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# Modeling the Efficiency of Public Service Delivery Using GDP Indicators

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## Abstract

Macroeconomic indicators are quantitative metrics that provide critical insights into the overall state and dynamics of an economy at both national and regional levels. These indicators are indispensable tools for economists, policymakers, business leaders, and investors, aiding in the comprehensive analysis of the current economic environment and supporting informed decision-making processes. For example, Gross Domestic Product (GDP), a key macroeconomic indicator, measures the total market value of all goods and services produced within a country's borders over a specific period, usually quarterly or annually. GDP serves as a comprehensive gauge of economic activity and growth trajectories. The scale of the population, labor force, and available land are critical indicators reflecting labor market conditions and economic resources. Government expenditures, primarily directed towards public services, constitute a significant portion of the state budget and often correlate with public sector employment levels. These indicators collectively provide a multidimensional view of economic performance, encompassing production, employment, trade, and public finances. However, the improvement of any single economic indicator does not fully capture the evaluation of a citizen's quality of life. Instead, quality of life depends on the effective management of the state budget, equitable resource distribution, and achieving income growth satisfaction. Each household can attain satisfactory living standards by aligning its expenditures with its income. Underlying this philosophy is the belief that every nation has the potential to enhance its economic prosperity and happiness index through prudent fiscal planning aligned with its wealth generation capacity. Guided by this principle, countries are assessed based on the size of their Gross Domestic Product (GDP), in accordance with the United Nations Sustainable Development Policy framework. Our focus is on evaluating the provision of public services, using key indicators to measure progress in this domain.

**Keywords**

Labor Force, Public Servants, Cluster Sampling, Sustainable Development

## 1. Introduction

The quantity of public sector employment (PSE) significantly influences the state budget, yet it also underpins the effective provision of essential public services, encompassing health care, education, infrastructure, and social welfare. The extent of public sector employment directly impacts the implementation of public policies, enforcement of regulations, and provision of public goods. Moreover, an expansion in public sector employment plays a pivotal role in fostering social cohesion and community development by generating employment opportunities, alleviating unemployment, and instilling a sense of security among citizens. Public sector jobs often offer stable wages and benefits, thereby contributing to income equality and poverty alleviation. Furthermore, the number of public sector employment shapes citizens' trust in governmental institutions. During crises such as natural disasters or pandemics, the presence of government personnel becomes indispensable for facilitating prompt and effective response and recovery efforts. While quantifying the precise impact of PSE numbers on budget expenditures proves challenging, the efficacy of public institutions and governance significantly influences the promotion of social well-being and happiness. There are numerous researchers, policymakers, and experts who might discuss or study this topic, including academics specializing in public administration, government officials involved in public service management, and consultants in the field of organizational efficiency. Christopher Hood, a renowned political scientist, who specializes in public administration, governance, and public sector reform, delves into the efficient and effective delivery of public services (Hood, 2000). Similarly, scholars such as Kahn (1983), Moore (1995), Ostrom (2015), and Donahue & Zeckhauser (2011) have produced significant works in this field. Through their research, publications, and policy recommendations, these experts have substantially contributed to understanding and enhancing the efficiency of public services. Anjula Gurtoo and Colin C. Williams examined the status of public service in developing countries, in the sectors of health, infrastructure, labor and marginalized populations, rural economy and public administration (Gurtoo & Williams, 2015).

The study encompassed 108 countries with comprehensive data sourced from official releases by the International Labor Organization and other online resources in 2022 (see **Table A1** in Appendix). The data to be used in the research was not complete for some countries and it was inconsistent with some sources. Therefore, the sample was created from those countries for which quantitative data were complete. These countries were categorized based on their GDP rankings: 24 nations with GDPs up to 30,000 million USD were classified as low in-

come; 33 countries with GDPs ranging from 30,000 million USD to 200,000 million USD were deemed below average; 25 nations with GDPs between 200,000 million USD and 500,000 million USD were categorized as average income; 10 countries with GDPs exceeding 1,000,000 million USD were classified as above average; 14 nations with GDPs between 1,000,000 million USD and 5,000,000 million USD were designated as high income; and 2 countries with GDPs surpassing 5000 billion USD were labeled as extremely high income. The average GDP among these 108 countries amounted to 480,000 million USD. The world's 108 countries have been categorized into six clusters based on their GDP levels: low, below average, average, above average, high, and extremely high.

Table 1 illustrates that 56% of the countries analyzed exhibit low or below-average GDP levels, with the United States and China, positioned in the very high GDP cluster, contributing a mere 1%.

Table 1. Clusters on GDP for considering 108 countries.

| GDP/US billion $/ | 0 - 30 | 30 - 200 | 200 - 500 | 500 - 1000 | 1000 - 5000 | 5000-up |
|---|---|---|---|---|---|---|
| GDP clusters | I Low | II Below average | III Average | IV Above average | V High | VI Very high |
| Number of countries | 24 | 33 | 25 | 10 | 14 | 2 |
| Probability | 0.23 | 0.33 | 0.22 | 0.09 | 0.12 | 0.01 |

## 2. A Research Methodology

The sample research method, a cornerstone of research methodology, entails selecting a subset (sample) from a larger population to study and generalize findings about the entire population. Given the impracticality of studying the entire population, sampling enables researchers to draw valid inferences from a representative and manageable group. In the study, we used a cluster sampling method and employed a first-order linear regression model with four factors. Thus,

$$\hat{Y} = c_0 + c_1 \cdot x_1 + c_2 \cdot x_2 + c_3 \cdot x_3 + c_4 \cdot x_4 . \quad (1)$$

Here $x_1, x_2, x_3$ and $x_4$ —sample values or factors, $c_0, c_1, c_2, c_3$ and $c_5$ —parameters of the model, $\hat{Y}$ —estimated values of the sample regression. The joint effects of the factors were not considered in the sample regression model, as the impact of these factors on the number of public sector employees was examined separately. The parameters were estimated using the method of least squares during the construction of a multivariate regression model. Subsequently, we applied the following criteria as filters.

