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Better public spending for better future: Analyzing the Influence of Democratic Governance on Public Expenditure Efficiency

Diploma thesis

2024 **Bc. Marco Majerčák**

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ABSTRAKT

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The final thesis is developed on the topic Better public spending for a better future: Analyzing the Influence of Democratic Governance on Public Expenditure Efficiency. The aim of the thesis was to determine the influence of democratic governance on the efficiency of public expenditure. In the first step, we defined optimal indicators representing the outcomes of public spending in three areas: Health, Education, and Social protection. In the next step, we linked the results with expenditures to determine the efficiency of public spending using Data Envelopment Analysis on a sample of 70 countries worldwide. The results indicate higher efficiency in public finance management in European countries, which, on average, have just a 6% potential for growth in these areas. In the final part of our work, we analyzed the influence of democratic governance on the efficiency of public spending from our previous models. From our findings, it is clear that there is a positive and significant impact of democracy on the growth of efficiency in public spending, especially in the areas of Health and Social Protection.

Key words: Democracy, Data Envelopment Analysis, Public spending efficiency

ABSTRAKT

MAJERČÁK, Marco: *Lepšie verejné výdavky pre lepšiu budúcnosť: Analýza vplyvu demokratického vládnutia na efektívnosť verejných výdavkov*. – Ekonomická univerzita v Bratislave. Národohospodárska fakulta; Katedra hospodárskej politiky. –Vedúci záverečnej práce: Ing. Peter Mandžák, Ph.D. – Bratislava: NHF EU, 2024, 52 s.

Záverečná práca je spracovaná na tému Lepšie verejné výdavky pre lepšiu budúcnosť: Analýza vplyvu demokratického vládnutia na efektívnosť verejných výdavkov. Cieľom diplomovej práce bolo zistiť vplyv demokratického vládnutia na efektívnosť verejných výdavkov. V prvom kroku sme definovali optimálne ukazovatele reprezentujúce výsledky verejných výdavkov v troch oblastiach: Zdravotníctvo, Školstvo a Sociálna ochrana. V ďalšom kroku sme výsledky prepojili s výdavkami na určenie efektívnosti verejných výdavkov pomocou Data Envelopment Analysis na vzorke 70 krajín sveta. Výsledky naznačujú vyššiu efektívnosť riadenia verejných financií v európskych krajinách, ktoré majú v priemere len 6 % potenciál rastu výsledkov v daných oblastiach. V záverečnej časti našej práce sme analyzovali vplyv demokratického vládnutia na efektívnosť verejných výdavkov z našich predchádzajúcich modelov. Z našich zistení je zrejmé, že demokracia má pozitívny a významný vplyv na rast efektívnosti verejných výdavkov, najmä v oblastiach zdravotníctva a sociálnej ochrany.

Kľúčové slová: Demokracia, Analýza obalu dát, Efektívnosť verejných výdavkov

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I would like to express my gratitude primarily to my supervisor, whose guidance and expertise significantly contributed to the improvement of the quality, methodology, and outcomes of this work. I would also like to thank the members of the Department of Economic Policy for their constant willingness to assist on any topic.

List of Abbreviations

AL	Albania
AT	Austria
BY	Belarus
BE	Belgium
BG	Bulgaria
HR	Croatia
CY	Cyprus
CZ	Czechia
DK	Denmark
EE	Estonia
FI	Finland
FR	France
GE	Georgia
DE	Germany
GR	Greece
HU	Hungary
IS	Iceland
IE	Ireland
IT	Italy
XK	Kosovo
LV	Latvia
LT	Lithuania
LU	Luxembourg
MT	Malta
MD	Moldova
NL	Netherlands
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
RS	Serbia
SK	Slovak Republic
SI	Slovenia
ES	Spain
SE	Sweden
CH	Switzerland
UA	Ukraine
GB	United Kingdom

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1 Introduction

In recent years, the role of government spending in enhancing citizens' well-being has become a topic of increasing debate. Governments allocate and redistribute resources to fulfil specific functions, with the aim of improving living standards. However, in light of various crises, the scope of government expenditure has expanded significantly, leading to a rise in national debt levels. Consequently, there is growing emphasis on enhancing the efficiency of handling public expenditure to improve outcomes within the current level of government spending.

On the other hand, several studies indicate that citizens have increasingly supported political representatives who deviate from traditional democratic processes, thereby diminishing the overall level of democratic governance (Human Development Report, 2024). Primary goal of this study is to analyze whether this decline in democratic governance could also affects the efficiency of public finance management.

Previous research on public spending efficiency has typically relied on a limited set of indicators or focused on a small sample of countries, which could distort results. Studies might be confined to specific regions like the OECD countries or EU, or they might use only a few indicators to assess a country's performance. This creates a gap in our understanding of public spending effectiveness when examined comprehensively across a wider range of indicators and a larger, global sample of countries.

The influence of democracy on public expenditure management has primarily been analysed at the regional level, with less emphasis on in-depth international comparisons. Therefore, examining how democracy affects public spending efficiency is not only timely due to the global decline in democratic governance, but it also contributes valuable insights to the academic study of factors influencing public spending efficiency.

This study analyzes the efficiency of public expenditures across a sample of 70 countries worldwide, focusing on the three largest spending categories: Education, Health, and Social Protection. For each category, a separate Performance Index has been constructed, comprising representative several outcome indicators used as outputs for efficiency models. The models incorporate two inputs: expenditure as a proportion of GDP and per capita PPP expenditure for each category. The efficiency analysis utilizes the Data Envelopment Analysis approach, consistent with prior literature (further details in the Literature Review section).

The efficiency findings indicate that European countries achieve the highest levels of efficiency in public spending across continents, while African nations demonstrate the lowest efficiency rates. European countries, on average, have potential to improve results by 6%, compared to up to 29% for African countries, within their current spending levels. Notably, the widest efficiency gap between countries is observed in Education.

However, the primary objective of this study is to assess the influence of a country's level of democracy on its efficiency in public spending. In the subsequent stage of analysis, Ordinary Least Squares (OLS) and Tobit regression techniques are employed to explore the impact of the Democracy Index on efficiency outcomes derived from DEA models. The regression results consistently confirm a significant and positive correlation between democracy and the management of public expenditures across most models. Thus, supporting our hypothesis regarding increased efficiency in public spending within more democratic countries globally.

2 Literature review

The efficiency of the public sector is a topic of growing interest due to its well-established link to public well-being (Grigoli et al, 2012). Efficient allocation of public resources, particularly in healthcare, education, and social protection, demonstrably improves living standards. Affordable and high-quality healthcare, education, and social programs foster a healthier, more educated, and productive citizens. This, in turn, translates to lower poverty rates, reduced crime, and a more equitable society. Ultimately, measuring and evaluating efficiency of public spending in these core areas is essential for building a sustainable and just society with a high overall standard of living.

Two methods are commonly used to measure efficiency: parametric and non-parametric methods (Porcelli, 2009). Non-parametric methods are employed in most publications that assess the effectiveness of public administration expenditures (e.g., Herrera et al, 2005). Several papers focus on specific areas of public spending efficiency using the non-parametric approach, such as education and healthcare spending (Prasetyo et al, 2013), social security (Antonelli, 2018), or public infrastructure (IMF, 2020). There are relatively fewer papers that address the efficiency of public spending as a whole. Afonso et al. (2005, 2020) focus directly on the calculation of the non-parametric efficiency of general public spending. They utilizes the Public Sector Performance Index (PSP) as an output and Public Expenditure to GDP as an input to measure the effectiveness of public expenditure. The PSP index methodology is divided into two sub-index groups: Opportunity indicators (Administration, Education, Health, Public Infrastructure) and Musgravian indicators (Distribution, Stabilization, Economic Performance)[1]. Their results indicate that the appropriate overall input efficiency score for public spending among the 36 OECD countries during the period 2006-17 ranged from 60% to 70%.

Another publication assessed the effectiveness of public spending partially in various areas, including Education, Health, Economic Affairs, General Public Services, Social Security and Welfare, Performance, and Stability (Adam et al, 2011). For each area, they assigned public expenditure per area in proportion to GDP as an input and used separate Key Performance Indicators (KPIs) as outputs. The KPIs for these areas slightly differed from Afonso's approach. For example, Afonso employs the PISA score as a KPI for education,

[1] The authors categorized the indicators into the mentioned two groups based on the primary functions expected from the state. The first group, referred to as "opportunity indicators," are designed to foster opportunities and establish fair competition in the markets. On the other hand, Musgravian indicators reflect the role of public finances in allocation, distribution, and stabilization.

whereas Adam does not utilize it. The results from Adam's publication include efficiencies for individual areas within countries (e.g., Education, Schooling, etc.).

In Japan, the measurement of the efficiency of public spending was used to determine the potential for consolidating public spending. Several Data Envelopment Analysis (DEA) models were created for individual areas (Education, Health, Administration, and Non-pension Social Protection). Subsequently, the resulting efficiencies were averaged, revealing that the total input efficiency of Japanese public spending is 78% (Monfort, 2015).

In a recent study, Adam et al (2020) focused more on a larger sample of countries to evaluate the effectiveness of public spending. Previous research primarily focused on evaluating the efficiency of public administration in developed countries within the OECD. However, given the robustness of the results, this publication expanded its examination to include up to 114 countries.Similar to Afonso's PSP index, they employed the same sectors as outputs (Administration, Education, Health, Infrastructure, Stability). However, they utilized only one KPI for each sector due to the absence of comprehensive databases for most indicators across all countries they examined. The input for the DEA model was Total Government Expenditure as a percentage of GDP. Their findings indicate that poorer countries with high levels of government consumption achieve lower levels of efficiency.

Christl et al. (2020) use 38 indicators to measure the efficiency of public spending in 23 EU countries, which they divide into 9 sub-indexes (Administration, Education, Health, Public Security, Environmental protection, Social security, Defense, Infrastructure and Stability). With a higher level of indicators, they want to achieve higher robustness of the results of the efficiency of public spending. The efficiency is calculated by several partial frontiers approaches, e.g., free disposal hull and order-m. Their results show that only two countries were efficient (Switzerland and Norway) and that decentralization of state administration contributes to its efficiency, but fiscal rules do not.

In the comprehensive study conducted by Afonso et al. in 2013, the focus was on assessing government performance and efficiency across twenty-three Latin American and Caribbean Countries (LAC) during the period 2001-2010. Public Sector Performance (PSP) scores were computed to gauge the outcomes of public sector activities, while Data Envelopment Analysis (DEA) scores were employed to quantify the efficiency of public sectors in achieving performance. The research presents correlation between public sector efficiency and the size of the government. Countries with total expenditure-to-GDP ratios below 25 percent exhibited the highest performance, followed by those with spending between 26 and 30 percent, and larger governments with ratios exceeding 30 percent.

Remarkably, the DEA analysis indicated that the sample countries could achieve the same output level with 40 percent fewer resources if they were technically efficient, or alternatively increase their output production by 19 percent with the same level of total spending. Guatemala and Chile emerged as pivotal players on the efficiency frontier in the DEA methodology, joined by Peru in specific modeling scenarios. Notably, nine out of the top ten most efficient countries, according to the input-oriented approach, were countries with smaller public sectors. The study also integrated a Tobit analysis, revealing that increased transparency and regulatory quality positively impacted efficiency scores, both from an output and input-oriented perspective. Conversely, transparency and control of corruption, alongside better regulatory quality and property rights, increased output-oriented efficiency.

Another study conducted by Afonso et al. (2010) delves into an analysis of public sector efficiency in new EU member states compared to emerging markets, employing a Data Envelopment Analysis (DEA) model. In their examination, the authors utilize total government expenditure to GDP as an input, incorporating opportunity indicators (such as life expectancy, mortality rate, PISA, etc.) and Musgravian indicators as outputs. The research reveals a noteworthy diversity in expenditure efficiency across new EU member states, particularly in contrast to high-performing emerging markets in Asia. The composite Public Sector Efficiency (PSE) scores highlight that countries with lean public sectors and public expenditure ratios hovering around 30% of GDP tend to exhibit higher efficiency levels. In the DEA results, specific countries, including Thailand, Cyprus, Korea, and Ireland, are identified as being close to the theoretical production possibility frontier. Notably, the top-ranking country achieves a certain PSE score using only one-third of the input required by the bottom-ranking country. The analysis emphasizes the potential for resource optimization, as average input scores suggest that countries could achieve the same outcomes with approximately 45% fewer resources if operating at full efficiency. However, the study points out that, on average, countries are delivering only about two-thirds of the output they could potentially achieve if operating on the efficiency frontier.

The study by Hauner et al. (2008) investigates the efficiency of public spending in education and healthcare across 114 countries from 1980 to 2006, utilizing Data Envelopment Analysis (DEA) models. The authors compile a comprehensive cross-country panel dataset, encompassing 1,800 country-year observations for the education sector and 900 observations for health. They regress performance and efficiency indicators on various potential determinants, including economic, institutional, demographic, and geographic factors. The key finding of the study is that higher government expenditure relative to GDP is associated with lower efficiency in the respective sector. Additionally, the research reveals that wealthier countries tend to exhibit better public sector performance and efficiency. Institutional and demographic factors are identified as significant contributors to these variations. Of note, one of the independent variables in the regression analysis is the democracy index, which indicates a significant positive impact on the growth of efficiency.

In their 2015 study, Brini et al. (2015) aim to assess the relative efficiency of public spending in eleven Middle East and North Africa (MENA) countries from 1996 to 2011. They employ non-parametric Data Envelopment Analysis (DEA) to estimate efficiency scores across four main categories: administration, health, education, and infrastructure. The subsequent Tobit regression model is then applied to explore the impact of governance, political, and economic factors on public spending efficiency. The findings highlight Jordan as the most efficient in public spending on administration, education, and health, with Tunisia leading in infrastructure. In contrast, Libya, Algeria, and Yemen exhibit relatively lower efficiency in public spending on administration and health. The study further reveals that political stability, trade freedom, and economic growth positively influence public spending efficiency. However, voice and accountability have a negative effect on efficiency. It's noteworthy that in the regression analysis, the variable of the democracy index is found to be significant only for expenditures in administration and health.

