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THE PERFORMANCE OF REGIONAL GOVERNMENTS UNDER THE RESULTS-BASED BUDGETING FRAMEWORK: A TWO-STAGE SECTORAL ANALYSIS

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Abstract. The results-based budgeting (RBB) framework is a public management strategy in which economic resources are allocated to certain budget programs, oriented towards delivering specific products and results to the population. The present paper analyzes the regional governments' efficiency in using their economic resources, under the RBB framework, with an application to the Peruvian context. To this end, we employ a data envelopment analysis (DEA) model with bootstrapping. In the first stage, different sectors of the regional governments are considered individually: education, security, health, sanitation, transportation, and recreation. In the second stage, the overall efficiency index is calculated using the sectoral indices obtained in the first stage. Finally, the factors or determinants influencing the level of efficiency are analyzed. The results show improvements in efficiency levels in the areas of health and sanitation, to the detriment of the rest of the sectors. The average overall efficiency level over the period 2013–2016 remains in the range of 0.25–0.30, which indicates an inefficiency level of 70%. Finally, the variables fiscal autonomy, capital stock, and population density show a positive relationship with respect to the overall efficiency index.

Mathematics Subject Classification. C14, D61, H61, R58.

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1. Introduction

Traditionally, in Peru, the budgets prepared by the Ministry of Economy and Finance have been incremental in nature, have not been associated with outputs or results, have been set up to respond to short-term economic issues, and have not emphasized the quality and efficiency of spending in favor of the population[1] [8]. The evaluation of the public expenditure has been mainly based on the quantity of expenditure (amount spent as a percentage of the total allocated) rather than on the quality of the expenditure. In this sense, the objective of the different regional governments was to spend as many resources as possible, and this in turn was considered

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[1]The efficiency of public spending refers to the effects it has on the economic and social conditions of countries and on people's daily lives [80].

to be the fundamental performance indicator. As Osborne and Gaebler [90] mentioned, the budgetary evaluation was based on the progress made in the implementation of the monetary amounts allocated, leaving aside the analysis of efficiency, that is, the results obtained as a function of the resources spent. In Peru, attempts were made to deal with this problem, but despite the reforms implemented in the 1990s, the 1993 constitution made no major changes to the design of the budget. A new budget management law was adopted in 1996 with the intention to improve the budget formulation and execution, in search of a better budget allocation, more flexibility to adapt to unforeseen events, and a longer timeframe to strengthen expenditure planning and efficiency. Despite all the changes made, the results were, however, not as expected [26]. It became necessary to implement a new methodology that would incorporate the actual results achieved by the government in the provision of public goods and services. In this way, the performance and the final products granted to the population would be evaluated, and not just the level of spending. As a result, the Ministry of Economy and Finance has been progressively implementing a results-based budgeting (RBB) framework as a new way of managing public resources with the aim to promote the country's economic and social development through greater efficiency in the use of the economic resources allocated to the regions. The RBB was constituted as a strategy by which economic resources would be allocated to certain programs, known as budgetary programs, which represent the programming units of the actions of public entities, which are integrated and articulated and are aimed at providing measurable products and outcomes to achieve a specific result in favor of the population, to influence the improvement of the quality of life and thus contribute to the achievement of a final result associated with a public policy objective [2]. The evaluation of this new program has been carried out by the Ministry of Economy and Finance and various competent bodies, who analyze the results obtained by the regional and local governments on the basis of the goals and objectives established previously.

Considering the above, and with the objective of analyzing the implementation of this public management strategy, in the present paper, we analyze the efficiency in the use of economic resources by the regional governments, considering the RBB as the evaluation framework. The analysis is carried out for the regions of Peru, which are responsible for the budget programs associated with different policy objectives that are aligned to the needs of the population. To measure the efficiency of regional governments, we employ data envelopment analysis (DEA) with bootstrapping. DEA is a non-parametric technique that allows us to estimate the efficiency of the economic units under study, called decision-making units (DMUs), based on the inputs used and the outputs generated.

In contrast to previous studies dedicated to analyzing the efficiency in the use of public resources, which will be detailed in the literature review section, the present study performs a two-stage sectoral analysis, considering the various sectors of the regional governments. The inputs are represented by the economic amounts allocated to the budget programs and the outputs are represented by the indicators associated with those programs. In the first stage, the efficiency indices are calculated for the different sectors considered: health, education, security, sanitation, transportation, and recreation[2]. In the second stage, the overall efficiency index is estimated, taking into account the indices for each sector calculated in the first stage. This overall index is constructed by weighing the expenditure in each sector against the total expenditure. Finally, the economic, demographic, political, and social factors (determinants) that influence the level of efficiency are studied. The remainder of the paper is organized as follows: in Section 2, we perform a review of the literature; in Section 3, we introduce the DEA model with bootstrapping; Section 3 is dedicated to providing a brief description of the data used; Section 4 presents the results; and finally, Section 5 concludes the paper.

[2]Aspects related to administrative, planning, or management issues (30% of total expenditure) are not considered because there are no budget programs and indicators for their evaluation. The sectors considered (health, education, security, sanitation, transportation, and recreation), with the exception of those mentioned above, account for more than 90% of the total expenditure allocated to the RBB.

2. Literature review

The performance of economic units has been analyzed based on Farrel's concept of efficiency [55], which can be understood through its two components: technical efficiency and allocative efficiency. The former refers to the capacity and willingness of the economic unit to produce the same amount of output using the minimum level of inputs and at a given technological level. The latter refers to the ability and willingness of the economic unit to equate the marginal value of its product and marginal cost [63]. Based on this approach, various methodologies have been proposed to analyze the efficiency of regional governments by estimating a production frontier obtained by combining a set of inputs and outputs. Regarding the methodologies employed, the literature provides a wide range of methods for the analysis of public efficiency. These methods differ, mainly, in how the production frontier or efficiency frontier is inferred. These different techniques can basically be classified into two alternative approaches: parametric and non-parametric.