**Criterion.** A value meets the criteria if the absolute difference between its actual value ($Y$) and its estimated value ($\hat{Y}$) is less than σ.

$$\left|Y - \hat{Y}\right| < \sigma . \quad (2)$$

Here, $Y - \hat{Y}$ were the residuals, and σ were the standard deviation for each

level.

We began by clustering the sample values and subsequently developed a regression model for each cluster. After filtering the model's outcomes based on criterion (2), our objective was to refine the most suitable cluster model. This approach to cluster regression effectively illustrates the trend of the factor in a straightforward manner.

## 3. The Estimation of Public Sector Employment Numbers

PSE plays a pivotal role in providing essential services to the populace. Within each cluster, we analyze the correlation between the number of public sector employees in a country and factors such as population size, area size, labor force, and GDP. We utilized MS Excel and EViews to perform the calculations.

### 3.1. Calculations for Cluster I

In this cluster, the analysis focuses on modeling the number of PSE in the 24 countries with low GDP, considering population, area size, labor force, and GDP. Among these variables, there is a weakly positive correlation of 32.9% between the number of public sector employees and the labor force, a very weakly positive correlation of 21% with population size, a very weakly negative correlation of 8% with area size, and a strong negative correlation of 52.1% with GDP size, indicating an overall negative relationship on average. For the models, $x_1$—GDP (million USD), $x_2$—number of labor force, $x_3$—population, $x_4$—area size (square kilometre) and $Y$—number of PSE are noted. A regression model was constructed using Equation (1) with sample values corresponding to cluster I. Thus,

$$\begin{aligned}\hat{Y} = 1096622.984 - 49.56463 \cdot x_1 + 0.128730 \cdot x_2 \\ - 0.003542 \cdot x_3 - 0.392865 \cdot x_4\end{aligned}. \quad (3)$$

According to the statistical parameters of Equation (3) for Cluster I, the coefficient of determination ($R^2$ = 0.417109) indicates that the four selected factors explain approximately 42% of the variance in public sector employment. The Durbin-Watson statistic (DW = 1.469647) suggests an autocorrelation of residuals. According to the analysis, all the coefficients except for the coefficient of $x_1$ are weakly significant, and also according to F-statistic, the model (3) does not obey the normal distribution law (see Table 2).

Table 2. Statistical outputs of model (3) in Cluster I.

| Variable | Coefficient | Std. Error | t-statistic | Probability |
|---|---|---|---|---|
| GDP | −49.56463 | 17.56019 | −2.822557 | 0.0109 |
| Labor force | 0.128730 | 0.107074 | 1.202252 | 0.2440 |
| Population | −0.003542 | 0.028518 | −0.124196 | 0.9025 |
| Area size | −0.392865 | 0.498023 | −0.788849 | 0.4399 |
| C | 1096622.984 | 378004.1 | 2.901087 | 0.0092 |

**Continued**

| | | | |
|---|---|---|---|
| R-squared | 0.417109 | Mean dependent variable | 534073.2 |
| Standard error of regression | 569581.0 | Std. Deviation dependent var | 678070.0 |
| Sum squared residual | 6.16E+12 | F-statistic | 3.399030 |
| Durbin-Watson statistic | 1.469647 | Probability of F-statistics | 0.029430 |

The model indicates that a one billion US dollar increase in GDP results in a decrease of 49 public sector employees. Conversely, an increase of 1000 in the labor force corresponds to an increase of 128 public sector employees, while a population increase of 10,000 leads to a decrease of 35 public sector employees. In this cluster, the average number of PSE is 534,073 with a standard deviation of 678,070. According to the single sigma rule, the acceptable range for the number of PSE is between 0 and 1,212,143. If the condition $Y - \hat{Y} \geq \sigma$ is fulfilled, the number of PSE in the country is considered too large, and if the condition $Y - \hat{Y} \leq -\sigma$ is fulfilled, the number is considered too small. Based on criterion (2), Cuba has an excessively high number of PSE, whereas Madagascar and Rwanda have too small (see Figure 1). This range is designated as Level A for Cluster I.

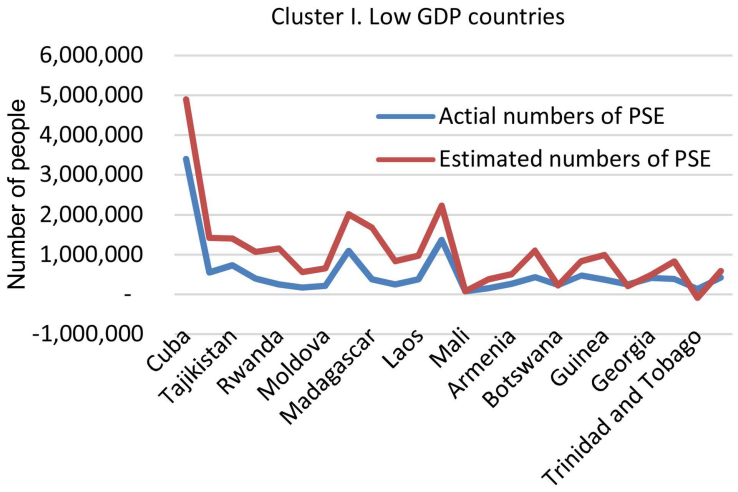


Figure 1. Comparison of actual and estimated values for cluster I.