The study by Ryap et al. (2007) addresses the issue of the efficiency of public expenditures in developing countries. The research utilizes DEA method to assess the efficiency of public expenditures, with total public expenditures as input variables and indicators in the fields of healthcare, education, and government performance as output variables. The authors focus on analyzing 52 developing countries and identifying determinants of the efficiency of public expenditures. The results show that the efficiency of public expenditures is primarily influenced by structural country variables and governance indicators, with economic policies contributing less to efficiency. In the specific context of the study, the authors find that Asian countries achieve significantly higher efficiency in public expenditures, while low-income European countries exhibit lower efficiency. Key determinants of efficiency include indicators such as the Rule of Law and political stability.

The study conducted by Asatryan et al. in 2014 investigates the impact of introducing the right to initiate direct democratic legislation into the local government code in the German State of Bavaria, focusing on 2000 German municipalities. The researchers utilize a two-step approach to assess the effects of direct democracy on public expenditure efficiency. In the first step, they construct an efficiency frontier using the Free Disposal Hull (FDH) method, with total public expenditure by municipality as input. In the second step, the study analyzes the impact of direct democracy, incorporating specific indicators related to initiatives. These indicators include a dummy variable indicating whether there was at least one petition for an initiative in a town and the turnout rate, representing the share of eligible votes in the total population participating in initiatives. The findings suggest a positive correlation between direct democratic activity and higher government efficiency in the provision of goods and services per unit of collected resources. On average, every second municipality hosted an initiative in the decade under consideration.

The study conducted by Geys et al. in 2010 focuses on analyzing expenditure efficiency in German municipalities using a Stochastic Frontier Approach. The researchers use total expenditure by municipality as input and create a single indicator from several output indicators, including students in public schools, kindergarten places, recovery area, and more, for the efficiency model. In the second step of the analysis, the study explores the impact of voter involvement on efficiency scores. The indicators of voter involvement include the ratio of eligible voters to the total population, the number of votes cast relative to the total municipal population, and the existence of free voter unions. The empirical analysis, conducted on a broad panel of 987 German municipalities for the years 1998, 2002, and 2004, reveals that higher voter involvement is generally associated with higher levels of (technical) efficiency rather than lower levels. This suggests a positive correlation between voter participation and efficiency in municipal expenditure.

The study conducted by Hauner in 2008 investigates the expenditure efficiency of 79 public regions in Russia. Utilizing a Data Envelopment Analysis (DEA) approach, the researcher establishes efficiency scores with total expenditure as inputs. The study primarily focuses on indicators related to education and health and additionally the Gini coefficient and poverty rates. In the subsequent step, Hauner explores potential determinants of efficiency in the examined regions. The indicators considered include income per capita, the percentage of alcohol and tobacco in household consumption, average temperature in January, population density, and indices of press freedom, democratic elections etc. The results of the econometric examination suggest that variations in efficiency among regions are largely explained by several factors. These include per capita income, the share of federal transfers in subnational government revenue, the quality of governance and democratic control, and the overall level of spending.

The research conducted by Adam et al. in 2008 delves into the examination of expenditure efficiency across 19 OECD countries. Employing a Stochastic Data Envelopment Analysis (DEA) methodology, the investigators compute efficiency scores across seven categories for each country: Health, Education, Economic affairs, General public services, Social security, Performance, and Stability. The efficiency scores are derived by utilizing expenditure to GDP ratios and representative output indicators specific to each category. To analyze the impact of democracy on public expenditure efficiency, the study introduces several indicators representing democratic influences. These indicators include the proportion of voters who participated in elections, the ideological position of the government on a political spectrum (ranging from 1 to 10), the number of surplus seats in parliament, a dummy variable for a coalition government, and the level of decentralization in a country. The findings indicate that a higher level of democracy tends to be associated with higher levels of expenditure efficiency. Notably, indicators such as coalition government and the surplus of seats in parliament emerge as significant factors influencing the relationship between democracy and expenditure efficiency.

Kurnia's (2012) research delves into the relationship between decentralization, democratization, and public sector efficiency (PSE) in the context of Indonesia's post-2004 democratic reform. Employing a two-stage methodology and spanning the period from 2005 to 2008, the study comprehensively analyzes the factors influencing the efficiency with which local governments deliver services, measured as the "flow of services" per unit of public expenditure. Positive and statistically significant association is observed between the degree of fiscal decentralization, measured by local revenue generation, and PSE. This implies that local governments with greater budgetary autonomy exhibit improved service delivery efficiency.

This finding aligns with theoretical underpinnings that suggest enhanced responsibility fosters prudent spending practices. Surprisingly, the thesis uncovers a negative association between democratic participation and PSE. While seemingly counterintuitive, this finding suggests that in the Indonesian context, issues like money politics, unequal participation, and political fragmentation, associated with increased voter participation, might hinder efficient service delivery. Moreover, the study explores the impact of political fragmentation, measured by the Herfindahl-Hirschman index, on PSE. The results reveal an ambiguous impact. While increased party diversity offers voters more choices, it can also create instability and impede effective governance, leading to an unclear net effect on efficiency. The research further examines the role of institutional quality. While the perception of corruption does not significantly impact PSE, the perception of better infrastructure is linked to higher efficiency. This suggests that even in the presence of corruption challenges, decentralization might indirectly improve efficiency by enabling better infrastructure development.

In the study conducted by Moreno-Enguix et al. (2017), the researchers present a comprehensive methodology for measuring Public Expenditure Efficiency (PEEI) at the country level, both for general government and its functions. The study utilizes Free Disposal Hull (FDH) and Data Envelopment Analysis (DEA) techniques, employing more than 60 weighted socioeconomic indicators grouped into six clusters aligned with COFOG. Analyzing 35 developed economies in 2012, including EU member states and other advanced nations, the research highlights significant disparities in public sector performance and efficiency. Findings reveal variations in efficiency across functions and countries, suggesting potential for improvement in all dimensions of performance. The study emphasizes the necessity for governments to reflect on their public expenditure policies, restructuring services and redistributing resources to enhance efficiency. Switzerland, Norway, and the Republic of Korea consistently emerge as efficient models, supporting the robustness of the proposed methodology. The research underscores the correlation between public sector performance, efficiency, and key socioeconomic indicators such as GDP per capita, democracy, corruption, and population density. Notably, a higher level of democracy is associated with improved public expenditure efficiency and reduced corruption.

This paper, conducted by Negri et al. (2023), aims to evaluate the efficiency of the European Union's public sector through a quality of governance perspective. The study involves 27 EU countries and utilizes a two-step methodology. In the first stage, Data Envelopment Analysis is employed to calculate efficiency scores based on inputs such as technical and democratic quality of government, along with public expenditure to GDP. The second step involves a quantile regression estimation technique to explore the determinants of efficiency, focusing on factors like human development index, population density, economic freedom, and democratic index. Notably, the findings reveal that governance quality is a crucial factor in analyzing public performance. The study emphasizes the impact of various factors, including democracy, on public sector efficiency. Specifically, the results indicate a significantly negative correlation between democracy and public sector efficiency.

In the study led by Borge et al. (2008), the focus is on assessing the expenditure efficiency of Norwegian local governments. The researchers followed a three-step approach. Firstly, they constructed an output index for local governments using 17 indicators, including factors such as the share of inhabitants above 80 years receiving home-based care, attendance in local government daycare institutions per child 0–5 years, and teaching hours per student. In the second step, instead of utilizing DEA analysis due to the high number of outputs, they simply calculated the output index as a ratio of total revenues by local government. Lastly, the researchers attempted to identify determinants of efficiency, employing independent variables like democratic participation, different party majorities, and socialist majority to represent the impact of democracy on efficiency. However, the study's results suggest that these indicators do not have a significant impact on the efficiency of local governments.

Halaskova's 2018 study focused on evaluating the efficiency of public expenditure on services in EU countries during 2009 and 2016. Using the Data Envelopment Analysis (DEA) model, the researchers employed public expenditure to GDP for primary COFOG categories (Health, Education, Social Protection, General Public Service) as inputs, while GDP per capita and employment in services served as outputs. The findings revealed a decrease in efficiency from 13 to seven countries between 2009 and 2016. Interestingly, countries with a larger public sector did not demonstrate established efficiency. The study emphasized the role of the tradition of public administration, showing similarities in efficiency across various EU countries.

Balaguer-Coll et al. (2006) present a comprehensive analysis of the efficiency of local governments in the Comunitat Valenciana, Spain. The study employs a two-stage approach, utilizing nonparametric activity analysis techniques such as Data Envelopment Analysis (DEA) and Free Disposable Hull (FDH) in the first stage to measure efficiency. Inputs in the efficiency model encompass capital expenditure, transfers, wages, and salaries, while outputs include areas of parks, tons of waste, and other relevant factors. The second-stage analysis reveals that both fiscal and political variables significantly impact municipality performance. This unique approach utilizes nonparametric smoothing techniques, deviating from traditional econometric methods like OLS or Tobit models. Noteworthy is the inclusion of an explanatory political variable, VOTES, representing the relative importance of votes held by the governing party. This variable is introduced to capture the dynamics of decision-making within local governments, especially when the governing party holds an absolute majority. The results of the study indicate a negative impact of a dominant ruling party with a significant majority on the efficiency of a municipality.

Gao (2015) conducted a comprehensive study on the political determinants of Public Sector Efficiency (PSE) across 117 countries from 2001 to 2010, utilizing a two-stage DEA-Tobit method. In the initial stage, the analysis employed the DEA method to discern two efficiency frontiers: developing-country frontiers and developed-country frontiers. Notably, developed nations exhibited higher PSE on average, attributed to a greater number of efficiency frontiers and fewer countries with poor performance. For the DEA models, the study considered one input and five outputs of public expenditure to measure PSE. Results indicated that adhering to best practices could potentially result in saving 36 percent of inputs or increasing outputs by 15 percent without altering current amounts. The subsequent Tobit models in the second stage examined the relationship between political factors and PSE. Surprisingly, the level of democracy itself was not found to be significantly related to PSE at the cross-national level. Instead, the durability of the political regime, regardless of its democratic or monocratic nature, emerged as a crucial factor in enhancing PSE. Long-lasting democracy and regime stability contributed to improved PSE by fostering high-quality institutions that provide strong property rights protection and freedom from corruption.

3 Data and Methodology

Our analysis of the efficiency of public expenditures and its relationship to the democratic establishment is divided into two main steps. The first step is the definition and analysis of the efficiency of public expenditures. In this part, we examine and evaluate the optimal form of methodological approach to measure and evaluate public sector efficiency. It includes the identification of the optimal model and the use of relevant indicators (inputs and outputs).

The second step of our analysis is to determine the influence of the democratic establishment on the efficiency of public administration expenditures. This step again requires defining the optimal econometric model and including relevant data.

3.1 Sample

In contrast to prior literature, our study opted to utilize an expanded dataset comprising 74 countries. The selection of countries was primarily influenced by the accessibility of comprehensive data for each nation. Notably, developed countries are overrepresented compared to developing nations, owing to their more extensive data coverage.

3.2 Determination of efficiency method

Efficiency is a key concept in management and economics and is usually used to evaluate the use of resources to achieve stated goals. We distinguish between technical, allocation and production efficiency.

Technical efficiency deals with the use of inputs to achieve certain outputs under given technical conditions. It is about how well organizations use their resources to produce goods or provide services with current technical capabilities.

Allocative efficiency refers to the correct distribution of resources among different alternatives in order to achieve the maximum satisfaction of needs and preferences. This means that an allocatively efficient organization can achieve a given level of outputs with minimal inputs.

Production efficiency is focused on the use of inputs in such a way that the maximum possible outputs are achieved under the given technical conditions. It is aimed at optimizing production processes or service provision in order to minimize losses and increase productivity.

For the purposes of this study we will analyze and utilize technical efficiency (Palmer et al. 1999).

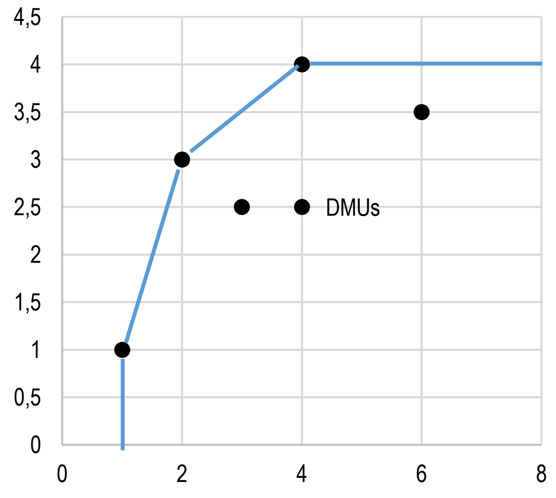
Measuring efficiency consists in estimating the boundary of the production function and the distance of individual entities (DMUs) from it. Economic efficiency is measured using two approaches: parametric or non-parametric methods. Parametric methods include stochastic frontier production function (SFA), rough frontier approach (TFA) and distribution free approach (DFA). Non-parametric methods include data envelopment analysis (DEA) and free distribution method (FDH).