The first approach, that is, the parametric approach, assumes a functional form for the production frontier. Among the most commonly used methods is the Stochastic Frontier Analysis approach introduced by Aigner *et al.* [7]. This methodology has been used by authors such as De Borger and Kerstens [45] and Deller *et al.* [46] in the analysis of public efficiency. On the other hand, the non-parametric approach does not assume a functional form for the production frontier. The most commonly used method is Data Envelopment Analysis (DEA). This type of model was introduced by Charnes *et al.* [35], based on the concept of efficiency proposed by Farrel [55] and subsequently extended by Banker *et al.* [13]. The DEA model is a technique that, through linear programming, constructs a production frontier based on the observed data and derives efficiency indices based on the relative distance of inefficient observations from the estimated frontier. These models analyze the minimum level of inputs needed to produce a certain amount of outputs (in which case the model is called an input-oriented DEA model) or the maximum amount of outputs that can be produced given a fixed level of inputs (in which case the model is called an output-oriented DEA model). Authors such as Afonso and Fernandes [4], Afonso and Venâncio [5], D'Inverno *et al.* [50], Doumpos and Cohen [51], Herrera and Francke [70], and Lo Storto [77] employed this methodology in the analysis of public efficiency. The analysis of the efficiency of the public sector can be divided into two main groups [45]. On the one hand, there are numerous studies that analyzed some of the services provided by the regional governments individually. Among these studies, we find authors that analyzed the efficiency in the elimination of solid waste [22, 59, 100, 114, 115]; management of water services [61, 66, 67, 92]; public transportation [19, 56, 60, 113]; local order and security [27, 44, 49, 58, 91, 112]; the provision of health services [15, 87]; quality of educational services [48]; performance of public administration [72], and social protection issues [6].

On the other hand, there are studies that analyzed global efficiency, and in this sense, they considered a range of services provided by the regional governments. The latter approach has a significant advantage when compared to those studies that analyzed the efficiency of only some of the sectors individually, and that is its ability to take into account the opportunity cost in the allocation of economic resources to the different services offered. In this category of studies, we can find authors that analyzed the global efficiency of regional governments for different countries: Spain [4], Portugal [5, 9], Germany [71], Greece [51], Italy [77], USA [65], Brazil [98] and Peru [70]. This last study by Herrera and Francke [70] analyzed the efficiency of public spending by provincial and district governments in 2003 in the case of Peru.

Although there are different studies on the subject, in the case of Latin America, and especially Peru, there are few investigations carried out on the efficiency of public spending by municipalities. As local public sector organizations face increasing pressure to improve service quality on the one hand and, at the same time, reduce costs, performance measurement is an important element of local government modernization, even more so in a developing country, such as Peru [1]. Benchmarking practices are indispensable facilitators of public sector reform by providing tools to measure and compare the performance of local municipalities to generate useful information to inform decision-making and learn from the best performers. This document adds empirical evidence on the evaluation of the cost efficiency of municipalities in Peru, its determinants and the relationship between cost efficiency and the effectiveness of public spending, that is, the quality of service. All this analysis can help public sector organizations to set goals that reflect their strategic mission, that are realistic and achievable, thus creating valuable challenges and allowing for greater efficiency and accountability, and to better understand and meet the needs of citizens in delivering services [10, 24, 68]. In addition, this article contributes to the existing literature on the evaluation of the global performance of municipalities by incorporating the time factor into the analysis, and thus being able to observe the dynamics and evolution of the results. Much of the literature is mainly represented by studies referring to a single year [40].

Municipalities were grouped into clusters based on certain common characteristics. The results showed that, on average, municipalities have poor management of public resources, because they could achieve the same provision of goods and services with up to 55% less inputs used. In analyzing the efficiency of public spending in the municipalities of the province of Tuscany (Italy), D'Inverno *et al.* [50] used a two-stage model, wherein in the first stage various sectors of the municipalities were included, and in the second stage the individual indices were aggregated to generate an overall efficiency indicator. This approach is also used in the present paper.

In addition, several studies evaluated the relationship between efficiency indices and certain variables that could influence the performance of regional governments. Among the variables used to explain the performance of regional governments are geographical, demographic, social, economic, and political aspects. In the case of the demographic aspect, the literature agrees with the fact that cities with high population concentration have better performance in using public resources [4, 50]. Sampaio and Stosic [98] stated that a lower population density increases the average cost of providing goods and services, so governments could be more efficient if their local population density was higher. With respect to social factors, Afonso and Venâncio [5] considered the level of social development, the level of educational quality, and the level of development of cultural and sports infrastructure in each region as determining factors of efficiency, and they found a positive relationship between these and the level of efficiency. Among the economic factors, De Borger and Kerstens [45] argued that a higher income per capita discourages the efficient monitoring by society of the execution of expenditure, given the high opportunity cost of such an action. For this reason, governments with high income indicators would have poor resource management performance. Another economic factor, proposed by Boetti *et al.* [20], is the degree of municipal autonomy. This is a measure of the degree of responsibility of local governments towards citizens, defined as the proportion of local taxes in relation to total expenditure. A higher level of revenue collected by regional entities would lead to higher levels of efficiency. Finally, Machado [80] referred to a political factor, finding that the regions governed by re-elected authorities have low levels of efficiency in the management of public resources.

3. Methodology

3.1. Sectoral analysis

DEA is, as previously mentioned, a non-parametric technique for estimating the efficiency of the economic units under study, called decision-making units (DMUs), based on the inputs used and the outputs generated. DEA was built based on the concept of efficiency proposed by Farrel [55] and later popularized by Charnes *et al.* [35]. In time, DEA has been widely used in almost every field, becoming an excellent and versatile management science tool that supports the decision-making process of an entity [30, 31, 34, 109, 111]. An advantage of DEA models lies in the few assumptions that they propose in estimating the production frontier that converts inputs into outputs. The production frontier is generated through linear programming, which considers each of the DMUs under study for its construction. The efficiency index of each DMU is measured by the distance of that unit and the estimated production frontier for all DMUs under study. Thus, a DMU is said to be efficient if its index is equal to 1 and it will be inefficient if the indicator is less than the unit.

