figure A1: Production Possibility Frontier (Model 2)

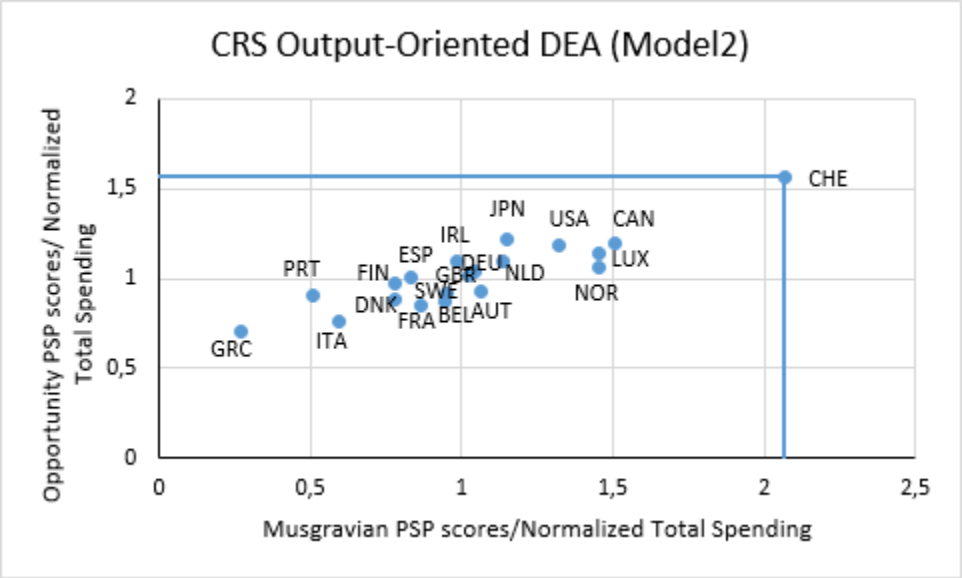

Figure A2: Production Possibility Frontier (Model 2) excluding Switzerland