In order to improve the model, countries that do not meet the criteria for the Level A model will be excluded. A new linear regression model will then be built for the remaining countries, designated as Level B. This process will continue, creating Level C and so on, until a model with a high coefficient of determination and satisfactory Durbin-Watson (DW) analysis is achieved. Initially, 21 countries were modeled, excluding Cuba (too large at Level A) and Madagascar and Rwanda (too low). At Level B, Yemen and Botswana were also excluded due to severity, leaving 19 countries for Level C. At this level, Tajikistan, Georgia, and Zambia were above the criterion, while Moldova, Nicaragua, and Albania were below it, resulting in 13 countries for Level D after excluding these six. Fi-

nally, Laos and Zimbabwe did not meet the criteria at Level D, leading to a Level E model with the remaining 11 countries. Consequently, Liberia and Senegal were excluded from the E-level countries, while nine countries—Kyrgyzstan, Niger, Afghanistan, Mali, Armenia, Haiti, Guinea, Bosnia and Herzegovina, and Trinidad and Tobago—qualified. Since all these countries met the criteria, the calculations were concluded. A regression model was then constructed for each of the five levels, and these equations were subsequently combined. Thus,

$$\hat{Y}_1 = \begin{pmatrix} \hat{Y}_{1A} \\ \hat{Y}_{1B} \\ \hat{Y}_{1C} \\ \hat{Y}_{1D} \\ \hat{Y}_{1E} \end{pmatrix} = \begin{pmatrix} -49.564 & 0.128 & -0.003 & -0.392 \\ -10.177 & -0.013 & 0.034 & -0.64 \\ -10.255 & -0.01 & 0.031 & -0.642 \\ -15.237 & -0.037 & 0.036 & -0.756 \\ -14.695 & -0.045 & 0.038 & -0.773 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} + \begin{pmatrix} 1096622.984 \\ 430301.568 \\ 425659.469 \\ 563251.076 \\ 546207.072 \end{pmatrix} \quad (4)$$

In system (4), the first equation corresponds to level A, and so on, with the fifth and last equation corresponding to level E. The determination coefficients ($R^2$) of the regression models for Cluster I were 0.417, 0.748, 0.773, 0.978, and 0.995 for levels A, B, C, D, and E, respectively. Additionally, the Durbin-Watson (DW) indices were 1.469, 1.995, 1.815, 2.017, and 1.885 for these levels. Notably, at level E, the DW index was very close to 2, indicating that the regression model for the last level is highly reliable. The coefficients of determination improved progressively from level A to level E, reaching 0.995, which signifies that the four selected factors account for 99.5% of the variation in the numbers of PSE. In the final model based on Equation (4), all the coefficients are highly significant (see Table 2). In Cluster I, countries at level E met the criterion (2). Among the countries in Cluster I, Armenia leads in this indicator (see Table 3).

Table 3. The model (4) results.

| Cluster I | | The number of public sector employments | | 24 countries |
|---|---|---|---|---|
| | | Too large | Too little | |
| Levels | A | Cuba | Madagascar, Rwanda | 3 |
| | B | Yemen, Botswana | - | 2 |
| | C | Tajikistan, Zambia, Georgia | Moldova, Nicaragua, Albania | 6 |
| | D | Laos, Zimbabwe | - | 2 |
| | E | Liberia | Senegal | 2 |
| Eligible countries | | Kyrgyzstan, Niger, Afghanistan, Mali, Armenia, Haiti, Guinea, Bosnia and Herzegovina, Trinidad and Tobago | | 9 |

At each level of Cluster I, the model was refined by excluding countries that did not meet the quantitative criteria for public sector employment. Among

countries with low GDP, those remaining at the E level demonstrate the best and most appropriate development trends for GDP, population, labor force, and area size. In this cluster, Armenia best met the criteria. For countries with low GDP, the size of the land showed a very weak correlation with the number of public sector employments. This near-irrelevance suggests that government activities are not effectively reaching the population or are creating an excessive burden. The same methodology was applied to further model the other clusters.

### 3.2. Calculations for Cluster II

Cluster II comprises 33 countries with below-average GDP income. Within this cluster, Cameroon, Jordan, Belarus, Venezuela, and Ukraine exceed the criteria, while Ethiopia and Kuwait fall below. At level B, out of 26 countries, Uzbekistan, Guatemala, Oman, and Morocco surpass the criteria, whereas Tanzania, Luxembourg, and Ecuador fall short. Moving to level C, among the remaining 19 countries, Serbia and Azerbaijan stand as outliers, while Costa Rica and Uruguay underperform. Of the 15 countries progressing to level D, Latvia and Croatia exceed expectations, whereas Bahrain and Slovenia lag behind. If these four countries were excluded and evaluated at level E, Bulgaria would not meet the criteria. Among the model-tested characteristics of the remaining 10 countries at the subsequent F level, Paraguay overachieves, while Lithuania underachieves. Lastly, all of the remaining eight countries meet the criteria for modeling at level G. The models for each of these levels were integrated to create the following system of equations.