In this paper, the DMUs represent each of the regional governments of Peru, which can be seen as the production functions that generate different outputs through the combination of a set of inputs. DEA models take two forms: (i) input-oriented and (ii) output-oriented. In the first approach, the linear programming model is configured so as to determine how much a firm could cut back on its input use if such input were to be used efficiently in order to achieve the same level of output. By contrast, in output-oriented DEA, the linear program is configured to determine a firm's potential output given its inputs if it operated efficiently along the best practice frontier. This paper uses an input-oriented model, so the production frontier is estimated in order to find the maximum possible reduction in the use of inputs while output levels remain constant. Regional governments have control over their economic resources and seek to efficiently use them by utilizing as few as possible to achieve their objectives. The inputs used in this paper correspond to the economic amounts allocated to the budget programs, while the outputs will be the indicators associated with those programs.

Let us define the set of DMUs as $J = \{1, 2, \dots, n\}$, where each DMU is composed of m inputs and s outputs. We denote the input and output vectors for each DMU_j by $\boldsymbol{x}_j = (x_{1j}, x_{2j}, \dots, x_{mj})'$ and $\boldsymbol{y}_j = (y_{1j}, y_{2j}, \dots, y_{sj})'$, respectively. We define the matrices of inputs and outputs $\boldsymbol{X}$ and $\boldsymbol{Y}$ as follows:

$$\boldsymbol{X} = (\boldsymbol{x}_1, \boldsymbol{x}_2, \dots, \boldsymbol{x}_n) \in \Re^{mxn}$$
$$\boldsymbol{Y} = (\boldsymbol{y}_1, \boldsymbol{y}_2, \dots, \boldsymbol{y}_n) \in \Re^{sxn}.$$

The production possibility set is defined using the nonnegative combination of DMUs in the set J as:

$$\boldsymbol{P} = \left\{ (\boldsymbol{x}, \boldsymbol{y}) \mid \boldsymbol{x} \geq \sum_{j=1}^{n} \lambda_j \boldsymbol{x}_j, \quad \boldsymbol{0} \leq \boldsymbol{y} \leq \sum_{j=1}^{n} \lambda_j \boldsymbol{y}_j, \quad \boldsymbol{\lambda} \geq 0 \right\}.$$

According to Charnes *et al.* [35], the DEA model can be represented as follows:

$$\min \theta - \epsilon \left[\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+ \right] \tag{3.1}$$

subject to

$$\begin{aligned}
&\sum_{j=1}^{n} x_{ij}\lambda_j + S_i^- = \theta x_{io}, && i = 1, 2, \dots, m,\\
&\sum_{j=1}^{n} y_{rj}\lambda_j - S_r^+ = y_{ro}, && r = 1, 2, \dots, s,\\
&S_r^+, S_i^- \geq 0, && r = 1, 2, \dots, s;\ i = 1, 2, \dots, m,\\
&\lambda_j \geq 0, && j = 1, 2, \dots, n,
\end{aligned}$$

where θ is the efficiency score, y_{ro} and x_{io} are the values for the rth output and the ith input for the DMU of interest (DMU_o), respectively; y_{rj} is the value of the rth output for the jth DMU, x_{ij} is the value of the ith input for the jth DMU. Here, $\epsilon > 0$ is a so-called non-Archimedean element defined to be smaller than any positive real number. S_i^- and S_r^+ are called input and output slacks, respectively. An important feature of DEA models is the ability to consider constant or variable returns-to-scale for the production frontier. Model (3.1) represents the case of constant returns-to-scale. Based on this model, Banker *et al.* [13] proposed a DEA model with variable returns-to-scale, which is achieved by adding the following restriction $\sum_{j=1}^{n} \lambda_j = 1$ to Model (3.2):

$$\min \theta - \epsilon \left[\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+ \right] \tag{3.2}$$

subject to

$$\sum_{j=1}^{n} x_{ij}\lambda_j + S_i^- = \theta x_{io}, \qquad i = 1, 2, \dots, m,$$

$$\sum_{j=1}^{n} y_{rj}\lambda_j - S_r^{+} = y_{ro}, \qquad r = 1,2,\ldots,s,$$
$$\sum_{j=1}^{n} \lambda_i = 1,$$
$$S_r^{+},\ S_i^{-} \geq 0, \qquad r = 1,2,\ldots,s; \quad i = 1,2,\ldots,m,$$
$$\lambda_j \geq 0, \qquad j = 1,2,\ldots,n.$$

An underlying problem with DEA models is their deterministic nature. The estimated production frontier depends on the particular input-output combination and the set of samples observed, and therefore the estimated efficiency is different from one sample to another. To obtain a confidence interval that covers the possible statistical errors, it is necessary to know the sample distribution derived from the actual data generating the process. However, it is not possible to achieve this frontier with just one sample. The DEA-bootstrap methodology is one of the stochastic approaches developed to solve this problem. Simar [102] and Simar and Wilson [103,104] applied the algorithm for the estimates of the DEA model based on the bootstrapping technique developed by Efron [53]. The algorithm used in this paper is developed by Simar and Wilson [103]:

(1) Estimate the technical efficiency score $\hat{\theta}_j$ for each regional government $j = 1,\ldots,n$.
(2) A random sample is generated by bootstrapping $\hat{\theta}_1,\ldots,\hat{\theta}_n$ to obtain new efficiency indices, $\hat{\theta}_1^*,\ldots,\hat{\theta}_n^*$. This is developed as follows:
   – Generate a simple (naïve) bootstrap sample $\beta_1^*,\ldots,\beta_n^*$. Draw the sample (with replacement) from $\hat{\theta}_1,\ldots,\hat{\theta}_n$.
   – Calculate the smoothed bootstrap sample, $\tilde{\theta}_1^*,\ldots,\tilde{\theta}_n^*$, from the naïve bootstrap sample *via* the following equation:
   $$\tilde{\theta}_j^* = \begin{cases} \beta_j^* + h\epsilon_j^*, & \text{if} \quad \beta_j^* + h\epsilon_j^* \geq 1 \\ 2 - \beta_j^* - h\epsilon_j^*, & \text{otherwise} \end{cases}$$
   where h is the bandwidth of a standard normal kernel density and ϵ_j^* is the random error of the standard normal distribution. This formula sets a bound to ensure that $\tilde{\theta}_j^*$ is equal or greater than unity. Silverman [101] describes the procedure for determining the bandwidth h.
   – We correct the variance of the bootstrap estimates by:
   $$\theta_j^* = \overline{\beta}^* + \frac{1}{\sqrt{1 + h^2/\widehat{\sigma}^2}}\left(\tilde{\theta}_j^* - \overline{\beta}^*\right),$$
   where $\overline{\beta}^*$ is the average of $\beta_1^*,\beta_2^*,\ldots,\beta_n^*$ and $\widehat{\sigma}^2$ is the sampling variance of $\widehat{\theta}_1,\widehat{\theta}_2,\ldots,\widehat{\theta}_n$.
(3) Calculate the pseudo-data set as $\left\{(x_j, y_j^*) : y_j^* = y_j\hat{\theta}_j/\theta_j^*; j = 1,\ldots,n\right\}$.
(4) We solve the DEA program to estimate the efficiency scores $\hat{\theta}_{j,b}^*$.
(5) Repeat steps 2 to 4 B times to generate $\left\{\hat{\theta}_{j,b}^* : b = 1,\ldots,B\right\}$. B represents the number of simulations.