Differences in Non-Parametric and Parametric methods of efficiency frontiers:

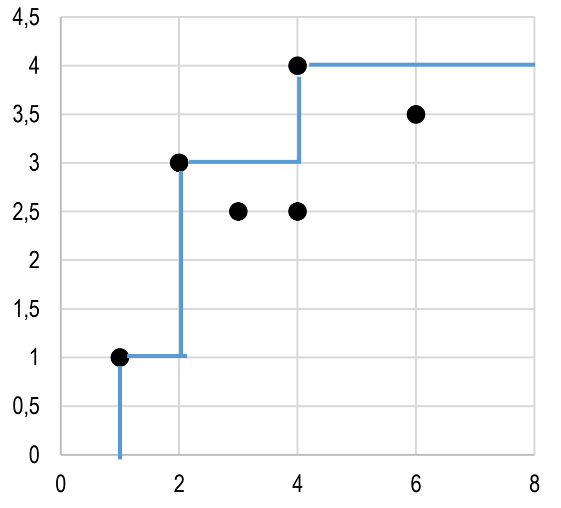
Parametric methods allow the use of panel data and distinguish random noise from inefficiency. They provide flexibility in the measurement of the production function and provide a significant estimate of measurement error. SFA is suitable if the classical assumptions about compound error terms are fulfilled. These methods also allow efficiency to be measured independently of other exogenous factors.

Non-parametric methods, such as DEA and FDH, do not need a specific functional form and allow measuring the efficiency of multiple inputs and outputs. These methods do not require prior weights for inputs and outputs and have the potential to estimate the frontier non-parametrically. DEA and FDH are both non-parametric methods, but there are partial differences between them. DEA focuses on maximizing the efficiency of individual decision-making units, while FDH focuses on finding the so-called "hull" in the space of inputs and outputs, which represents the limit of technological possibility. FDH provides a more general idea of efficiency than DEA. They also differ in the creation of the production function

Graf 1: Frontier of DEA



Graf 2: Frontier of FDH



Advantages and disadvantages of parametric and non-parametric methods:

Parametric methods allow modeling of inefficiency and noise, but require specification of the technology, which can be limiting. On the contrary, non-parametric methods do not have such limitations, but are sensitive to extreme values and do not take statistical properties into account. Parametric methods allow hypothesis testing and provide standard errors, and on the other hand, nonparametric methods have larger ones.

For the purposes of our study, we have opted for a non-parametric DEA approach to measure efficiency, as seen in previous literature (Afonso, 2005, 2011; Christl, 2018; IMF, 2015). This approach is more flexible and decreases the need for a large number of DMUs and avoids imposing assumptions about the functional form of the stochastic frontier.

3.3 Inputs

Our DEA models will evaluate the efficiency of multiple countries using government spending data. We will focus on the period 2010-2020 to avoid fluctuations from year to year. For efficiency models, we utilize different combinations of the six inputs.

These six inputs represent government spending in three key areas categorized by COFOG: Health, Education and Social Protection. To ensure data stability, we will use average spending for each category over the entire period 2010-2020.

Data will be presented in two forms for each COFOG category. The first form expresses the average expenditure as a share of the average GDP of the country for the same period. This allows us to compare spending levels relative to the overall economic size of each nation. The second form reflects the average expenditure per person (PPP) in each category. In this case, we calculate the average expenditure for the years with available data within the period 2010-2020. This approach takes into account potential limitations caused by missing data points in some years for certain countries.

In cases where data are missing for a specific COFOG category and country for some years, we will calculate the average only for years with available data. In this way, we ensure that we make the most of the available information while taking into account potential gaps.

Our DEA models will draw data from two renowned international organizations: the International Monetary Fund (IMF) and the World Bank. These institutions provide reliable and comprehensive information on countries macroeconomic indicators, including GDP and government spending, as well as development data in areas such as health, education and social protection. By combining data from these sources, we will ensure consistency and accuracy in evaluating the effectiveness of government spending in the countries under study through DEA models.

3.4 Outputs

In this chapter, we will present the outputs of DEA models for three categories from COFOG: **Education, Health, and Social Protection.** The data for the outputs in the models represent averages between 2015-2020, as the results respond to the inputs with a slight delay. In cases where no data were available for a country between 2015-2020, we utilized the last available data. This approach ensures that we maximize the utilization of available information while addressing potential data gaps.

Within these three COFOG categories, we have devised a representative performance index that signifies the outcomes for each respective category. Methodologically, we employed normalization around the average to generate these indices.

An essential foundation for the selection of indicators was relevant literature, which provided a thorough insight into the areas of education, healthcare, and social protection. For the next step, we utilized the World Development Indicators database from the World Bank. This database is a source of high-quality and internationally comparable statistics on global development and the fight against poverty. It contains 1,400 time series of indicators for 217 economies and more than 40 country groups, with data for many indicators going back more than 50 years. These thorough and broad sources of data provided us with a robust foundation for creating our outputs within DEA models.

3.4.1 Compilation of Education Performance Index

The results for education have been divided into three subgroups: *Education Attainment, Pupils to Teacher Ratios, and Literacy.*

The Literacy sub-indicator comprises: Adult Literacy Rate and Pupils Above Minimum Proficiency in Reading and Mathematics at the End of Primary Education.

The adult literacy rate serves as a standard measure of recent progress in student achievement. It represents the cumulative outcomes of primary and secondary education by indicating the proportion of the population that has acquired basic literacy and numeracy skills in the preceding decade or so.

The Minimum Proficiency Level (MPL) establishes the benchmark for fundamental knowledge in a given domain (mathematics, reading, etc.), as assessed through learning evaluations.

The MPLs for reading and mathematics, utilized to report on indicators, outline the essential knowledge and skills students should demonstrate for specific grade levels. These benchmarks are derived from an analysis of curricula and assessment programs worldwide, and detailed descriptions can be found in the table below.

Education level	**Mathematics**	**Reading**
End of Primary	Students demonstrate skills in number sense, computation, real-world problems, basic measurement, 2D shape recognition, and reading and interpreting simple data displays.	Students independently and fluently read simple, short narrative and expository texts. They locate explicitly stated information, interpret and explain key ideas, and provide simple personal opinions or judgments about the information, events, and characters in a text.

The Pupil-Teacher Ratio sub-index includes three indicators: Pupil-Teacher Ratio at Primary School, Pupil-Teacher Ratio at Secondary School and Pupil-Teacher Ratio at Tertiary Level.

The pupil-teacher ratio is calculated by dividing the number of students at a certain level of education by the number of teachers at the same level of education. Education data is collected by the UNESCO Institute for Statistics from official responses to its annual education survey. All data is mapped to the International Standard Classification of Education (ISCED) in order to ensure comparability of educational programs at an international level. The current version was formally adopted by UNESCO member states in 2011.

We chose to include Student-Teacher Ratio as an output in the DEA models, mainly because of the positive relationship between growth in student test scores and decline in class sizes based on previous studies (Biddle et al. 2002, Wang et al. 2022).

The Educational attainment sub-index includes three indicators: Share of adults with at least completed primary education, Share of adults with at least completed secondary education and Share of adults with at least completed tertiary education.

The relatively high concentration of the adult population at a certain level of education reflects the capacity of the educational system at the relevant level of education. Educational attainment is closely related to the abilities and competencies of a country's population and can be seen as a proxy for both quantitative and qualitative aspects of the supply of human capital.

It is calculated by dividing the number of the population aged 25 and over who have attained or completed primary education by the number of the population in the same age category and then multiplying by 100. The number 0 means zero or small enough to be rounded to zero. The data are mainly collected by the UNESCO Institute for Statistics from national population censuses, household surveys and labor force surveys. All data is mapped to the International Standard Classification of Education (ISCED) in order to ensure comparability of educational programs at an international level. The current version was formally adopted by UNESCO member states in 2011.

To create individual and overall Education Performance Index (EPI), the outcome indicators are first normalized with a min-max normalization over the period from 2015-2020 (or the last known number). The values of each outcome indicator are then normalized to the percentage of the average value of the given indicator across our sample of 74 countries. This procedure can be implemented using the following formula:

$$epsi_i = \frac{1}{N}\sum_{j=1}^{N}\frac{x_{ij} - x_{\min j}}{x_{\max j} - x_{\min j}}$$

Where:

- $epsi_i$ is a sub-index (Literacy/Pupil Teacher ratio/Educational attainment) for country i
- N is the number of indicators in the sub-index

- x_{ij} is indicator j for a country i, which is normalized around the sample of 74 countries using the min – max approach.

The EPI index for country *i* is then calculated as the arithmetic mean of the sub-indexes $epsi_i$.

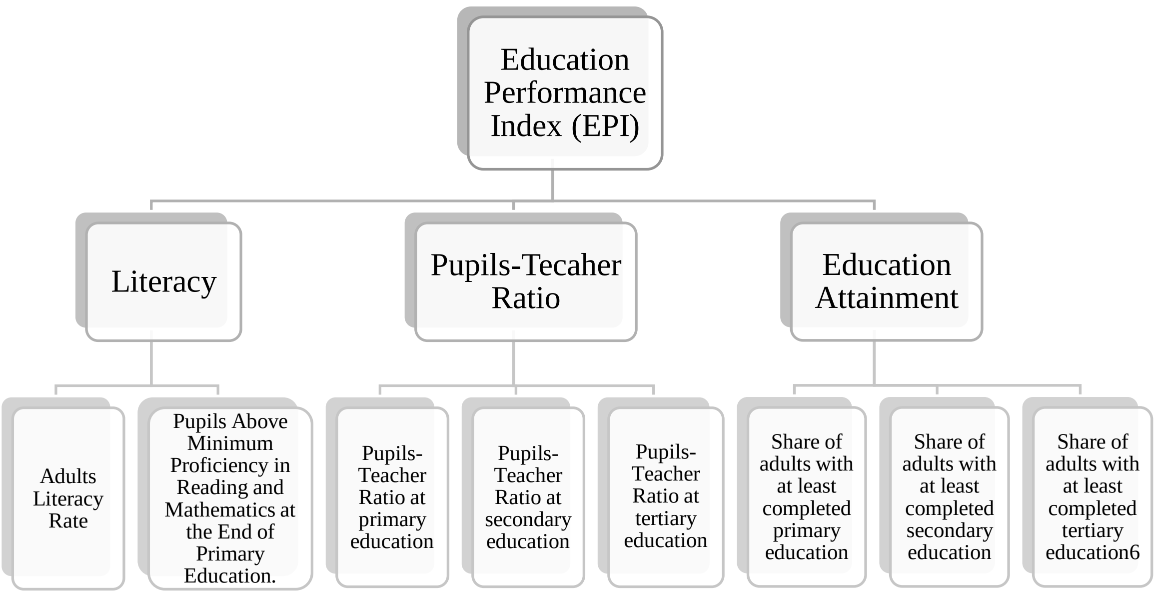
$$EPI_i = \frac{1}{N}\sum_{j=1}^{N} epsi_{ij}$$

Where:

- EPI_i is an Education performance index for country *i*
- N is the number of sub-indexes in the index (in our case N is represented by a number 3)
- $epsi_{ij}$ is sub-index *j* for a country *i*.

Compared to normalization by standard deviation, this approach ensures positive values and eliminates the issue of zero values as seen when using the min-max approach.

Picture 1: Compilation scheme of Education Performance Index



Source: Custom methodology

3.4.2 Compilation of Health Performance Index

The Health Performance Index consists of two sub-indexes: Life expectancy and Mortality.

Life expectancy at birth is defined as the time that, based on current mortality rates, a newborn can expect to live if these levels do not change. However, the actual age-specific mortality of any particular birth year cannot be known in advance. If levels are falling, actual life expectancies will be higher than life expectancies calculated based on current mortality rates. Life expectancy at birth is one of the most commonly used indicators of health status. The increase in life expectancy at birth can be attributed to several factors, including rising living standards, improving lifestyles and better education, and most importantly greater availability of quality health services. This indicator is presented as a total for both sexes.

The Mortality sub-index includes two indicators: Mortality rate under 5 years per 1,000 births and Cause of death, according to communicable diseases and maternal, prenatal and nutritional conditions (% of the total number).

Child mortality is the mortality of children under five years of age and it refers to the probability of death between birth and exactly the fifth birthday expressed per 1,000 live births. It includes neonatal mortality and infant mortality (probability of dying in the first year of life). Child mortality rates are a key indicator of public health outcomes as they reflect the overall health and well-being of a population, particularly in terms of maternal and child health care, access to health services and socio-economic development. In order to compare estimates of neonatal, infant and child mortality and ensure consistency between estimates from different agencies, the United Nations Child Mortality Estimation Group has developed and adopted a statistical method that uses all available information to reconcile differences. The method uses statistical models to obtain the best-estimated trend line by fitting a country-specific mortality regression model against their reference dates.

Data on causes of death are compiled by WHO, mainly based on data from national systems of authorities, as well as from selected registration systems, population laboratories and epidemiological analyzes of specific conditions. Data are classified based on the International Statistical Classification of Diseases and Related Health Problems. The data were carefully analyzed with regard to the incomplete coverage of registration systems and the likely differences in the pattern of causes of death that would be expected in under-covered and often poorer subpopulations. Special attention has also been paid to misattribution or miscoding of causes of death in cardiovascular diseases, cancer, injuries, and general ill-defined categories.

To create individual and overall Health Performance Index (HPI), the outcome indicators are first normalized with a min-max normalization over the period from 2015-2020 (or the last known number). The values of each outcome indicator are then normalized to the percentage of the average value of the given indicator across our sample of 74 countries, following similar procedures as outlined in the previous chapter. This procedure can be implemented using the following formula:

$$hpsi_i = \frac{1}{N}\sum_{j=1}^{N}\frac{x_{ij} - x_{\min j}}{x_{\max j} - x_{\min j}}$$

Where:

- $hpsi_i$ is a sub-index (mortality) or an indicator (Life expectancy) for country *i*
- N is the number of indicators in the sub-index
- x_{ij} is indicator *j* for a country *i*, which is normalized around the sample of 74 countries using the min – max approach.