$$\hat{Y}_2 = \begin{pmatrix} 5.973 & 0.388 & -0.135 & 0.347 \\ 7.641 & 0.369 & -0.119 & 0.106 \\ 6.692 & 0.307 & -0.096 & 0.097 \\ 6.996 & 0.122 & -0.032 & 0.093 \\ 7.002 & 0.063 & -0.112 & 0.074 \\ 7.056 & 0.041 & -0.004 & 0.065 \\ 7.159 & 0.008 & 0.007 & 0.053 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} + \begin{pmatrix} 70019.526 \\ -291073.501 \\ -219093.611 \\ -174200.064 \\ -137932.054 \\ -121807.281 \\ -108277.298 \end{pmatrix} \quad (5)$$

In Cluster II, the determination coefficients ($R^2$) of regression models were 0.669, 0.862, 0.838, 0.958, 0.993, 0.995, and 0.998 for levels A, B, C, D, E, F, and G, respectively. The coefficient notably increased to 0.999 at the final level, indicating a substantial enhancement in the model's explanatory power. Correspondingly, the Durbin-Watson (DW) indices were 1.981, 2.483, 2.437, 1.552, 2.361, 2.785, and 2.306 for these seven levels, respectively, with the index nearing 2 at the G level, affirming the robustness of the last-level regression model. Countries at level G within Cluster II—El Salvador, Estonia, Bolivia, Uganda, Mongolia, Ghana, Slovakia, and Hungary—all adhere to the criteria for public sector employments (see Table 4). Mongolia leads among these countries in terms of this indicator within the cluster.

**Table 4.** Some results of the model (5) on Cluster II.

| Cluster II | | The number of public sector employments | | 33 countries |
|---|---|---|---|---|
| | | Too large | Too little | |
| Levels | A | Cameroon, Jordan, Belarus, Venezuela and Ukraine | Ethiopia, Kuwait | 7 |
| | B | Uzbekistan, Guatemala, Oman, and Morocco | Tanzania, Luxembourg, and Ecuador | 7 |
| | C | Serbia, Azerbaijan | Costa Rica, Uruguay | 4 |
| | D | Latvia, Croatia | Bahrain, Slovenia | 4 |
| | E | - | Bulgaria | 1 |
| | F | Paraguay | Lithuania | 2 |
| | G | El Salvador, Estonia, Bolivia, Uganda, Mongolia, Ghana, Slovakia and Hungary (Eligible countries) | | 8 |

### 3.3. Calculations for Cluster III

This cluster comprises 25 countries with an average GDP. Like the preceding cluster, as the levels progress from A onward, all seven remaining countries at level F successfully met the criteria for modeling. These models for each level were then integrated to create the following system of equations. Thus,

$$\hat{Y}_3 = \begin{pmatrix} 1.93 & 0.009 & 0.015 & 0.739 \\ 1.354 & 0.001 & 0.033 & 0.386 \\ 0.385 & -0.013 & 0.047 & 0.272 \\ 0.439 & -0.006 & 0.043 & 0.412 \\ -0.208 & -0.015 & 0.047 & 0.377 \\ -1.306 & -0.016 & 0.048 & 0.321 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} + \begin{pmatrix} -16010.815 \\ -139000.26 \\ 139251.202 \\ 94583.336 \\ 339480.901 \\ 725254.859 \end{pmatrix} \quad (6)$$

In Cluster III, the determination coefficients ($R^2$) of regression models were 0.626, 0.874, 0.946, 0.981, 0.993, and 0.999 for levels A, B, C, D, E, and F, respectively. Notably, the coefficient reached 0.999 at the final level, signifying a significant enhancement in the model's explanatory power. Additionally, the Durbin-Watson (DW) indices were 2.706, 2.594, 1.69, 1.715, 2.227, and 2.117 for these levels, respectively, with the index nearing 2 at the C level, indicating the high quality of the last-level regression model. Within Cluster III, the countries at level F—Kazakhstan, Portugal, Finland, Czech Republic, Iran, Vietnam, and Singapore—all meet the criteria (see Table 5). Additionally, Kazakhstan leads among the countries in this cluster regarding this indicator.

**Table 5.** Some results of the model (6) on Cluster III.

| Cluster III | | The number of public sector employments | | 25 countries |
|---|---|---|---|---|
| | | Too large | Too little | |
| Levels | A | Iraq, Pakistan, Egypt | Bangladesh, Nigeria | 5 |
| | B | South Africa | Colombia, Philippines | 3 |

**Continued**

| | | | |
|---|---|---|---|
| C | Greece, Romania | Peru, Chile | 4 |
| D | Denmark, Thailand | New Zealand, Austria | 4 |
| E | Malaysia | Qatar | 2 |
| F | Kazakhstan, Portugal, Finland, Czech Republic, Iran, Vietnam and Singapore | | 7 |

### 3.4. Calculations for Cluster IV

This cluster comprises 10 countries with above-average GDP. As with the previous cluster, all seven remaining countries at level C met the criteria for modeling, following a sequential improvement from level A. The models for each of these levels were then integrated to create the following system of equations. Thus,

$$\hat{Y}_4 = \begin{pmatrix} -0.711 & 0.402 & -0.086 & -0.033 \\ 0.606 & 0.1 & 0.008 & 0.175 \\ 0.786 & 0.074 & 0.016 & 0.199 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} + \begin{pmatrix} 437048.504 \\ 115551.183 \\ 47407.401 \end{pmatrix} \quad (7)$$

The determination coefficients for regression models within Cluster IV were 0.928, 0.992, and 0.999 for levels A, B, and C, respectively. Notably, the coefficient reached its highest value of 0.999 at level C, signifying a substantial improvement in the model's explanatory power. Additionally, the Durbin-Watson (DW) indicators exhibited values of 2.245, 2.496, and 1.864 for levels A, B, and C, correspondingly. Remarkably, the indicator approached the desired threshold of 2 in the final C level, indicating enhanced model performance.