The bootstrap bias estimate for the original DEA estimator $\hat{\theta}(x_o, y_o)$ can be calculated as:

$$\widehat{bias}_B\left(\hat{\theta}(x_o, y_o)\right) = B^{-1}\sum_{b=1}^{B} \hat{\theta}_b^*(x_o, y_o) - \hat{\theta}(x_o, y_o). \tag{3.3}$$

Furthermore, $\hat{\theta}_b{}^*(x, y)$ are the bootstrap values and B is the number of bootstrap replications. In this way, a biased corrected estimator of $\theta(x_o, y_o)$ can be calculated as:

$$\hat{\hat{\theta}}(x_o, y_o) = \hat{\theta}(x_o, y_o) - \widehat{bias}_B\left(\hat{\theta}(x_o, y_o)\right) \tag{3.4}$$

$$= 2\hat{\theta}(x_o, y_o) - B^{-1} \sum_{b=1}^{B} \hat{\theta}_b^*(x_o, y_o).$$

However, according to Daraio and Simar [41], this bias correction can generate additional disturbances in the sample, so it would be necessary to calculate the variance of the efficiency indices computed *via* the bootstrapping process, $\theta_b^*(x, y)$. The calculation of the variance of the bootstrap values is given as follows:

$$\hat{\sigma}^2 = B^{-1} \sum_{b=1}^{B} \left[\hat{\theta}_b^*(x_o, y_o) - B^{-1} \sum_{b=1}^{B} \hat{\theta}_b^*(x_o, y_o) \right]^2. \quad (3.5)$$

The bias correction illustrated in 3.5 needs to be avoided unless:

$$\frac{\left| \hat{bias}_B \left(\hat{\theta}(x_o, y_o) \right) \right|}{\hat{\sigma}} > \frac{1}{\sqrt{3}}.$$

3.2. Overall efficiency analysis

One drawback to consider with DEA models is their weak power of discrimination between efficient and inefficient units, which occurs when the number of variables increases [32]. Increasing the number of inputs and outputs automatically increases the efficiency of the DMUs [74]. Therefore, when trying to analyze the efficiency of the different sectors of the regional governments (such as education, health, sanitation, security, and so on), several works [4,70] chose to aggregate the expenditure in each of these in a single input, considering as outputs the indicators of each service provided. This large number of outputs considered will create a disadvantage by discriminating between efficient and inefficient units. For this reason, in this paper, we perform an analysis of the different sectors of regional governments.

However, another drawback in considering public sectors individually is the way in which each of the indices calculated for each sector is aggregated into a single indicator that measures overall efficiency. In the literature, a variety of approaches have been adopted to tackle this issue[3]. Different "rules of thumb" have been proposed in order to achieve reasonable levels of discrimination; for example, there are rules proposed in Bowlin [21] and in Dyson *et al.* [52]. On the one hand, there are various studies that use the Shannon entropy approach [17, 76]. Soleimani-Damaneh and Zarepisheh [108] first introduced Shannon's entropy into the DEA method and proposed an entropy DEA model. In this approach, the efficiency indices of each of the DEA models are first calculated. Then, the degree of importance of each of these DEA models based on Shannon's entropy is determined, to finally use these weights to create a global index [94].

On the other hand, it is suggested to make use of the "benefit of the doubt" (BoD) approach [16, 37], which calculates the weights through a process of maximization. The conceptual basis for this approach is the following: the relative performance of a set of indicators is a revealed preference by the organizational unit about the relative importance of the indicators. A benefit-of-the-doubt approach recognizes these revealed preferences by assigning higher weights to those indicators on which the organizational unit performs well and lower weights to indicators on which it performs less well. Specifically, weights are assigned in a way to optimize the composite measure, subject to a set of specified constraints [37]. This is one of the most commonly used approaches when one wants to add efficiency ratings from individual DEA models. In this regard, see, *e.g.*, D'Inverno *et al.* [50], who evaluated the efficiency of spending in municipalities in Italy; Lovell and Pastor [78], who assessed macroeconomic performance; Despotis [47], who re-weighted the components of the Human Development Index; and Cherchye and Kuosmanen [36], who assessed sustainable development.

Despite these methodological alternatives, other approaches consider that the definition of a strict rule for the calculation of weights seems too rigid and useless in relation to the research needs. These approaches suggest

[3]Blackorby and Russell [18] examine the conditions under which indexes constructed at various levels of aggregation can be consistent with one another, that is, the extent to which efficiency indexes can be consistently aggregated.

calculating the overall efficiency index by using a weighted average, considering as a weight for each efficiency index the percentage of expenditure in each sector in relation to the total expenditure [39,50]. In this paper, we adopt the latter approach. The calculation is similar to the "benefit of the doubt" approach, with the difference that the weights depend on the expenditure of each region and not on a maximization process. The overall efficiency index will, therefore, be calculated as the sum of all individual sectoral efficiency indices multiplied by their respective weights.