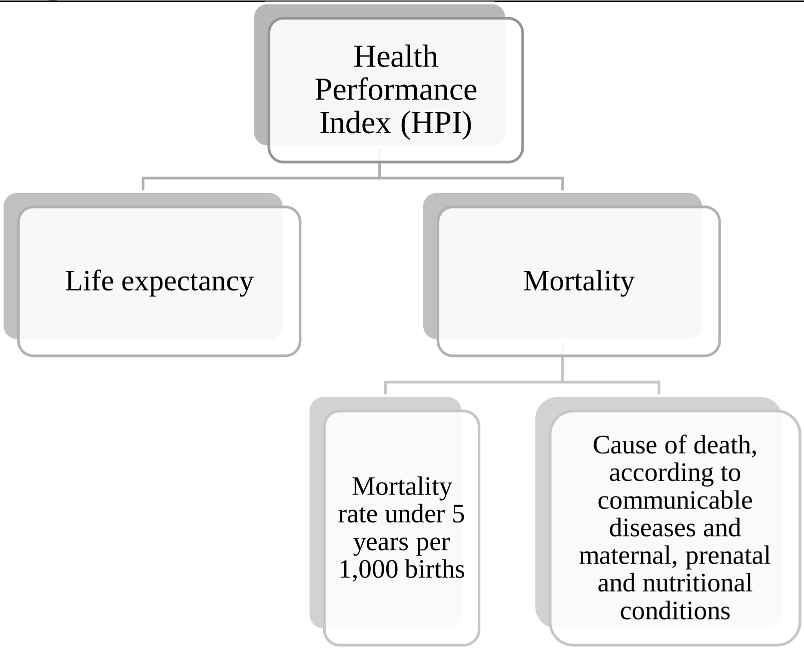
The HPI index for country *i* is then calculated as the arithmetic mean of the sub-indexes $hpsi_i$.

$$HPI_i = \frac{1}{N}\sum_{j=1}^{N} hpsi_{ij}$$

Where:

- HPI_i is an Health performance index for country *i*
- N is the number of sub-indexes in the index (in our case N is represented by a number 2)
- $hpsi_{ij}$ is sub-index *j* for a country *i*.

Picture 2: Compilation scheme of Health Performance Index



Source: Custom methodology

3.4.3 Compilation of Social Protection Performance Index

The Social Protection Performance Index consists of two separate indicators: Gini Index and Social Protection Coverage and one sub-index: Poverty.

The Gini Index is a measure of statistical dispersion that represents the distribution of income or capital of the population of a given country.

The value of the Gini Index ranges from 0 to 1, while:

A Gini index value of 0 represents complete equality, which means that every citizen has the same income or amount of wealth.

A Gini index value of 1 means complete inequality, where one person has all the income or wealth.

In practice, the Gini Index measures how income or wealth is distributed away from a perfect equal distribution. Mathematically, the Gini index is calculated as the ratio of the area under the Lorenz curve (a graphical representation of the cumulative distribution of income or wealth) and the area under the line of perfect equality (which is a 45-degree straight line) to the total area under the line of perfect equality. The Gini coefficient serves as the optimal outcome measure for a well-functioning social protection system mainly because of its ability to represent the distribution of income or wealth in society. A lower Gini coefficient indicates a more equitable distribution of resources, which means reduced levels of poverty, social exclusion and economic inequality. A well-designed social protection system, which includes measures such as unemployment support, targeted contributions for the most vulnerable groups of the population, has a positive effect on reducing income inequalities. Data are based on primary household survey data obtained from government statistical agencies and World Bank country departments.

The Social protection coverage measures the proportion of the population covered by at least one social protection cash benefit. It is calculated as the ratio of the population receiving cash benefits under at least one social protection contingency or function (contributory or non-contributory benefit) or actively contributing to at least one social security scheme to the total population.

The main data source for this indicator is the Social Security Inquiry (SSI), which is an online questionnaire available at https://qpss.ilo.org/. The SSI collects administrative data from national ministries of labour, social security, welfare, finance, and other relevant entities.

The goal of this indicator is aligned with the broader aim of ending poverty in all its forms everywhere. By ensuring that a significant portion of the population is covered by social protection cash benefits, it aims to provide a safety net for vulnerable individuals and households, thereby contributing to poverty reduction efforts.

The Poverty sub-index includes three indicators: Poverty gap at 2.15; 3,65$ and 6,85$ a day (2017 PPP) (%).

International comparison of the level of poverty is difficult mainly because of different definitions of poverty limits in individual countries. Some poverty lines tend to be higher in richer countries where the lines are set higher than in poorer countries. Since 1990, the World Bank has been trying to introduce a common standard for measuring extreme poverty, which represents conditions in the poorest countries. The measurement of poverty of the inhabitants of different countries is carried out on a single scale by means of conversion in the purchasing power parity.

In the past, $1 per day was commonly used as the threshold for extreme poverty, measured in 1985 international prices and adjusted for local currency using purchasing power parity (PPP). Gradually, the international poverty line is regularly updated according to new data on PPP prices to effectively represent changes in the cost of living around the world. Currently, the extreme poverty line is defined as $2.15 per day in 2017 PPP. The $3.65 poverty line is derived from typical national poverty lines in countries classified as Lower Middle Income and the $6.85 poverty line is derived from typical national poverty lines in countries classified as Upper Middle Income. These boundaries attempt to keep the actual value of the poverty line constant across countries, allowing for comparisons over time. Poverty lines are also a tool for the effectiveness of social policies and social security systems.

The indicator "Poverty gap" in the values of 2.15, 3.65 and 6.85 USD (%) provides an insight into how effectively these systems manage to alleviate poverty and improve the living conditions of the inhabitants. Lower values of this indicator indicate better efficiency in the fight against poverty. The statistics reported here are based on consumption data or, when unavailable, on income surveys.

To create individual and overall Social Protection Performance Index (SPPI), the outcome indicators are first normalized with a min-max normalization over the period from 2015-2020 (or the last known number). The values of each outcome indicator are then normalized to the percentage of the average value of the given indicator across our sample of 74 countries, following similar procedures as outlined in the previous chapter. This procedure can be implemented using the following formula:

$$sppi_i = \frac{1}{N}\sum_{j=1}^{N}\frac{x_{ij} - x_{\min j}}{x_{\max j} - x_{\min j}}$$

Where:

- $sppsi_i$ is a sub-index (poverty) or an indicator (Gini Index/Social protection Coverage) for country *i*
- N is the number of indicators in the sub-index
- x_{ij} is indicator *j* for a country *i*, which is normalized around the sample of 74 countries using the min – max approach.

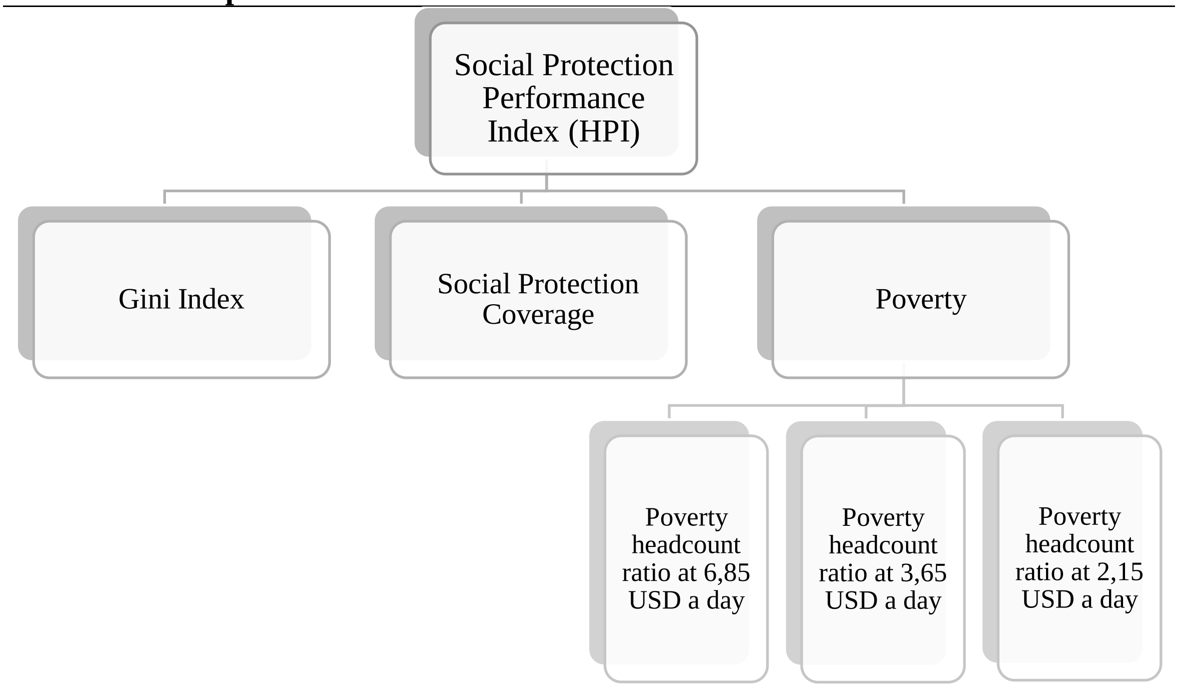
The SPPI index for country *i* is then calculated as the arithmetic mean of the sub-indexes $sppsi_i$.

$$SPPI_i = \frac{1}{N}\sum_{j=1}^{N} hpsi_{ij}$$

Where:

- $SPPI_i$ is an Social protection performance index for country *i*
- N is the number of sub-indexes in the index (in our case N is represented by a number 3)
- $hpsi_{ij}$ is sub-index *j* for a country *i*.

Picture 3: Compilation scheme of Social Protection Performance Index



Source: Custom methodology

3.5 DEA methodology – First step

Our analysis is structured into two separate steps. Initially, we focus on determining the efficiency of public expenditure through the utilization of DEA models. We employ DEA (Data Envelopment Analysis) models to assess the efficacy of public expenditure across three COFOG expenditure categories: Health, Education, and Social Protection, as outlined in preceding sections.

We utilize a total of four DEA models for each of these categories.

Our methodology involves integrating two inputs: public expenditure for a specified COFOG category relative to GDP, and public expenditure per capita in PPP. Meanwhile, we incorporate four output measures: in one model, these consist of three sub-indexes for specific performance indicators fo category (j), while in another model, it utilizes a comprehensive performance index for the respective category (j). In the table below you can see a description of each model for category (j).

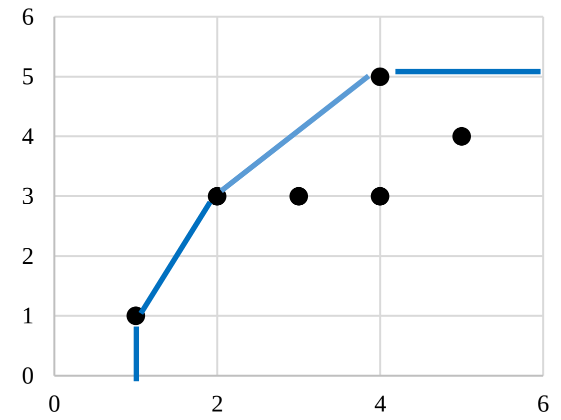
Table 1: Summary of Inputs and Outputs used in different DEA models

	Model 1	**Model 2**	**Model 3**	**Model 4**
Inputs				
Public expenditure for a COFOG category (j) relative to GDP	X	X		
Public expenditure pre capita for a category (j)			X	X
Outputs				
Performance Index for a category (j)		X		X
Three sub-indexes for a category (j)	X		X	

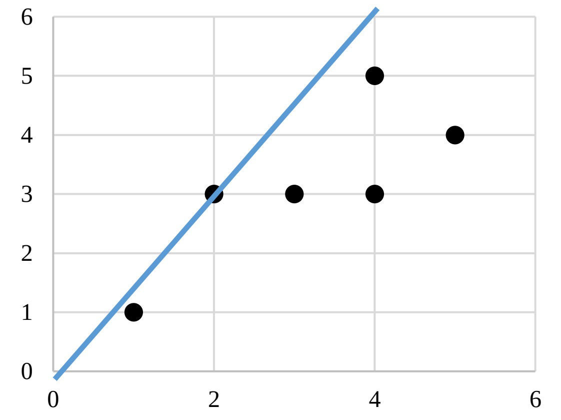
The overall efficiency for each category is calculated as the average efficiency derived from these four models. This approach allows us to assess research efficiency with a varied set of inputs and outputs, enhancing the overall robustness of our analysis.

The study employs a BCC model with variable returns to scale, akin to prior literature (see Avkiran, 2018), which assumes diminishing marginal returns to scale. Moreover, the outcome indicators in our models also incorporate the assumption of diminishing returns to scale, as there is no linear relationship between the growth of public expenditures and the growth of our representative outcomes. The contrast between the VRS and CRS frontiers can be seen in the graph (***Graph 1***; ***Graph 2***). These models are transformed into linear programs and solved using mathematical techniques. The objective is to either maximize the output of units for a given set of inputs (output-oriented DEA) or minimize the inputs required for a given output (input-oriented DEA). Given our aim to maximize the achievements of universities (Visbal-Cadavid, 2017), our study adopts an output orientation.

Graph 1: DEA frontier with VRS approach



Graph 2: DEA frontier with CRS approach



The efficiency of a Decision Making Unit (DMU) is then determined by its distance from the efficiency frontier. The efficiencies for individual countries are derived as the average efficiencies of both models. Mathematically, the efficiency scores for model 1 and 2 can be calculated using the following formula:

$$\max_{\varphi,\lambda} \varphi$$

$$s.t. -\varphi yi + Y\lambda \geq 0$$

$$xi - X\lambda \geq 0$$

$$\lambda \geq 0$$

where yi is a column vector of outputs, xi is a column vector of inputs, λ is a vector of constants, I1' is a vector of ones, X is the input matrix and Y is the output matrix. φ is a scalar (that satisfies $1 \leq \varphi \leq +\infty$),and φ-1 is the proportional increase in outputs that could be achieved by each country with input quantities held constant. 1/φ defines the technical output efficiency score, varying between zero and one (Afonso, 2005).