The countries classified as C level within Cluster IV—Belgium, Norway, Sweden, Argentina, Türkiye, and the Netherlands—each meet the criteria for PSE numbers, as outlined in Table 6. Notably, the Netherlands has emerged as the frontrunner in this cluster, surpassing its counterparts in this particular indicator.

Table 6. Some results of the model (7) on Cluster IV.

| Cluster IV | | The number of public sector employments | | 10 countries |
|---|---|---|---|---|
| | | Too large | Too little | |
| Levels | A | Poland | United Arab Emirates | 2 |
| | B | Israel | Ireland | 2 |
| | C | Belgium, Norway, Sweden, Argentina, Türkiye, and Netherlands | | 6 |

### 3.5. Calculations for Cluster V

This cluster includes 14 high-income countries. It is improved successively from A level to D level. Calculation results:

$$\hat{Y}_5 = \begin{pmatrix} 0.819 & 0.161 & -0.043 & 1.031 \\ 0.136 & 0.11 & -0.027 & 0.545 \\ 0.467 & 0.128 & -0.033 & 0.516 \\ 0.198 & 0.129 & -0.033 & 0.489 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} + \begin{pmatrix} -1338139.007 \\ 2381032.023 \\ 1335355.596 \\ 1835313.419 \end{pmatrix}. \quad (8)$$

The determination coefficients for regression models within Cluster V were 0.769, 0.929, 0.981, and 0.995 for levels A, B, C, and D, respectively. Notably, the coefficient reached its peak at 0.995 in the final level, indicating a significant enhancement in the model's explanatory capability. Additionally, the Durbin-Watson (DW) indices were recorded at 2.256, 1.409, 2.148, and 2.679 for levels A, B, C, and D, respectively. However, it's worth noting that in the last C level, the index showed less stability, suggesting potential areas for further investigation.

In Table 7, Indonesia, Spain, Mexico, Brazil, Italy, India, and Germany—comprising the final D level of this cluster—all meet the specified criteria. Particularly noteworthy is India, which exhibits the most favorable indicators for PSE numbers. Moreover, we opted not to develop a dedicated model for the USA and China, as they are very high-GDP countries included in Cluster VI.

Table 7. Some results of the model (8) on Cluster V.

| Cluster V | | The number of public sector employments | | 14 countries |
|---|---|---|---|---|
| | | Too large | Too little | |
| Levels | A | Russia | Austral, Canada | 3 |
| | B | United Kingdom | Japan | 2 |
| | C | France | South Korea | 2 |
| | D | Indonesia, Spain, Mexico, Brazil, Italy, India, and Germany | | 7 |

## 4. Analysis of Cluster Model Findings

- Within Cluster I countries, the correlation between the number of public sector employments and the factors examined in the study demonstrates moderate to weak associations, as illustrated in Figure 2.


Figure 2. Correlation between number of PSE and other factors/Cluster I/.

Moreover, these factors exhibit a limited influence on the number of government employees, while the size of the GDP appears to correlate with a decrease in the provision of government services. Notably, within Cluster I, the correlation coefficient between PSE and the labor force demonstrates a progressive increase with each level shift (see Figure 2). In this cluster of countries, the public service aims to bolster the workforce, aligning with an economic policy rooted in agriculture and traditional production.

- Cluster II countries constituted the majority of the surveyed nations. In these countries, GDP exhibited a robust correlation with PSE numbers, whereas other factors displayed correlations below the average (refer to Table 8).

Table 8. Correlation between the number of PSE and other factors for Cluster II.

| Factors | Levels in Cluster II | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | |
| GDP | 0.416 | 0.353 | 0.764 | 0.85 | 0.88 | 0.889 | 0.887 | 0.720 |
| Labor force | 0.629 | 0.634 | 0.453 | 0.472 | 0.388 | 0.391 | 0.347 | 0.473 |
| Population | 0.543 | 0.553 | 0.425 | 0.455 | 0.373 | 0.376 | 0.326 | 0.436 |
| Area size | 0.374 | 0.163 | −0.201 | −0.045 | −0.218 | −0.222 | −0.273 | −0.060 |

In Cluster II, the majority of countries are in the developing phase, with economies predominantly reliant on resource extraction and low-tech manufacturing. Consequently, the influence of capital flight on GDP and foreign trade balance is anticipated to be significant. Mongolia, the primary representative of this cluster, relies heavily on the mining sector, which accounts for over 80% of its GDP, posing challenges to long-term sustainable development policies.

- Regarding Cluster III nations, there exists a pronounced correlation between the number of public sector employments and both population size and labor force magnitude. As previously calculated in cluster II, the correlation coefficient between the number of PSE with each of the factors—GDP, labor force, population and area size were calculated for levels A to F. Their mean values were 0.378, 0.87, 0.925 and 0.434 respectively.

Conversely, other factors exhibit correlations below the average. Notably, as the level shifts within this cluster, the correlation of GDP with these factors diminishes, while the correlation with other variables increases. In these countries, all factors exhibited a positive and beneficial impact on PSE numbers. Nevertheless, with each level change, the correlation between PSE number and GDP size decreased, while the influence of other factors steadily ascended. Notably, a robust correlation was observed between PSE and population size.