3.3. Global efficiency and explanatory variables

Once the efficiency analysis has been carried out, the next step involves investigating the factors that determine the levels of efficiency or inefficiency found. The analysis is carried out by estimating regression models considering as explanatory variables those on which the evaluated management units do not have interference, also called nondiscretionary variables [115]. In most empirical studies, according to Saranga and Nagpal [99], linear regression, known as Ordinary Least Squares (OLS) or Tobit models are used. D'Inverno *et al.* [50] carried out a two-stage analysis in order to study the efficiency of public spending in Tuscan municipalities. In the second stage, the authors used the Tobit model to analyze the determinants that influence the efficiency of municipalities. The obtained results may be consistently included in the long-standing debate on the municipal size, proving that the bigger the municipality, the greater its level of public expenditure efficiency is. De Borger and Kerstens [45] analyzed the efficiency of local governments in Belgium, in the first stage, and examined the degree to which the calculated inefficiencies could be explained by a common set of explanatory variables, in the second stage. The estimated efficiency indices ranged from 0.57 to 0.94. The OLS and Tobit models were also applied in different areas: implementing sustainable development policy [25], primary health care [84], efficiency benchmarking of tourism services [95], energy efficiency [75].

The choice of the regression model to perform this analysis will depend on the distribution of the dependent variable. A first approximation involves estimating a linear regression using ordinary least squares. However, when the dependent variable is censored, the parameters estimated by this model are inconsistent, inconsistency that increases with the number of censored observations. The use of standard linear regression is inappropriate and can lead to distorted results, since the condition of the least squares is not fulfilled [64]. A solution to this problem is to estimate a Tobit model using maximum plausibility under the assumptions of normality and homoscedasticity [45]. According to McDonald [81], the two-stage analysis requires the specification of the underlying Data Generating Process (DGP), *i.e.*, how the input and output variables, the production frontier, and the environmental variables are correlated. Simar and Zelenyuk [107] and Banker and Natarajan [12] were the first to propose DGP for the second-stage analysis. Both studies relied on different assumptions for the DGP. Banker and Natarajan [12] presented a less restrictive approach than Simar and Zelenyuk [107]. Nonetheless, Banker and Natarajan [12] claimed that "...the DEA-based procedure with OLS, maximum likelihood, or even Tobit estimation in the second stage perform as well as the best of the parametric methods in estimation of the impact of contextual variables on productivity ...". As suggested in the recent literature (see, *e.g.*, [40,77]), to properly conduct the regression stage analysis, bias-corrected efficiency scores are computed using a bootstrap procedure (see [105,107]) and then are used as dependent variables in the regression model. We use the Tobit model based on the statements of Banker and Natarajan [12] and the fact that bootstrapping sampling is used in the first stage, thus solving the bias problem.

The general formulation of Tobit model is given as follows:

$$y_i^* = x_i^{'}\beta + \mu_i \tag{3.6}$$
$$\begin{aligned} y_i^* > 0 \quad &\text{if} \quad y_i = y_i^* \quad (i = 1, 2, \ldots n) \\ y_i^* \leq 0 \quad &\text{if} \quad y_i = 0 \end{aligned}$$

$x_i^{'}$ = independent variable
y_i = dependent variable; 0 or 1

β = estimated coefficients
μ_i = error term.

3.4. Data

A fundamental step in the process of calculating the efficiency consists in the choice of appropriate variables (both inputs and outputs) to be used in the analysis. The definition and measurement of inputs and outputs for the public sector is not free of problems and ambiguities. Regional governments have the responsibility to provide various services to their people [45]. An important objective of each regional government is to serve as many beneficiaries as possible using as few inputs as possible, *i.e.*, consuming fewer resources or bearing lower costs. In line with the above, efficiency is defined as the capacity of each regional government to provide public services to the largest possible number of beneficiaries with the least amount of resources. In this paper, inputs are represented by the measures related to the costs necessary to provide public services, *i.e.*, the amounts allocated to each budget program [77].

In the empirical literature, there is a clear consensus that the current expenditure of regional governments should be considered as input variables [4, 11, 51, 71]. The sectors considered for each regional government are: health, education, security, sanitation, transportation, and recreation. According to the RBB framework, each of the above sectors is composed of certain budget programs. The inputs to be considered include the amounts allocated to each of these budget programs, in per capita terms[4]. With regard to outputs, as the literature highlights, it is difficult to find data that directly measure the results of regional governments. This disadvantage is overcome by using the RBB framework, given that each budget program has its own indicators, thus being considered as outputs.

Tables 1 and 2 show the different budget programs considered for each service provided by the regional governments, the indicators associated with each program, the unit of measurement of these indicators, and the source from which they were obtained[5]. For the education sector, the following are considered: the % of children, of school age, who attend classes (at the primary and secondary level) and the % of students with a satisfactory level in the reading comprehension and mathematics exams[6] [82,96]. In the transport sector, the outputs are % of paved roads (km of paved roads/Total km) and the ratio of traffic accidents (1/number of traffic accidents) [54]. In the recreation and culture sector, we use % of all venues (sports and cultural) that are under the public administration of the regional government [70]. In the health area, the mortality rate in children under one year of age and % of children under 5 with malnutrition are considered [3,83]. For the sanitation area, the indicators considered correspond to % of the population with access to water and sewage services [67,92]. Finally, in the security area, it includes indicators associated with the crime rate (1/number of crimes reported per 100 000 people) and misconduct (1/number of misconduct reported per 100 000) [70].

The data used considers the 24 regional governments[7] of Peru during the period 2013–2016.

4. Results and discussion

4.1. Overall and sectoral analysis

The analysis of the efficiency of regional governments in the education sector shows that, in the year 2013, the most efficient regions were Lambayeque, Tacna, and Lima, with values of 0.914, 0.823, and 0.791, respectively (Tab. 3). During the following years, both Lambayeque and Tacna remained among the first three most efficient

[4]The information on budgetary spending can be found on the "Friendly Consultation" portal of the Ministry of Economy and Finance of Peru `https://apps5.mineco.gob.pe/transparencia/mensual/`.

[5]Tables A.1–A.4 (see Appendix A) show the descriptive statistics (average, standard deviation, percentiles, maximum, and minimum values) for the inputs and outputs considered.