3.6 Analysis of outliers

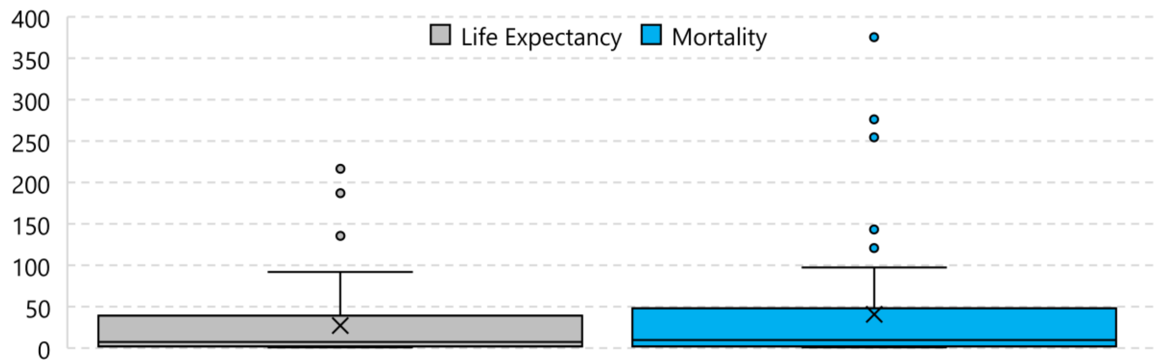
As part of the process of establishing an objective frontier for efficiency analysis, we conducted data cleaning to define outliers. In this phase, we conducted a comparative assessment involving our three normalized sub-indexes and composite performance index for category (j) along with normalized inputs for category (j). This step is essential for excluding countries from our dataset that might exhibit significantly superior results compared to their inputs. In such instances, there is a potential risk of distorting our frontier due to an outlier, leading to the emergence of several countries appearing highly inefficient. Our analysis of outliers utilized the Interquartile Range approach, where an outlier is identified as a data point falling outside 1.5 times the Interquartile Range, calculated as the difference between Q3 and Q1. The definition of an outlier can be expressed in the following equation:

$$Outlier = Data\ point < (Q1 - 1.5 \times IQR)\ or\ Data\ point > (Q3 + 1.5 \times IQR)$$

Where IQR = Q3 – Q1.

The utilization of the interquartile method is applicable in constructing box plots. An outlier represents a data point above the maximum or below the minimum. In Graph 3, we compare the normalized sub-indexes (Life expectancy and Mortality) in the Health performance index with public expenditure on healthcare per capita. We observe 3 to 5 outliers in these sub-indexes. Across all three sub-indices, Myanmar, Afghanistan, and Nepal are presented as outliers. For the purposes of this work and to achieve optimal results in subsequent analysis, we exclude these countries from our observations.

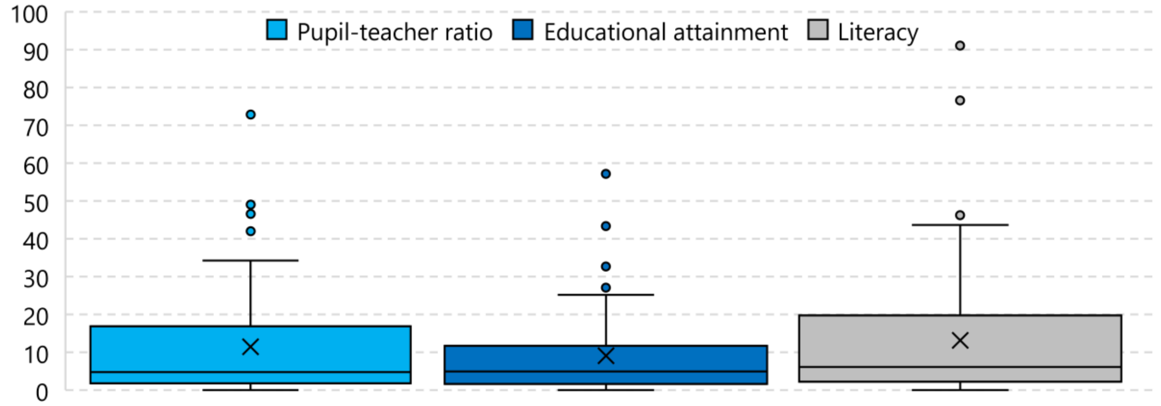
Graph 3: Adjustment of outliers within sub-indexes of HPI, Share of normalized results / normalized public expenditure on health per capita (PPP)



Source: custom calculations

Similar to the previous section, we conducted data cleaning for the sub-indexes of the Education performance index. Employing the same method, we compared the normalized results in relation to the normalized public expenditure on education per inhabitant. From **Graph *4***, it is evident that we observe 3-5 outliers for each sub-index. Myanmar, Armenia, Kyrgyzstan, and Nepal appeared as outliers in two or more sub-indexes. Therefore, we will exclude them from our sample for the analysis of education in this study.

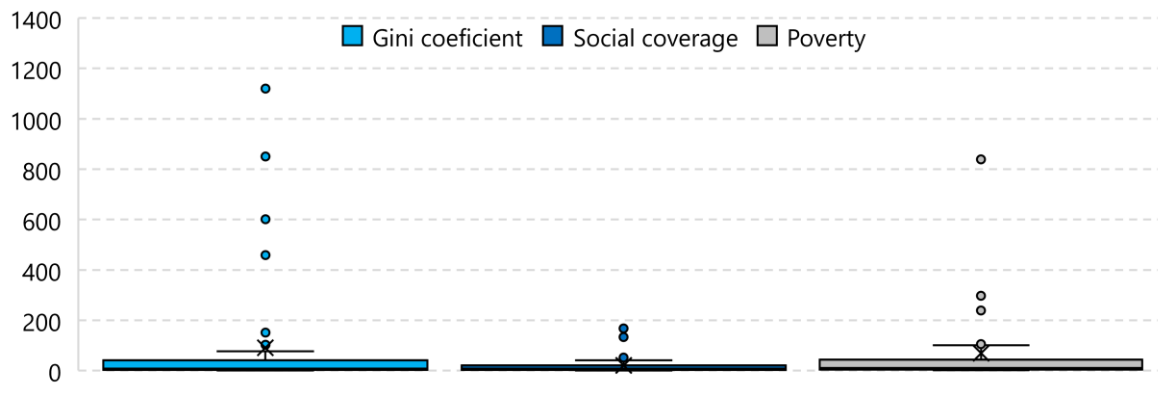
Graph 4: Adjustment of outliers within sub-indexes of EPI, Share of normalized results / normalized public expenditure on education per capita (PPP)



Source: custom calculations

In the final stage of our outlier analysis, we extended our scrutiny to the social protection data. Much like our approach with education and healthcare, we thoroughly compared inputs and outputs across three sub-indexes derived from the Social protection performance index—namely, Social coverage, Gini index, and Poverty. Through rigorous interquartile analysis, we pinpointed five countries that exhibited outlier status in at least two of these sub-indices. These countries include Myanmar, Kiribati, Nepal, Kenya, Indonesia, and Kyrgyzstan. Consequently, we have opted to exclude these countries from our observation and refrain from incorporating them into our analysis of the social protection system. This decision is aimed at ensuring the integrity and accuracy of our analytical framework, thereby enhancing the reliability of our findings.

Graph 5: Adjustment of outliers within sub-indexes of EPI, Share of normalized results / normalized public expenditure on education per capita (PPP)



Source: custom calculations

3.7 Democratic Dividends: OLS and Tobit regression – Second step

The primary objective of this study is to determine the impact of a country's democratic establishment on the efficiency of government public spending. In the initial step, we described the methodological approach by which we will evaluate public spending efficiency across three categories: Health, Education, and Social Protection. Subsequently, in the second step, regression analysis will be employed to examine the influence of democracy on efficiency within the mentioned three categories. To enhance the robustness of our findings, we incorporate control variables into our models to mitigate potential confounding factors and isolate the influence solely attributable to the democracy indicator.

The Democracy Index, published by the Economist Group, is a key tool for assessing the global environment for democracy. Rooted in quantitative and comparative analysis, this index focuses on democratic rights and institutions. Developed by the Economist Intelligence Unit, a division of the British Economist Group, the index uses a thorough methodology to assess democracy in individual countries.

The Democracy Index uses 60 indicators that are divided into five distinct categories: electoral process and pluralism, civil liberties, government functioning, political participation and political culture. Through a combination of expert opinions and public opinion, individual indicators are carefully evaluated, leading to a nuanced understanding of democratic performance.

Scores derived from these assessments are then aggregated and normalized to create an overall score for each country ranging from 0 to 10. This score, rounded to two decimal places, plays a key role in classifying countries into one of four regime types: full democracy, flawed democracy, hybrid regimes, or authoritarian regimes.

Renowned for its credibility, the Democracy Index enjoys wide recognition in the international press and academia, underscoring its importance as a tool for comprehensively assessing and understanding the state of democracy worldwide.

When deciding between OLS regression and Tobit regression for modeling DEA efficiency scores, several considerations come into play. Firstly, the nature of DEA efficiency scores, constrained within the interval [0;1], makes Tobit regression more suitable as it is tailored for modeling bounded variables, unlike OLS, which may predict scores outside this range.

Secondly, Tobit regression accounts for the censored distribution of DEA scores, acknowledging that they can only assume the value 1 with positive probability and cannot fall below 0. The interpretation of regression coefficients differs between the two methods: in OLS, coefficients represent direct effects, while in Tobit regression, they represent marginal effects on the probability of observing a score of 1 rather than 0 (Koff, 2007). To ensure the robustness of our findings, we opted to employ both regression approaches—namely, the non-linear tobit regression and the linear ordinary least squares (OLS) regression. The Tobit regression can be implemented using the following formula:

$$y_{it}^* = \boldsymbol{X}_{it}\beta + u_{it}$$

$$y_{it} = \begin{cases} 1 \; if \; y_{it}^* \geq 1 \\ y_{it}^* \; if \; 1 < y_{it}^* < 0 \\ 0 \; if \; y_{it}^* \; \leq 0 \end{cases}$$

Where: y_{it} is the observed DEA efficiency score, y_{it}^* is the latent variable, $\boldsymbol{X}_{it}$ represents the vector of independent variables for country i in year t, β is the vector of coefficients to be estimated and u_{it} is the error term. The second equation introduces the censoring mechanism. If y_{it}^* is less than or equal to 0, then y_{it} is set to 0. If y_{it}^* is between 0 and 1, then y_{it} takes the value of y_{it}^*. If y_{it}^* is greater than or equal to 1, then y_{it} is set to 1. The OLS regression can be implemented using the following formula:

$$y_{it} = \boldsymbol{X}_{it}\beta + u_{it}$$

Where: y_{it} is the observed DEA efficiency score for i country in a year t, $\boldsymbol{X}_{it}$ represents the vector of independent variables for university i in year t, β is the vector of coefficients to be estimated and u_{it} is the error term.

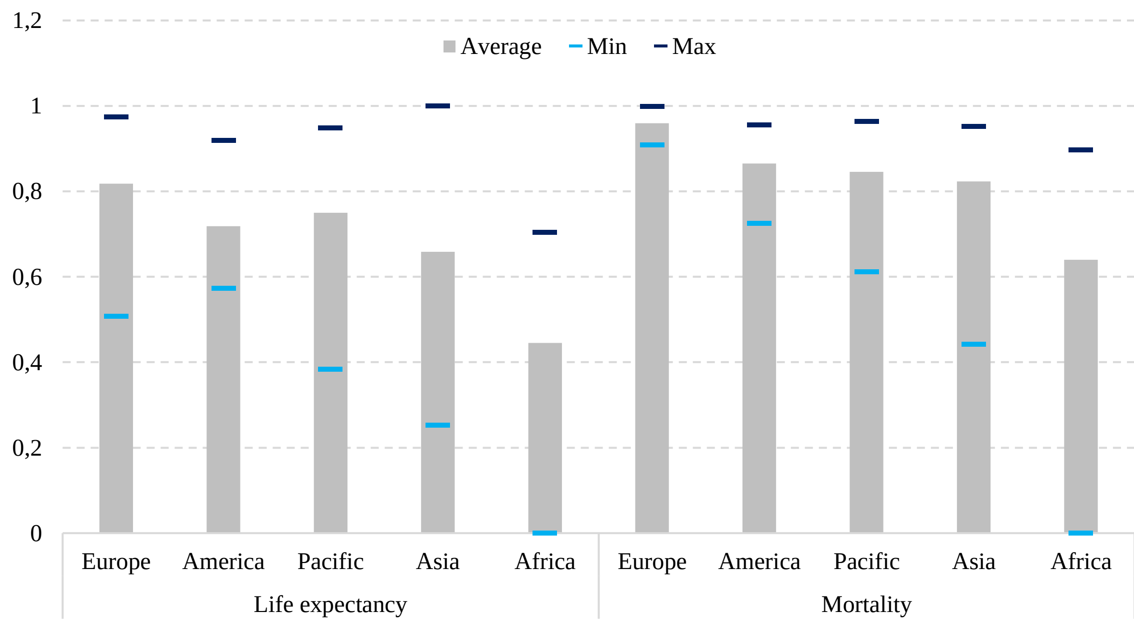
4 Results

4.1 Performance

This study focused on defining representative outputs of public finances for the purposes of efficiency analysis. Our methodology describes in detail our approach to public expenditure analysis. We divided the government's tasks into three COFOG categories: health, education and social protection. Within each category, we have created a separate performance indicator to assess the country's performance. Graph 6 shows how the countries in our sample performed in sub-indexes within the health performance index. European countries achieved the best results in all sub-indexes, with the most significant results achieved in the mortality sub-index. The reason is because European countries have the lowest infant and preventable mortality rates in the world.