- Cluster IV countries stand out from other clusters due to their positive and above-average correlations with all factors regarding PSE. As previously, the correlation coefficient between the number of PSE with each of the factor (GDP, labor force, population and area size) was calculated for levels A to C.

Their mean values were 0.585, 0.981, 0.97 and 0.519 respectively.

Despite the fluctuating effect of GDP size on public sector employment, the impact of other factors consistently grows with increasing levels. The 10 countries within this cluster are indisputably highly developed nations, characterized by policies tailored to their populations and workforces, ensuring access to public services commensurate with their geographical areas and settlements.

- In Cluster V countries, factors apart from GDP displayed strong and positive correlations with PSE numbers. As previously calculated in cluster II, the correlation coefficient between the number of PSE with each of the factor (GDP, labor force, population and area size) was calculated for levels A to D.

Their mean values were 0.169, 0.764, 0.697 and 0.638 respectively. Notably, the average correlation coefficients in the table reveal a very weak influence of GDP size on public sector employment, a trend linked to the developed nature of these countries and their high economic potential. Here, it is evident that sustainable services are prioritized, with a focus on both the workforce and the population.

## 5. Conclusion

A methodology for improving the model was adopted by passing criteria from one level to another within the cluster. As a result, we were able to construct the best-fitting model for each cluster. It also identifies the countries that best fit the cluster. However, this study does not aim to rank countries in any way.

In Cluster I, there is a noted deficiency in public service accessibility, overshadowed by potent political, economic, and geopolitical influences. Armenia, serving as the primary representative, leans towards implementing public services rooted in local customs and traditional lifestyles. Cluster II countries prioritize leveraging GDP growth to allocate state budget resources towards future capital formation, judicious use of land and underground resources, and directing public services towards enhancing education and workforce capabilities, alongside implementing long-term sustainable development policies. Mongolia, the cluster's key representative, grapples with these challenges presently. Conversely, in Cluster III nations, the emphasis on public service implementation tailored to their populations and labor forces yields positive outcomes for sustainable development in these developing countries. Kazakhstan, the cluster's main representative, experiences rapid development fueled by its land resources and geopolitical advantages. Cluster IV countries exemplify a superior model of public services, serving as a benchmark for others, with direct implications on the happiness index of nations. The Netherlands, the primary representative of this cluster, stands as a global leader in banking, financial services, and the implementation of optimal policies for sustainable development. Cluster V countries serve as exemplary models in delivering public services to remote areas compared to counterparts in other clusters. Notably, India, the cluster's main representative, holds the title of the world's most populous country and has

emerged as a significant player in IT industry workforce training. It can be inferred that this conducive public service environment enables these countries to embrace modern technologies and sustain robust economic development over the long term by fostering workforce skills.

This study utilized data from 108 countries. With our developed methodology, it becomes feasible to estimate the number of public sector employments in other nations. For instance, as of 2022, Switzerland's workforce stands at 4,968,223, with approximately 723.1 thousand in public sector employment (according to the Labor Force Survey in ILOSTAT Explorer). The country's population is 8779 thousand, with a gross domestic product of $818.4 billion and an area spanning 41,285 square kilometers. Based on our classification, Switzerland falls into cluster IV. According to the latest model of this cluster, the projected number of public sector employments in the country is 1,218,125.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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## Appendix

Table A1. The data sourced by international organizations in 2022.

| | Countries | Population | Area size | Lavor force | Number of PSE | GDP |
|---|---|---|---|---|---|---|
| | | | **Cluster I. Low GDP** | | | |
| 1 | Cuba | 11,194,449 | 106,440 | 5,233,000 | 3,401,450 | 2020 |
| 2 | Liberia | 5,418,377 | 96,320 | 1,372,000 | 552,916 | 4001 |
| 3 | Tajikistan | 10,143,543 | 139,960 | 2,209,000 | 728,970 | 10,492 |
| 4 | Kyrgyzstan | 6,735,347 | 191,800 | 2,344,000 | 398,480 | 10,931 |
| 5 | Rwanda | 14,094,683 | 24,670 | 4,446,000 | 248,976 | 13,313 |
| 6 | Niger | 27,202,843 | 1,266,700 | 4,688,000 | 168,768 | 13,970 |
| 7 | Moldova | 3,435,931 | 32,850 | 1,327,000 | 214,974 | 14,421 |
| 8 | Afghanistan | 42,239,854 | 652,860 | 7,512,000 | 1,096,752 | 14,939 |
| 9 | Madagascar | 30,325,732 | 581,795 | 9,504,000 | 380,160 | 14,955 |
| 10 | Nicaragua | 7,046,310 | 120,340 | 3,039,000 | 246,159 | 15,672 |
| 11 | Laos | 7,633,779 | 230,800 | 3,337,000 | 380,418 | 15,724 |
| 12 | Yemen | 34,449,825 | 527,970 | 7,100,000 | 1,370,300 | 16,940 |
| 13 | Mali | 23,293,698 | 1,220,190 | 3,241,000 | 77,784 | 18,827 |
| 14 | Albania | 2,832,439 | 27,400 | 1,090,000 | 156,960 | 18,882 |
| 15 | Armenia | 2,777,970 | 28,470 | 1,394,000 | 270,436 | 19,503 |
| 16 | Haiti | 11,724,763 | 27,560 | 4,810,000 | 432,900 | 20,254 |
| 17 | Botswana | 2,675,352 | 566,730 | 1,308,000 | 235,440 | 20,352 |
| 18 | Zimbabwe | 16,665,409 | 386,850 | 3,939,000 | 476,619 | 20,678 |
| 19 | Guinea | 14,190,612 | 245,720 | 5,409,000 | 367,812 | 21,228 |
| 20 | Bosnia and Herzegovina | 3,210,847 | 51,000 | 1,026,337 | 251,453 | 24,528 |
| 21 | Georgia | 3,728,282 | 69,490 | 1,959,000 | 413,349 | 24,605 |
| 22 | Senegal | 17,763,163 | 192,530 | 6,096,000 | 384,048 | 27,684 |
| 23 | Trinidad and Tobago | 1,534,937 | 5130 | 621,000 | 142,209 | 27,899 |
| 24 | Zambia | 20,569,737 | 743,390 | 6,275,000 | 420,425 | 29,784 |
| | | | **Cluster II. Below average GDP** | | | |
| 1 | El Salvador | 6,364,943 | 20,720 | 2,738,000 | 221,778 | 32,489 |
| 2 | Estonia | 1,322,765 | 42,390 | 692,900 | 164,910 | 38,101 |
| 3 | Latvia | 1,830,211 | 62,200 | 1,022,000 | 296,380 | 41,154 |
| 4 | Paraguay | 6,861,524 | 397,300 | 3,190,000 | 334,950 | 41,722 |