[6]These exams are given annually by the Ministry of Education, to students in the second year of primary and secondary education.

[7]Peru has 25 regions, which includes the *Constitutional province of Callao*. Callao is not included in our analysis because we consider the variables in per-capita terms, and since Callao has a very reduced population, this could generate distortions in the data.

TABLE 1. Description of variables.

Budget program	Indicator name	Unit of measure	Source
Health			
Articulated nutritional program	Prevalence of chronic malnutrition in children under 5 years of age	Percentage	Demographic and Family Health Survey
Maternal and neonatal health	Neonatal mortality rate (children who die before their first birthday)	Cases per 1000 live births	Demographic and Family Health Survey
Education			
Learning achievements of students in regular basic education	Elementary 2 grade students from public educational institutions who are at a sufficient level in reading comprehension and mathematics	Percentage	Census evaluation of students
	Secondary 2 grade students from public educational institutions who are at a sufficient level in reading comprehension and mathematics	Percentage	Census evaluation of students
Increase in the access of the population from 3 to 16 years of age to public education services in regular basic education.	Net primary education attendance ratio	Percentage	Ministry of Education – ESCALE
	Net secondary attendance ratio	Percentage	Ministry of Education – ESCALE
Security			
Reduction of crimes and faults that affect citizen safety	Crime rate per 100 000 inhabitants	Cases per 100 000	Yearbook-Police National of Peru
	Fault rate per 100 000 inhabitants	Cases per 100 000	Yearbook-Police National of Peru

regions, but what is important to highlight is the increase in efficiency experienced by Lima: 0.814 in 2014, 0.822 in 2015, and 0.882 in 2016 (this means an increase of approximately 12%). Among the least efficient DMUs are the highlands and the less developed regions, such as Huancavelica, Ayacucho, and Pasco; and the jungle regions, such as Madre de Dios and Amazonas (whose efficiency index decreased by 22% from 2013 to 2016). It was possible to check in general a strong relationship between the index of efficiency and the geographic localization. The regions marked by social inequalities presented low indexes of efficiency. Thus, one may conclude that the lack of worthy housing, the high rates of criminality, and the misdistribution of services can influence students' performance in a negative way [86]. It is interesting to note the case of the region of Moquegua, which has experienced a significant improvement in its educational quality in recent years. However, this improvement has not been reflected in higher levels of efficiency. This would indicate that good indicators do not necessarily lead to an efficient use of the resources allocated. Effectiveness does not imply efficiency. In a study using similar variables, Kosor *et al.* [73] calculated the technical efficiency of public spending on education for EU-28, concluding that "...the average efficiency in spending is high, although there are stark differences among countries in their efficiency scores. Five most efficient countries were identified (Bulgaria, Hungary, Ireland, Luxembourg and Malta)". In Table 5, we can see that the education sector maintains its average efficiency level of 0.58, with a standard deviation that increased from 0.154 to 0.166. These results indicate that despite the best indicators considered, satisfactory student achievement and access to primary and secondary education, the regions have not been able to improve their performance in the use of their resources.

TABLE 2. Description of variables.

Budget program	Indicator name	Unit of measure	Source
Sanitation National sanitation program	Potable water coverage	Percentage	National Survey of Budget Programs
	Coverage of sewage services	Percentage	National Survey of Budget Programs
Transportation Reduction of accidents and time on the country's roads	Paving roads	Percentage	Statistics – Ministry of Transportation and Communications
	Accidents rate	Index	Statistics – Ministry of Transportation and Communications
Recreation and culture Increase in the practice of cultural, sports and recreational activities in the population	Municipalities that manage sports facilities	Percentage	National Survey of Municipalities
	Municipalities that manage recreational and cultural facilities	Percentage	National Survey of Municipalities

TABLE 3. Sector efficiency indices.

Region	Health				Education				Security			
	2013	2014	2015	2016	2013	2014	2015	2016	2013	2014	2015	2016
Amazonas	0.157	0.091	0.162	0.338	0.482	0.379	0.341	0.377	0.613	0.389	0.212	0.247
Ancash	0.360	0.308	0.623	0.754	0.634	0.585	0.658	0.644	0.025	0.188	0.181	0.173
Apurimac	0.105	0.111	0.150	0.250	0.418	0.364	0.318	0.309	0.021	0.279	0.385	0.363
Arequipa	0.709	0.704	0.783	0.834	0.711	0.816	0.858	0.877	0.004	0.059	0.045	0.057
Ayacucho	0.145	0.090	0.158	0.254	0.307	0.344	0.392	0.387	0.049	0.776	0.702	0.596
Cajamarca	0.188	0.114	0.311	0.497	0.549	0.502	0.533	0.521	0.080	0.763	0.793	0.770
Cusco	0.187	0.204	0.358	0.464	0.484	0.443	0.502	0.541	0.010	0.090	0.137	0.136
Huancavelica	0.129	0.086	0.161	0.285	0.360	0.295	0.422	0.391	0.618	0.585	0.802	0.795
Huánuco	0.126	0.162	0.344	0.465	0.542	0.544	0.598	0.512	0.108	0.761	0.823	0.825
Ica	0.530	0.600	0.802	0.866	0.740	0.767	0.749	0.789	0.013	0.095	0.080	0.090
Junín	0.299	0.410	0.394	0.622	0.656	0.613	0.713	0.612	0.017	0.247	0.249	0.262
La Libertad	0.437	0.342	0.909	0.912	0.705	0.682	0.719	0.753	0.023	0.194	0.183	0.169
Lambayeque	0.573	0.425	0.810	0.831	0.914	0.886	0.917	0.884	0.009	0.102	0.089	0.079
Lima	0.697	0.700	0.752	0.786	0.791	0.814	0.822	0.882	0.009	0.049	0.063	0.077
Loreto	0.184	0.190	0.315	0.564	0.547	0.489	0.511	0.478	0.081	0.750	0.791	0.335
Madre de Dios	0.188	0.245	0.392	0.342	0.386	0.305	0.370	0.443	0.033	0.044	0.165	0.075
Moquegua	0.526	0.515	0.595	0.479	0.611	0.466	0.567	0.466	0.082	0.084	0.186	0.086
Pasco	0.264	0.229	0.440	0.311	0.391	0.469	0.515	0.498	0.131	0.666	0.778	0.686
Piura	0.250	0.254	0.630	0.621	0.722	0.701	0.720	0.732	0.029	0.229	0.236	0.212
Puno	0.224	0.230	0.369	0.728	0.537	0.529	0.588	0.591	0.085	0.585	0.778	0.574
San Martin	0.180	0.276	0.312	0.632	0.500	0.537	0.556	0.598	0.029	0.430	0.532	0.465
Tacna	0.716	0.709	0.679	0.729	0.823	0.824	0.792	0.795	0.024	0.058	0.087	0.085
Tumbes	0.252	0.216	0.271	0.277	0.494	0.464	0.554	0.557	0.008	0.072	0.074	0.063
Ucayali	0.253	0.200	0.263	0.492	0.532	0.573	0.585	0.573	0.036	0.252	0.356	0.289