The graph also reveals the greatest dispersion in Asia, where some countries (like Korea and Japan) boast the best healthcare in the world, while others (like Indonesia and Thailand) have some of the worst. The countries of the African continent achieve the worst results in all sub-indexes, mainly due to the several times lower level of public expenditure that would ensure an optimal level of health care.

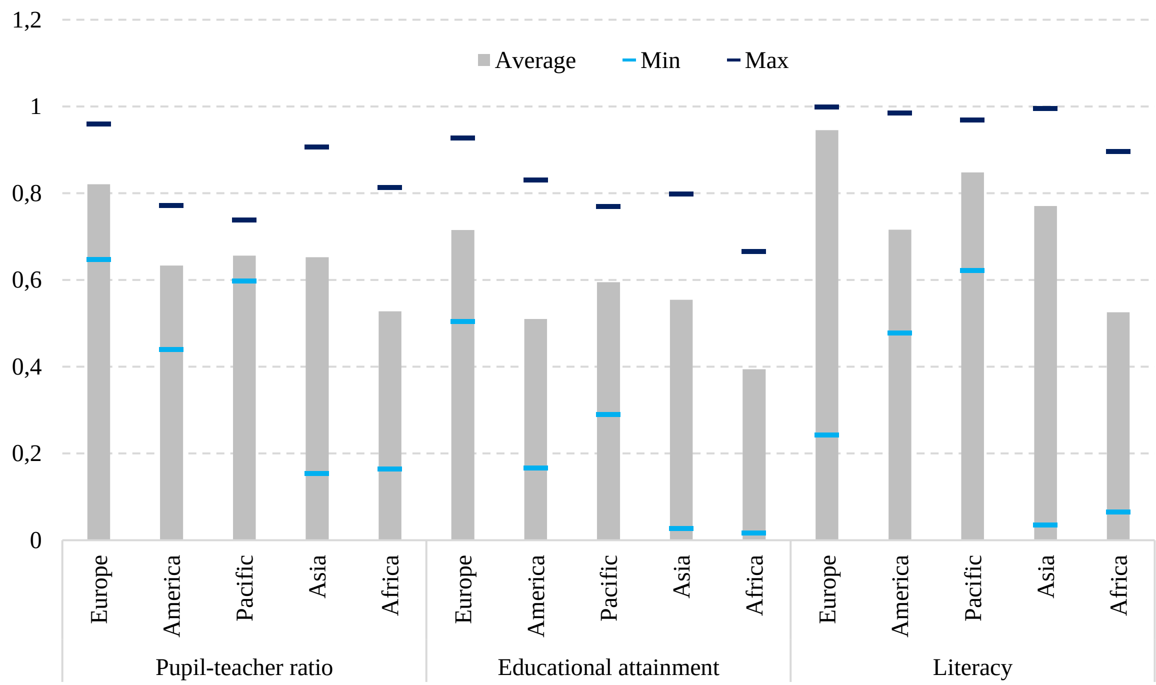
Graph 6: Comparison amongst continents in Health Performance sub-indexes



Source: World Bank, Custom calculations

Similar to the health sector, the countries of the European continent achieve the highest results within the performance sub-indexes in education. The highest values are in the literacy sub-index, where most EU countries have a 100 percent share of literate people. Countries in the Pacific region also have high values, where the average is primarily increased by Australia and New Zealand. Asia shows the highest degree of dispersion of results between individual countries for similar reasons as for the health sub-indices. The absolute lowest values in the Education Performance Index were in Afghanistan and Somalia.

Graph 7: Comparison amongst continents in Education Performance sub-indexes



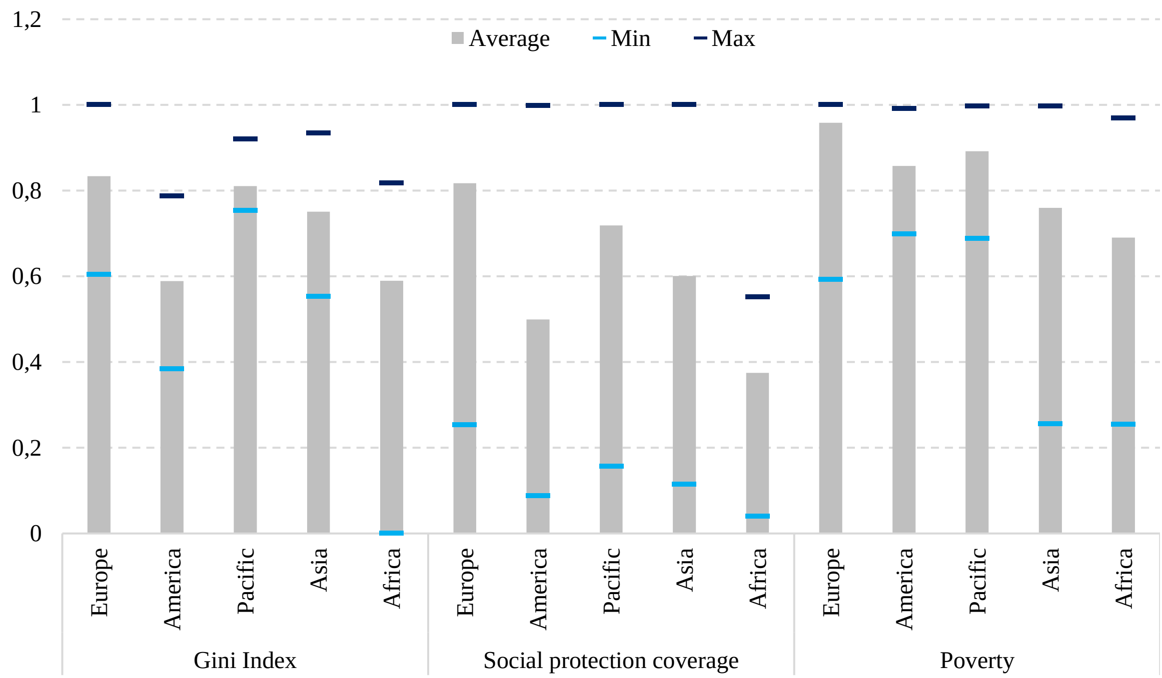
Source: World Bank, custom calculations

Within the sub-indexes of the Social Protection Index, we observe a similar trend as in the other two categories. European countries generally score the best, while African countries tend to perform the worst. The Gini coefficient, which measures income inequality, reveals that Pacific nations, particularly Australia and New Zealand, show levels comparable to Europe. This can be attributed to their effective progressive tax systems that help reduce inequality. It is notable that countries on the American continent achieve low values of the Gini coefficient because of their proportional tax systems.

When it comes to poverty, there is a strong contrast between European and African countries. European countries have largely solved the problem of widespread poverty in the past, while it is still one of the main problems for Africa. This significant difference is reflected in the poverty sub-index of the Social Protection Index. The countries with the highest overall performance index in the field of social protection were Slovenia, Finland, Belgium and Slovakia.

However, to assess the effectiveness of these programs, it is necessary to link the outputs (benefits provided) to the inputs (government spending). This allows for a more comprehensive understanding of how efficiently resources are used.

Graph 8: Comparison amongst continents in Social Protection Performance sub-indexes



Source: World Bank, custom calculations

Just looking at the outputs alone does not provide a complete picture. By considering both sides of the equation, we can better understand which countries are achieving good social outcomes while using their resources efficiently.

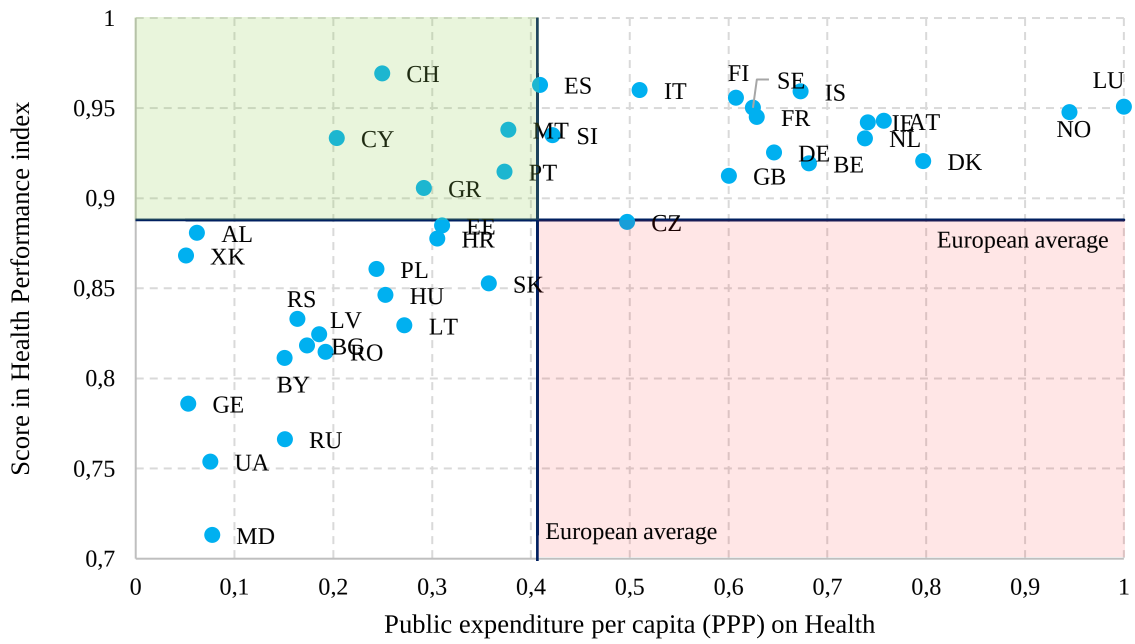
4.2 Linking Inputs with Outcomes

Given the larger sample of European countries compared to other continents, we decided to focus our analysis on comparing costs and outcomes in this particular region. Examining all countries at once would result in crowded and confusing comparison.

Graph 9 deals specifically with health care expenditure and the corresponding results for European countries from our sample. This graph is divided into four quadrants, each is defined by average spending and average results across Europe states. The green quadrant highlights countries that, despite spending less on healthcare than the European average, achieve above-average results. Switzerland is a prime example, achieving the best overall HPI score while maintaining lower than average healthcare spending.

Conversely, the red quadrant includes countries with above-average healthcare spending but below-average outcomes. The Czech Republic is slightly in this quadrant, indicating possible areas for improvement, as it spends more than average on healthcare without achieving the corresponding results. Luxembourg and Norway have the highest public expenditure on health care per capita, yet they also achieve high results. On the other hand, Moldova, Russia, and Ukraine exhibit the lowest health expenditure while also demonstrating the poorest outcomes in the HPI.

Graph 9: Comparison of expenditure and outcomes in Health in European countries

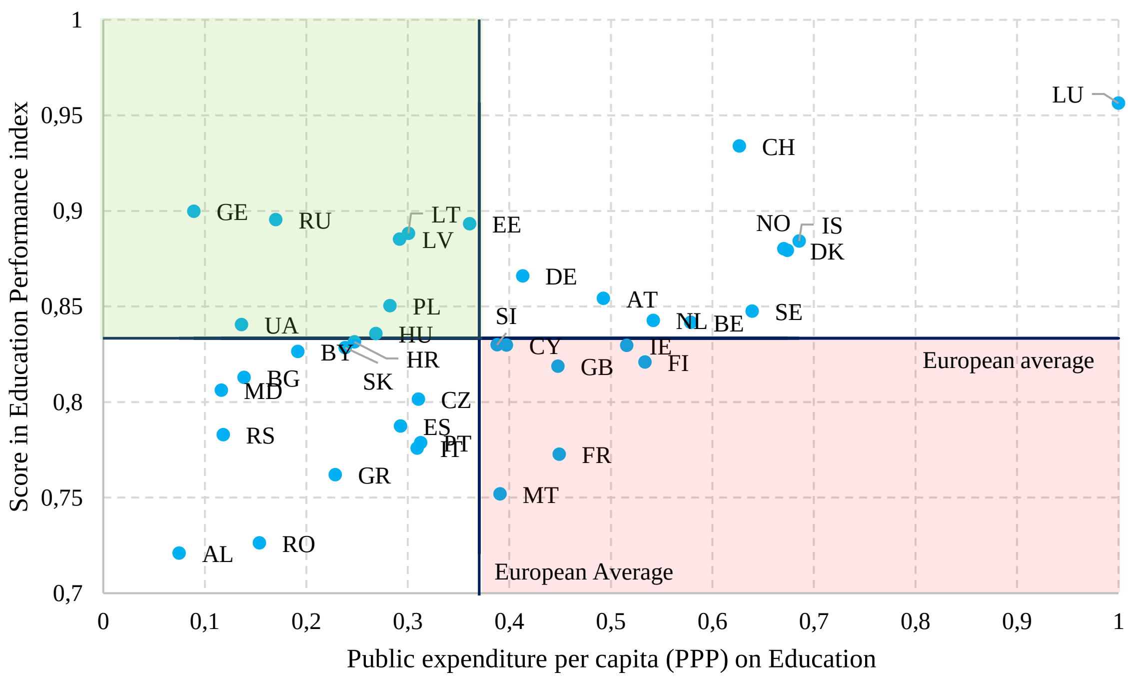


Source: World Bank, custom calculations

We conducted a similar comparison of results with education expenditures. Here, a concerning trend emerges: a higher number of countries fall within the red quadrant. This indicates that they spend above-average on education yet achieve below-average results.