Continued

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | Bolivia | 12,388,571 | 1,083,300 | 4,992,000 | 384,384 | 43,069 |
| 6 | Cameroon | 28,647,293 | 472,710 | 8,426,000 | 825,748 | 44,342 |
| 7 | Bahrain | 1,485,509 | 760 | 716,500 | 68,784 | 44,391 |
| 8 | Uganda | 48,582,334 | 199,810 | 17,400,000 | 713,400 | 45,559 |
| 9 | Jordan | 11,337,052 | 88,780 | 1,898,000 | 461,214 | 47,452 |
| 10 | Mongolia | 3,447,157 | 1,553,560 | 1,068,000 | 390,888 | 52,989 |
| 11 | Slovenia | 2,119,675 | 20,140 | 913,400 | 190,901 | 62,118 |
| 12 | Serbia | 7,149,077 | 87,460 | 2,920,000 | 680,360 | 63,502 |
| 13 | Costa Rica | 5,212,173 | 51,060 | 2,222,000 | 275,528 | 68,381 |
| 14 | Lithuania | 2,718,352 | 62,674 | 1,452,000 | 390,588 | 70,334 |
| 15 | Croatia | 4,008,617 | 55,960 | 1,715,000 | 511,070 | 70,965 |
| 16 | Uruguay | 3,423,108 | 175,020 | 1,700,000 | 266,900 | 71,177 |
| 17 | Belarus | 9,498,238 | 202,910 | 5,000,000 | 3,600,000 | 72,793 |
| 18 | Ghana | 34,121,985 | 227,540 | 12,070,000 | 772,480 | 72,839 |
| 19 | Tanzania | 67,438,106 | 885,800 | 24,890,000 | 1,144,940 | 75,709 |
| 20 | Azerbaijan | 10,412,651 | 82,658 | 4,680,000 | 1,024,920 | 78,721 |
| 21 | Uzbekistan | 35,163,944 | 425,400 | 18,120,000 | 3,297,840 | 80,392 |
| 22 | Luxembourg | 654,768 | 2590 | 208,800 | 24,430 | 82,275 |
| 23 | Bulgaria | 6,687,717 | 108,560 | 2,551,000 | 538,261 | 89,040 |
| 24 | Guatemala | 18,092,026 | 107,160 | 4,465,000 | 272,365 | 95,003 |
| 25 | Venezuela | 28,838,499 | 882,050 | 14,010,000 | 3,404,430 | 102,328 |
| 26 | Oman | 4,644,384 | 309,500 | 968,800 | 762,446 | 114,667 |
| 27 | Ecuador | 18,190,484 | 248,360 | 6,953,000 | 486,710 | 115,049 |
| 28 | Slovakia | 5,795,199 | 48,088 | 2,727,000 | 763,560 | 115,469 |
| 29 | Ethiopia | 126,527,060 | 1,000,000 | 52,820,000 | 3,486,120 | 126,783 |
| 30 | Morocco | 37,840,044 | 446,300 | 11,730,000 | 985,320 | 134,182 |
| 31 | Ukraine | 36,744,634 | 579,320 | 17,990,000 | 4,803,330 | 160,503 |
| 32 | Hungary | 10,156,239 | 90,530 | 4,263,000 | 1,295,952 | 178,789 |
| 33 | Kuwait | 4,310,108 | 17,820 | 2,380,000 | 442,680 | 184,558 |
| | **Cluster III. Average GDP** | | | | | |
| 1 | Greece | 10,341,277 | 128,900 | 4,918,000 | 1,047,534 | 219,066 |
| 2 | Kazakhstan | 19,606,633 | 2,699,700 | 9,022,000 | 2,102,126 | 220,623 |
| 3 | Qatar | 2,716,391 | 11,610 | 1,424,000 | 160,912 | 237,296 |
| 4 | Peru | 34,352,719 | 1,280,000 | 16,160,000 | 1,325,120 | 242,632 |