With respect to the health sector, we can observe that all regions, with the exception of Moquegua, increased their level of efficiency by 2016, with La Libertad, Ica, and Arequipa being the most efficient regions in this sector. One of the main reasons for the increase in the level of efficiency has been the presence, in recent years, of investments in public hospitals under the Public-Private Partnerships (PPPs) modality. Table 5 shows that the health sector increased its level of efficiency from 0.320 in 2013 to 0.556 in 2016 (an increase of more than 75%). Interestingly, this result is, for example, much lower than what the OECD countries were reported to have registered a decade before, wherein the average input efficiency varied between 0.832 and 0.946; Korea, Japan, and Sweden were found to be the best performers in health, and not spending too many resources [3]. The standard deviation remained in the range of 0.2, which indicates that the increase in the efficiency level has been homogeneous among the regions. These results are accompanied by improvements in the under-five chronic malnutrition rate, which declined from 20% in 2013 to 15.5% in 2016; and improvements in the infant mortality rate, which dropped from 13% to 10%. We can also observe that the regions located in the mountains and the jungle are the worst performers. In this sense, regions such as Amazonas, Apurimac, Ayacucho, Madre de Dios, Huancavelica, and Pasco are below average in terms of efficiency. Coastal regions, on the other hand, are the best performers. The regions that do not perform well in healthcare can learn from the regions which are doing well in health and *vice versa*, to improve their respective practices.

In the security sector, we observe that all regions, with the exception of Amazonas, experienced significant increases in their level of efficiency, if 2013 is taken as a reference, the year in which the efficiency indicators are quite low. However, if we compare the results of 2016 with 2014, we observe a decrease in efficiency in most regions. On an average, the security sector indices were 0.313 in 2016. These rates indicate that to be fully efficient, there should have been an increase near to 70%. This, for example, marks a significant difference with the results of [27], which when analyzing the efficiency of the security levels provided by the New South Wales Police Service, found indicators of up to 85%. From the beginning, in 2012, the Budget Program titled "Reduction of crimes and faults that affects citizen safety" concentrated its efforts on improving coverage in urban and urban-marginal areas, targeting areas with the highest population density and high crime rates. This recognizes, in turn, that the problems of violence and crime in the rural areas of the country have a specificity that requires other types of police interventions. The latter, however, have not produced the expected results. The coastal regions such as Lima, Arequipa, Moquegua, Ica, and Tacna are the worst performers. The results are reinforced by security and crime indicators, such as vehicle and home thefts. Crime and missing persons rates increased during the reporting period. These indicators could, nonetheless, be biased because the people who are victims of criminal acts do not necessarily file their complaints officially, due to lack of trust in the authorities. Another factor that could be affecting efficiency levels are the limitations of the judiciary power. While the police services can capture and detain criminals who carry out different types of crimes, there is a lack of a solid substantiation of the cases, combined with high levels of red tape and corruption [58]. In addition to releasing suspected criminals (who could potentially commit other crimes), the low incarceration rate also generates other problems, creating incentives for potential witnesses not to cooperate with prosecutors for fear of retaliation.

In the sanitation sector (Tab. 4), we observe that some regions such as Lima, Ica, and Lambayeque experienced efficiency gains, while other regions experienced a slight decrease in their efficiency. The southern regions of Peru (Puno, Ayacucho, Tacna, and Moquegua) are the regions that show the worst performance in their efficiency indicators during the four years of analysis. These differences across regions over time are a direct consequences of the feature that there are large variations between the conditions and results of Peruvian regions. This result can be best understood in light of the significant percentage of Peru's population that still does not have access to sanitation services, especially in rural areas[8]. As of 2018, approximately 5 million people do not have access to water services (15% of the country's total population) and 11 million lack sewerage (34%). Another factor that could explain this poor performance is related to the fall in public investment (which is associated with the sanitation programs promoted by the Ministry of Housing, Construction and Sanitation),

[8]One of the government's main objectives was to get 100% coverage of drinking water and sanitation by the year 2021. At present, this objective is far from being achieved.

TABLE 4. Sector efficiency indices.