France and Malta have the lowest results in this quadrant, mainly due to the low proportion of people with the highest completed tertiary education. On the other hand, Georgia and Russia have below-average spending on education, but achieve some of the best results in the field of education. In the case of Georgia, this is mainly due to the high number of teachers per pupil, and Russia has a high proportion of people with a maximum tertiary education. The Baltic countries are also all in the green quadrant, which indicates the efficiency of the use of public spending in these countries. Croatia and Slovakia lag slightly below the green quadrant. The best results in education in Europe are achieved by Luxembourg and Switzerland, but these countries also spend the most public finances on education.

Graph 10: Comparison of expenditure and outcomes in Education in European countries

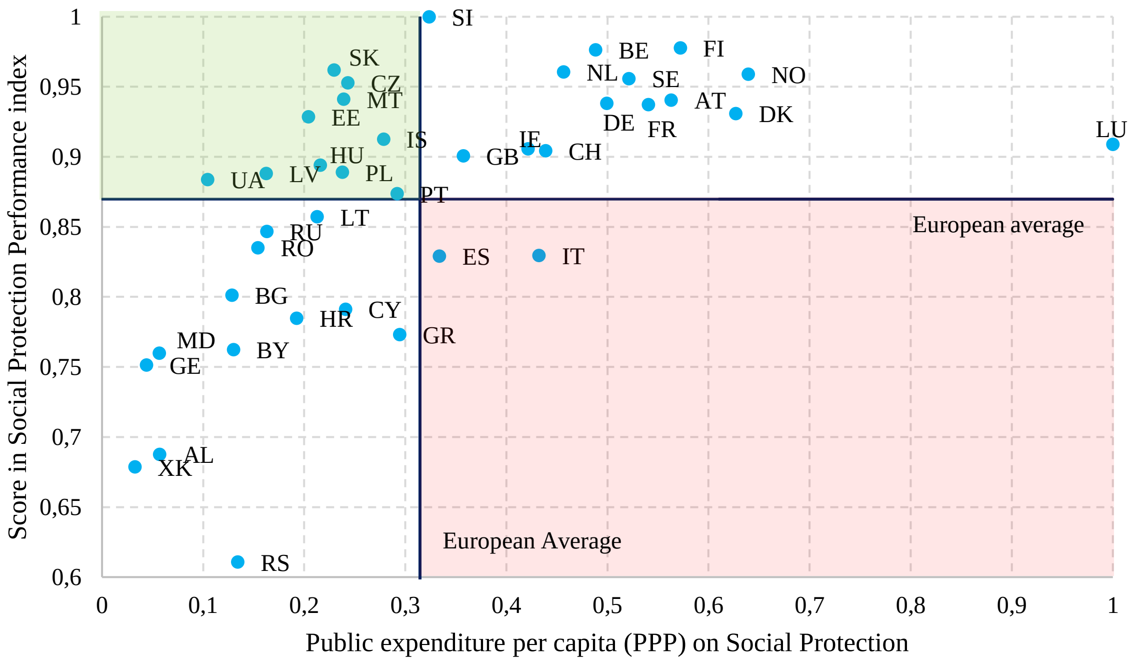


Source: World Bank, custom calculations

In the last part, we linked expenditures with results also in the field of Social Protection. Within this category, we record only two countries in the red quadrant, namely Italy and Spain. In these countries, public expenditure on social protection are above the European average, but the results lag mainly in income inequality, which is among the largest in

Europe. In contrast, Slovakia and the Czech Republic showcase the best results within the green quadrant. These countries boast robust state-run social protection systems, reflected in their low income inequality. The Baltic countries also have positive results, as only Lithuania is slightly below the green quadrant. Slovenia has the best results in Europe, which also shows the highest value in all three sub-indices from the SPPI.

Graph 11: Comparison of expenditure and outcomes in Social Protection in European countries



Source: World Bank, custom calculations

Across the three categories we observed in European countries, a general trend emerges as marginal public expenditure increase, marginal results tend to decrease. This finding supports the hypothesis concerning the construction of variable return to scale DEA models. In the next part, we will analyze the efficiency of public expenditure on a sample of all countries.

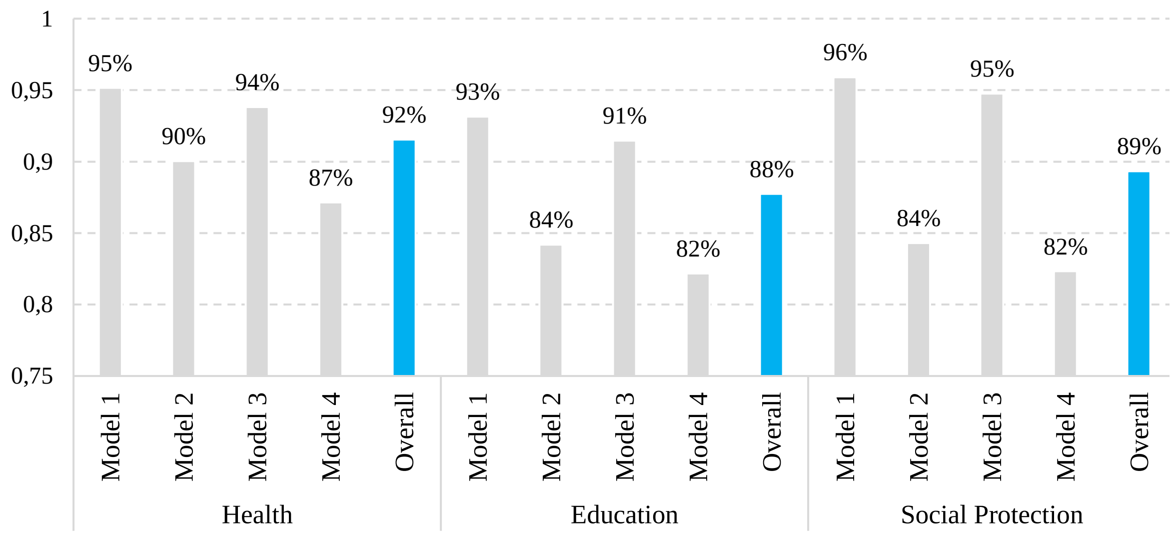
4.3 Efficiency analysis – DEA

Direct comparisons of results between countries can be misleading because individual nations allocate varying expense ratios to achieve similar inputs. As discussed earlier, Data Envelopment Analysis (DEA) serves as our chosen method for measuring efficiency. To enhance the robustness of our findings, we analyze each category (Health, Education, and

Social Performance) using four DEA models with different input and output combinations (presented in ***Table 1***).

By examining efficiency within each model, we observe that the Healthcare sector boasts the highest average efficiency rate (***Graph 12***). This suggests that, on average, countries are operating closest to their potential within the confines of their current healthcare spending. Conversely, the Education sector demonstrates the lowest efficiency, indicating a potential improvement of 12 percentage points without requiring additional public expenditures. Interestingly, we observe a relatively high variation in efficiency scores between models utilizing three outputs (three sub-indexes for category j). This can be attributed to the inherent characteristic of DEA models: as the total number of inputs and outputs increases, the resulting efficiency scores tend to exhibit less variability.

Graph 12: Average efficiency for a different DEA models



Source: custom calculations

To assess how sensitive our DEA models are to changes in combinations of inputs and outputs, we compared the correlation between efficiency scores across all models. ***Table 2*** showcases three prominent red triangles, each representing a strong positive correlation between efficiencies within a specific sector. This indicates that for a given sector, the efficiency scores from different models tend to agree with each other.

The education sector stands out with the lowest variation in efficiency scores under different input and output scenarios. This consistency stems from the education performance index's extensive set of indicators. This comprehensive approach minimizes discrepancies between sub-indices and the overall index, leading to more stable and reliable efficiency scores. In contrast, the healthcare sector exhibits a slightly higher degree of variation in efficiency scores across models. This can be partially explained by the healthcare performance index's limited number of indicators, but also reflects some variation in healthcare inputs across countries. Even within healthcare, however, most models demonstrate a correlation exceeding 70%, indicating a generally strong agreement in efficiency assessment.

As expected, the correlation between models from different sectors is generally lower. A country might excel in education efficiency but show lower efficiency in social protection, as exemplified by Russia. This makes sense because the factors influencing efficiency differ significantly across sectors. Nonetheless, the high correlation of efficiencies across various input and output configurations bolsters our confidence in the robustness of overall efficiency scores for each sector. This suggests that the core efficiency assessment remains reliable even with some variation in how efficiency is calculated.

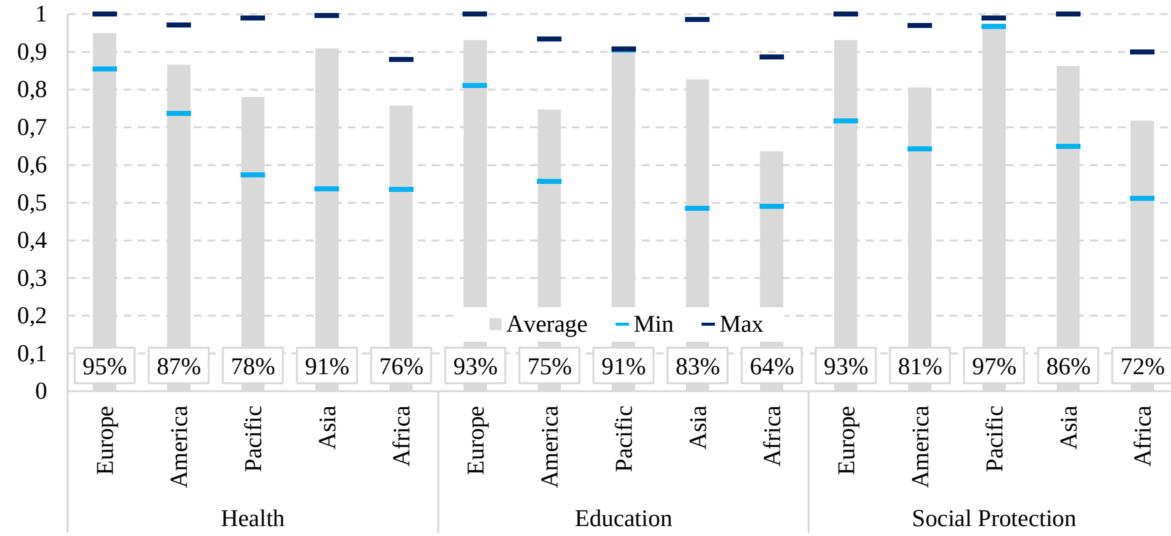
Table 2: Correlation map of DEA efficiency scores in different models*

		Health - models					Education - models					Social Protection - models				
		1	2	3	4	OVR	1	2	3	4	OVR	1	2	3	4	OVR
Health - models	1	1,00														
	2	0,89	1,00													
	3	0,76	0,63	1,00												
	4	0,72	0,79	0,89	1,00											
	OVR	0,90	0,89	0,91	0,95	1,00										
Education - models	1	0,62	0,50	0,73	0,66	0,69	1,00									
	2	0,53	0,39	0,68	0,59	0,60	0,93	1,00								
	3	0,58	0,47	0,73	0,68	0,68	0,98	0,94	1,00							
	4	0,53	0,38	0,71	0,61	0,62	0,92	0,98	0,94	1,00						
	OVR	0,57	0,44	0,73	0,65	0,66	0,97	0,98	0,98	0,98	1,00					
Social Protection - models	1	0,52	0,46	0,65	0,68	0,64	0,55	0,52	0,58	0,54	0,56	1,00				
	2	0,58	0,51	0,63	0,67	0,66	0,62	0,57	0,66	0,57	0,62	0,83	1,00			
	3	0,59	0,50	0,67	0,70	0,68	0,64	0,63	0,69	0,64	0,66	0,95	0,85	1,00		
	4	0,66	0,59	0,71	0,75	0,75	0,63	0,61	0,69	0,63	0,65	0,84	0,94	0,90	1,00	
	OVR	0,63	0,55	0,70	0,74	0,72	0,64	0,61	0,69	0,63	0,66	0,92	0,96	0,95	0,98	1,00

**OVR – Overall efficiency*

Our analysis reveals a clear trend in efficiency across continents. European countries achieve the highest average efficiency scores, which aligns with our initial expectations (***Graph 13***). Conversely, African countries exhibit the lowest average efficiency. This disparity is particularly pronounced in the education sector, where African countries appear to lag behind the most.