**Continued**

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | New Zealand | 5,228,100 | 263,310 | 2,413,000 | 277,495 | 247,234 |
| 6 | Portugal | 10,247,605 | 91,590 | 5,395,000 | 793,065 | 251,945 |
| 7 | Iraq | 45,504,560 | 434,320 | 8,900,000 | 3,328,600 | 264,182 |
| 8 | Finland | 5,545,475 | 303,890 | 2,685,000 | 700,785 | 280,826 |
| 9 | Czech Republic | 10,495,295 | 77,240 | 5,304,000 | 816,816 | 290,924 |
| 10 | Chile | 19,629,590 | 743,532 | 8,367,000 | 786,498 | 301,025 |
| 11 | Romania | 19,892,812 | 230,170 | 9,451,000 | 1,512,160 | 301,262 |
| 12 | Colombia | 52,085,168 | 1,109,500 | 25,760,000 | 1,081,920 | 343,939 |
| 13 | Pakistan | 240,485,658 | 770,880 | 108,800,000 | 7,942,400 | 376,533 |
| 14 | Iran | 89,172,767 | 1,628,550 | 30,500,000 | 4,544,500 | 388,544 |
| 15 | Denmark | 5,910,913 | 42,430 | 2,795,000 | 844,090 | 395,404 |
| 16 | Philippines | 117,337,368 | 298,170 | 42,780,000 | 3,892,980 | 404,284 |
| 17 | South Africa | 60,414,495 | 1,213,090 | 22,190,000 | 3,483,830 | 405,870 |
| 18 | Malaysia | 34,308,525 | 328,550 | 13,190,000 | 1,991,690 | 406,306 |
| 19 | Vietnam | 98,858,950 | 310,070 | 54,800,000 | 4,164,800 | 408,802 |
| 20 | Bangladesh | 172,954,319 | 130,170 | 65,000,000 | 2,015,000 | 460,201 |
| 21 | Singapore | 6,014,723 | 700 | 3,444,000 | 340,956 | 466,789 |
| 22 | Austria | 8,958,960 | 82,409 | 4,707,000 | 376,560 | 471,400 |
| 23 | Egypt | 112,716,598 | 995,450 | 29,950,000 | 6,349,400 | 476,748 |
| 24 | Nigeria | 223,804,632 | 910,770 | 83,200,000 | 2,995,200 | 477,386 |
| 25 | Thailand | 71,801,279 | 510,890 | 38,370,000 | 3,683,520 | 495,341 |
| | **Cluster IV. Above average GDP** | | | | | |
| 1 | United Arab Emirates | 9,516,871 | 83,600 | 5,340,000 | 544,680 | 507,535 |
| 2 | Israel | 9,174,520 | 21,640 | 3,493,000 | 1,096,802 | 522,023 |
| 3 | Ireland | 5,056,935 | 68,890 | 2,161,000 | 473,259 | 529,245 |
| 4 | Belgium | 11,686,140 | 30,280 | 5,150,000 | 1,086,650 | 578,604 |
| 5 | Norway | 5,474,360 | 365,268 | 2,707,000 | 871,654 | 579,267 |
| 6 | Sweden | 10,549,347 | 450,295 | 5,600,661 | 1,200,000 | 591,189 |
| 7 | Argentina | 45,773,884 | 2,736,690 | 18,000,000 | 3,204,000 | 632,770 |
| 8 | Poland | 41,026,067 | 306,230 | 17,600,000 | 4,153,600 | 688,177 |
| 9 | Türkiye | 85,816,199 | 769,630 | 31,300,000 | 4,695,000 | 905,988 |
| 10 | Netherlands | 17,618,299 | 33,720 | 9,090,000 | 1,808,910 | 991,115 |
| | **Cluster V. High GDP** | | | | | |
| 1 | Indonesia | 277,534,122 | 1,811,570 | 150,000,000 | 13,050,000 | 1,319,100 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | Spain | 47,519,628 | 498,800 | 8,528,000 | 1,262,144 | 1,397,509 |
| 3 | Mexico | 128,455,567 | 1,943,950 | 54,510,000 | 6,432,180 | 1,414,187 |
| 4 | South Korea | 51,784,059 | 97,230 | 27,750,000 | 2,858,250 | 1,665,246 |
| 5 | Australia | 26,439,111 | 7,682,300 | 12,440,000 | 3,595,160 | 1,675,419 |
| 6 | Brazil | 216,422,446 | 8,358,140 | 110,000,000 | 13,310,000 | 1,920,096 |
| 7 | Italy | 58,870,762 | 294,140 | 25,940,000 | 4,150,400 | 2,010,432 |
| 8 | Canada | 38,781,291 | 9,093,510 | 19,520,000 | 4,138,240 | 2,139,840 |
| 9 | Russia | 144,444,359 | 16,376,870 | 78,000,000 | 31,668,000 | 2,240,422 |
| 10 | France | 64,756,584 | 547,557 | 30,680,000 | 6,136,000 | 2,782,905 |
| 11 | United Kingdom | 67,736,802 | 241,930 | 33,500,000 | 7,537,500 | 3,070,668 |
| 12 | India | 1,428,627,663 | 2,973,190 | 475,000,000 | 18,050,000 | 3,385,090 |
| 13 | Germany | 83,294,633 | 348,560 | 45,900,000 | 5,921,100 | 4,072,192 |
| 14 | Japan | 123,294,513 | 364,555 | 70,000,000 | 5,390,000 | 4,231,141 |
| | **Cluster VI. Very high GDP** | | | | | |
| 1 | China | 1,425,671,352 | 9,388,211 | 878,000,000 | 69,274,200 | 17,963,171 |
| 2 | United States | 339,996,563 | 9,147,420 | 164,400,000 | 22,029,600 | 25,462,700 |