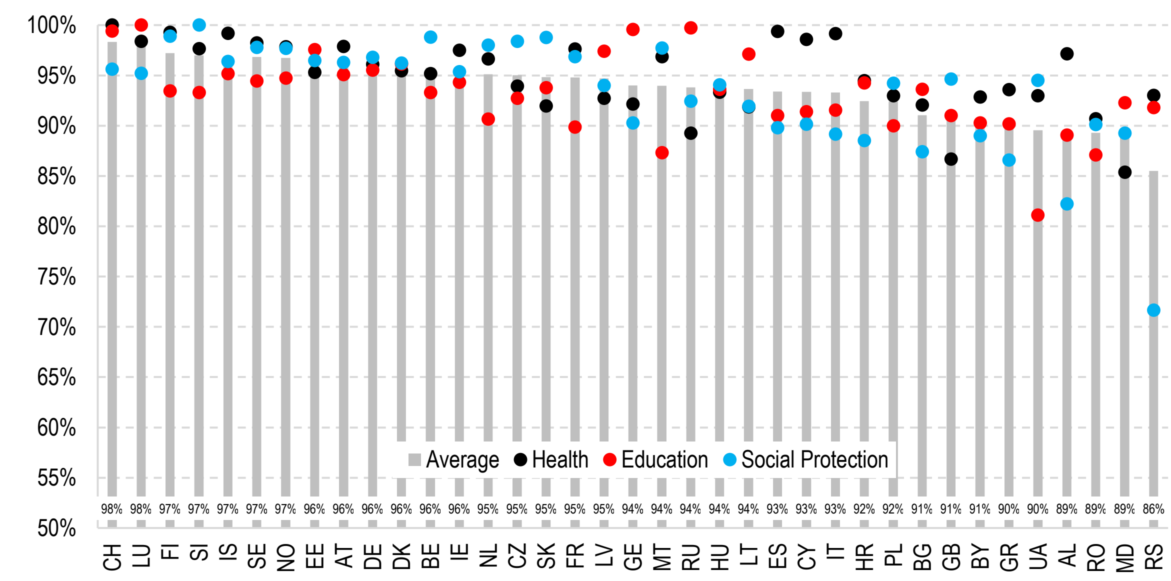
Graph 13: Comparison amongst continents in Overall efficiency scores in each category



Source: Custom calculations

Consistent with our focus throughout this study, we again delve into the efficiency of European countries. Luxembourg and Switzerland stand out with the highest average efficiency across the three categories. These nations, operating at their current spending levels, demonstrate minimal potential for improvement in the results, averaging just 2 percentage points. Scandinavian countries also exhibit considerable efficiency, largely attributable to their healthcare sector performance. Conversely, Russia ranks lowest in efficiency among European countries, particularly in social protection, presenting an opportunity to enhance results by over 35 percentage points with current expenditures.

Graph 14: Comparison of efficiencies amongst Europe countries



Source: custom calculations

4.4 Impact of a Democracy

Having analyzed efficiency across three categories, we now shift our focus to the core objective of this study: examining the influence of democratic governance on public spending efficiency. We employ individual regressions, utilizing average efficiency scores from the four DEA models for each category (j) as the dependent variable. The key independent variable in our analysis is the Democracy Index score for each country. To ensure the robustness of our findings, we utilize two regression methods: Ordinary Least Squares (OLS) and Tobit (detailed methodology provided elsewhere).

Table 3 reveals a statistically significant positive effect of the Democracy Index on public spending efficiency across all models. While the significance level is slightly lower in the education category, it remains statistically significant at the 0.01 level. In models using Average Efficiency as the dependent variable, the democracy coefficient can be interpreted as follows: a one-point increase in a country's Democracy Index score is associated with, on average, a 2 percentage point improvement in public spending efficiency

Table 3: Summary table of regression models without control variables

	DEA scores							
	OLS				Tobit Regression			
	Health	Education	Social Protection	Average Efficiency	Health	Education	Social Protection	Average Efficiency
Intercept	81.36 *** (3.81)	76.45 *** (6.27)	75.32 *** (4.61)	77.85 *** (3.90)	81.57*** (3.79)	76.10 *** (6.56)	75.13 *** (4.33)	77.92 *** (4.13)
LogSigma					-2.63*** (0.09)	-2.16*** (0.09)	-2.46*** (0.09)	-2.58*** (0.09)
Democracy Index	1.73 *** (0.42)	1.82 * (0.75)	2.24 *** (0.51)	1.98 *** (0.59)	1.72*** (0.45)	1.93 * (0.82)	2.25 *** (0.62)	2.03 *** (0.54)
R^2	0.181	0.087	0.208	0.197				
Adj. R^2	0.167	0.071	0.195	0.183				
F-statistic	13.5	5.59	15.58	5.24				
Log-likelihood					72.03	43.80	59.04	68.92
N	70	70	70	70	68	68	69	70

*Signif. codes: 0 "***" 0.001 "**" 0.01 "*" 0.05 "."*

To mitigate potential issues with causality and omitted variable bias, we incorporated control variables into our models. These variables aim to isolate the specific impact of democratic governance on efficiency. We included population, density, and GDP per capita as control variables, accounting for factors that could distort the results.

Table 4 demonstrates that democracy exerts a significant influence on public spending efficiency in most models. Education, however, appears to be the lone exception where democracy's effect is not statistically significant. Conversely, both Social Protection and Health sectors exhibit a clear positive association between democratic governance and efficiency.

Table 4: Summary table of regression models with control variables

	DEA scores							
	OLS				Tobit Regression			
	Health	Education	Social Protection	Average Efficiency	Health	Education	Social Protection	Average Efficiency
Intercept	78.46 *** (3.96)	80.09 *** (6.33)	74.97 *** (4.80)	77.84 *** (4.22)	78.44 *** (3.84)	80.38 *** (6.11)	75.28 *** (4.73)	77.82 *** (4.08)
LogSigma					1.926 *** (0.09)	2.39 *** (0.09)	2.13 *** (0.09)	1.99 (0.09)
Democracy Index	1.86 ** (0.62)	0.58 (0.99)	1.96 * (0.75)	1.47 * (0.66)	1.85 ** (0.60)	0.48 (0.96)	1.93 ** (0.07)	1.46 * (0.63)
Population (mil.)	0.01 * (0.00)	-0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.01 * (0.00)	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Density	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
GDP per capita (thous.)	0.02 (0.04)	0.16 * (0.07)	0.04 (0.05)	0.07 . (0.04)	0.03 (0.04)	0.18 * (0.07)	0.04 (0.05)	0.08 . (0.04)
R^2	0.25	0.165	0.233	0.252				
Adj. R^2	0.193	0.105	0.179	0.199				
F-statistic	4.667	2.768	4.263	4.738				
Log-likelihood					-201	-229	-211	-204
N	70	70	70	70	68	68	69	70

*Signif. codes: 0 "***" 0.001 "**" 0.01 "*" 0.05 "."*

5 Conclusion

The results of our work contribute to academic research primarily in the analysis of efficiency using a high number of indicators representing the outcomes of public expenditures. Our novel performance indexes for each area confirmed assumptions that higher levels of expenditure lead to better outcome indicators, while also affirming the hypothesis of diminishing marginal returns to scale.

The worst results in performance indexes were observed in African countries, while conversely, European countries had the best results, which is in line with previous literature and supports the methodology we chose for creating outcome indicators. Asian countries showed the highest variability in performance indexes, confirming the high contrast within different regions of Asia, where on one hand, there are some of the most developed countries in the world like South Korea and Japan, and on the other hand, some of the poorest countries in the world like Cambodia and Bhutan. We took a closer look at the results and expenditures in European countries, where we divided the countries into four quadrants defined by the average expenditures and outcomes for the given areas across European countries. Estonia is the only European country with below-average expenditures in all three areas and above-average outcomes, indicating a high efficiency in the utilization of public spending in this country. For the Health sector, we did not identify any country with above-average public spending and below-average outcomes, indicating a high average efficiency in the utilization of public spending in that area.

In our efficiency analysis, we identified a significant gap in the efficiency of public spending between African countries and European countries. While the average European country has a 6% potential for efficiency growth with current public expenditures, the average African country has up to 29%. Furthermore, we identified Switzerland and Luxembourg as countries with the highest level of efficiency in managing public expenditures globally, with only a 2% potential for improvement. Examining specific areas, we found the lowest level of efficiency on average in the education sector, signaling the need for greater prioritization of this area in the process of managing public expenditures.

In the final part of this study, we examined the impact of democratic governance on the efficiency of public financial management. Initially, we analyzed the influence of the democracy index variable on the resulting efficiency from our previous models, demonstrating that democratic governance has a positive and significant impact on public expenditure management in all areas. To enhance the robustness of the results, we incorporated control variables into our models to limit the influence solely to the democracy variable. From the results in **Table *4***, it is evident that the impact of democracy slightly diminished after controlling for other variables, yet it remained significant and positive in all areas except for education, where its significance discontinued. From the resulting model, we can interpret the results for democracy as follows: a one-point increase in a country's democracy index score leads to an average increase of 1.5 percentage points in the efficiency of public expenditures.

The findings of our work are intended to contribute mainly to academic research in the field of analyzing the efficiency of public financial management. Potential limitations and avenues for future research lie in the number of observations, which could be increased through the use of panel data. Similarly, future studies could further explore other factors potentially influencing the efficiency of public expenditures.

6 References

Adam, A., & Tsarsitalidou, S. (2023). Overall public sector efficiency. In book: Handbook on Public Sector Efficiency (pp.103-128). ISBN: 1839109157

Adam, A., Delis, M. D., & Kammas, P. (2008). Fiscal Decentralization and Public Sector Efficiency: Evidence from OECD Countries. Economics of Governance, 15(1).

Adam, A., Delis, M., & Kammas, P. (2011). Public Sector Efficiency: Leveling the Playing Field between OECD Countries. Public Choice, 146(1), 163–183.

Afonso, A., Jalles, J. T., & Venâncio, A. (2020). Government spending efficiency, measurement and applications: A cross-country efficiency dataset.EconPol Working Paper 50. Munich: ifo Institute - Leibniz Institute for Economic Research at the University of Munich.

Afonso, A., Romero-Barrutieta, A., & Monsalve, E. (2013). Public Sector Efficiency: Evidence for Latin America. ISEG Economics Working Paper No. 20. 42. SSRN: 2365007

Afonso, A., Schuknecht, L., & Tanzi, V. (2005). Public Sector Efficiency: An International Comparison. Public Choice, 123(3), 321–347.

Afonso, A., Schuknecht, L., & Tanzi, V. (2010). Public sector efficiency: evidence for new EU member states and emerging markets. Applied Economics, 42(17), 2147–2164.

Antonelli, M. A., & De Bonis, V. (2019). The efficiency of social public expenditure in European countries: a two-stage analysis. Applied Economics, 51(1), 47–60.

Asatryan, Z., & De Witte, K. (2015). Direct democracy and local government efficiency. European Journal of Political Economy, 39, 58–66.

Balaguer-Coll, M. T., Prior, D., & Tortosa-Ausina, E. (2007). On the determinants of local government performance: A two-stage nonparametric approach. European Economic Review, 51(2), 425–451.

Biddle, B. J., & Berliner, D. C. (2002). Small Class Size and Its Effects. Educational Leadership, 59(5).

Borge, L.-E., Falch, T., & Tovmo, P. (2008). Public sector efficiency: the roles of political and budgetary institutions, fiscal capacity, and democratic participation. Public Choice, 136(3), 475–495.

Brini, R., & Jemmali, H. (2016). Public spending efficiency, governance, political and economic policies: Is there a substantial causal relation? Evidence from selected MENA countries. International Journal of Economics and Financial Management, 1(1), 2545–5966.

Del Rocío Moreno-Enguix, M., & Bayona, L. V. L. (2017). Factors Affecting Public Expenditure Efficiency in Developed Countries. Politics and Policy, 45(1), 105–143.

Gao, Y. (2015). Democracy and Public Sector Efficiency: An Empirical Study with the Cross-National Data. Gao, Y. (2015). Democracy and Public Sector Efficiency: An Empirical Study on the Cross-National Data. SSRN Electronic Journal.

Geys, B., Heinemann, F., & Kalb, A. (2010). Voter involvement, fiscal autonomy and public sector efficiency: Evidence from German municipalities. European Journal of Political Economy, 26(2), 265–278.

Grigoli, F., & Ley, E. (2012). Quality of Government and Living Standards: Adjusting for the Efficiency of Public Spending. IMF Working Papers, 2012(182).

Halaskova, M., Halaskova, R., & Prokop, V. (2018). Evaluation of Efficiency in Selected Areas of Public Services in European Union Countries. Sustainability, 10(12), 4592.

Hauner, D. (2008). Explaining Differences in Public Sector Efficiency: Evidence from Russia's Regions. World Development, 36(10), 1745–1765.

Hauner, D., & Kyobe, A. J. (2008). Determinants of Government Efficiency. IMF Working Papers, 2008(228), 1018-5941

Herrera, S., & Pang, G., (2005). Efficiency Of Public Spending In Developing Countries: An Efficiency Frontier Approach. The World Bank - Policy Research Working Papers Vol. 1, 2 & 3

Christl, M., Köppl-Turyna, M., & Kucsera, D. (2020). Determinants of Public-Sector Efficiency: Decentralization and Fiscal Rules. Kyklos, 73(2), 253–290.

IMF. (2020). Well Spent: How Strong Infrastructure Governance Can End Waste in Public Investment. IMF - Book, 344, 9781513511818

Kurnia, A. S. (2012). Public sector efficiency of decentralized local government in Indonesia : a political and institutional analysis. School of Economics and Finance, Curtin Business School.

Monfort, B. (2015). Can Increased Public Expenditure Efficiency Contribute to the Consolidation of Public Finances in Japan? CEAFJ DISCUSSION PAPER SERIES.

Negri, C., & Dincă, G. (2023). Public sector's efficiency as a reflection of governance quality, an European Union study. PLoS One, 18(9), e0291048.

Palmer, S., & Torgerson, D. J. (1999). Economics notes: Definitions of efficiency. BMJ, 318(7191), 1136.

Porcelli, F. (2009) Measurement of Technical Efficiency. A Brief Survey on Parametric and Non-Parametric Techniques. - References - Scientific Research Publishing." 1 May. 2024

Prasetyo, A. D., & Zuhdi, U. (2013). The Government Expenditure Efficiency towards the Human Development. Procedia Economics and Finance, 5, 615–622.

Rayp, G., & Van De Sijpe, N. (2007). Measuring and explaining government efficiency in developing countries. The Journal of Development Studies, 43(2), 360–381.

United Nations. (2024). Human Development Report 2023-24. Human Development Reports.

Visbal-Cadavid, D., Martínez-Gómez, M., & Guijarro, F. (2017). Assessing the Efficiency of Public Universities through DEA. A Case Study. Sustainability, 9(8), 1416.

Wang, L., & Calvano, L. (2022). Class size, student behaviors and educational outcomes. Organization Management Journal, 19(4), 126–142.