Region	Sanitation				Transportation				Recreation			
	2013	2014	2015	2016	2013	2014	2015	2016	2013	2014	2015	2016
Amazonas	0.073	0.088	0.058	0.040	0.042	0.068	0.047	0.055	0.740	0.069	0.254	0.163
Ancash	0.166	0.299	0.179	0.071	0.414	0.202	0.134	0.175	0.366	0.087	0.282	0.170
Apurimac	0.068	0.156	0.068	0.028	0.037	0.078	0.045	0.029	0.592	0.179	0.116	0.062
Arequipa	0.135	0.377	0.272	0.107	0.076	0.099	0.079	0.109	0.071	0.073	0.133	0.101
Ayacucho	0.085	0.187	0.074	0.049	0.025	0.062	0.039	0.076	0.151	0.397	0.602	0.261
Cajamarca	0.045	0.170	0.122	0.037	0.062	0.111	0.062	0.085	0.125	0.130	0.360	0.249
Cusco	0.034	0.163	0.090	0.045	0.048	0.065	0.030	0.048	0.040	0.068	0.086	0.060
Huancavelica	0.028	0.081	0.040	0.023	0.518	0.099	0.055	0.029	0.194	0.077	0.231	0.076
Huánuco	0.044	0.170	0.158	0.045	0.147	0.137	0.044	0.043	0.316	0.265	0.385	0.351
Ica	0.093	0.380	0.224	0.151	0.595	0.544	0.664	0.607	0.073	0.083	0.152	0.163
Junín	0.183	0.827	0.169	0.116	0.120	0.205	0.100	0.083	0.326	0.537	0.813	0.338
La Libertad	0.113	0.514	0.317	0.108	0.159	0.187	0.111	0.165	0.083	0.200	0.344	0.184
Lambayeque	0.056	0.557	0.289	0.174	0.729	0.784	0.681	0.730	0.408	0.684	0.751	0.706
Lima	0.221	0.793	0.773	0.693	0.385	0.459	0.169	0.103	0.353	0.199	0.192	0.146
Loreto	0.036	0.312	0.288	0.110	0.372	0.472	0.140	0.360	0.610	0.742	0.650	0.465
Madre de Dios	0.683	0.732	0.525	0.212	0.018	0.044	0.019	0.021	0.271	0.269	0.313	0.227
Moquegua	0.119	0.532	0.088	0.042	0.197	0.158	0.174	0.093	0.230	0.055	0.173	0.059
Pasco	0.036	0.248	0.094	0.029	0.681	0.609	0.272	0.375	0.038	0.184	0.157	0.048
Piura	0.039	0.195	0.147	0.115	0.241	0.261	0.085	0.110	0.480	0.806	0.358	0.208
Puno	0.060	0.172	0.091	0.036	0.122	0.115	0.082	0.044	0.138	0.118	0.141	0.060
San Martin	0.054	0.264	0.115	0.041	0.094	0.143	0.056	0.085	0.248	0.257	0.453	0.240
Tacna	0.710	0.536	0.632	0.137	0.311	0.263	0.103	0.022	0.089	0.126	0.176	0.066
Tumbes	0.088	0.321	0.129	0.162	0.279	0.316	0.182	0.123	0.072	0.138	0.648	0.421
Ucayali	0.024	0.203	0.474	0.084	0.167	0.121	0.054	0.035	0.771	0.338	0.425	0.372

which has decreased in both the urban and rural sectors. Water and sanitation services are unsustainable due to insufficient investment, serious economic problems for operators, lack of state support and inadequate legal regulations [85]. The estimated infrastructure gap in the sanitation sector is US$16 billion [89], which could be closed only over the following eight years. At a general level, the significant increase in the global indicator in the water and sanitation sector is clear, which went from 0.13 in 2013 to 0.34 in 2014. This increase was driven by the increase in expenditures assigned to the "National sanitation program", which went from 176 soles per capita to 187 soles during these two years. In 2015, the indicator fell to 0.22, as did the per capita spending, which decreased by 12% (to 165.8). In 2016, the fiscal spending of this program increased again, however the indicator continued to decline (0.11). In addition to the problems mentioned in the previous paragraph, 2016 represented a complex year, in fiscal terms, given the general elections. The mayors (who represent political parties that run in the elections) tend to distribute their expenses in proselytising and short-term actions, in search of the popular support of the population. Tables 4 and 5 show more details.

In the transportation sector (Tab. 4), most regions experienced a drop in efficiency. The main reasons can be attributed to the road infrastructure gap, the traffic congestion, and the road traffic accident rate. The infrastructure gap regarding roads is worth approximately S/. 31.85 billion[9] (without considering the effect of the El Nio phenomenon), which is reflected in the poor conditions of the roads and the transportation service. Vehicle congestion has been increasing in recent years, causing travel delays and impairing connectivity between regions, damaging the country's trade and economic growth. Another factor that explains the performance of the regions in this sector is the high rates of road traffic accidents on all roads in the country (from 1932 in 2013

[9]Peruvian Nuevos Soles (S/.) is the national currency of Peru.

TABLE 5. Descriptive statistics – Efficiency indices for the years 2013, 2014, 2015, and 2016.

	Mean	St. dev.	Min	Max	Percentiles				
					10	25	50	75	90
2013									
Health	0.320	0.195	0.105	0.716	0.128	0.181	0.251	0.504	0.703
Education	0.576	0.154	0.307	0.914	0.373	0.483	0.545	0.709	0.807
Security	0.089	0.162	0.004	0.618	0.008	0.014	0.029	0.081	0.372
Sanitation	0.133	0.177	0.024	0.710	0.031	0.040	0.070	0.131	0.452
Transportation	0.243	0.210	0.018	0.729	0.031	0.066	0.163	0.382	0.638
Recreation	0.283	0.216	0.038	0.771	0.056	0.085	0.239	0.398	0.675
Overall index	0.263	0.114	0.071	0.469	0.109	0.180	0.236	0.363	0.456
2014									
Health	0.309	0.197	0.086	0.709	0.090	0.169	0.238	0.421	0.702
Education	0.558	0.170	0.295	0.886	0.324	0.449	0.533	0.696	0.820
Security	0.323	0.264	0.044	0.776	0.054	0.086	0.238	0.585	0.762
Sanitation	0.345	0.215	0.081	0.827	0.122	0.171	0.282	0.528	0.762
Transportation	0.233	0.194	0.044	0.784	0.063	0.099	0.150	0.303	0.577
Recreation	0.253	0.218	0.055	0.806	0.069	0.084	0.181	0.321	0.713
Overall index	0.298	0.114	0.116	0.513	0.146	0.190	0.284	0.385	0.484
2015									
Health	0.458	0.233	0.150	0.909	0.159	0.281	0.380	0.667	0.806
Education	0.596	0.162	0.318	0.917	0.355	0.504	0.576	0.720	0.840
Security	0.364	0.289	0.045	0.823	0.069	0.101	0.224	0.759	0.797
Sanitation	0.226	0.190	0.040	0.773	0.063	0.090	0.152	0.289	0.579
Transportation	0.143	0.170	0.019	0.681	0.035	0.049	0.083	0.162	0.468
Recreation	0.342	0.208	0.086	0.813	0.125	0.161	0.298	0.446	0.700
Overall index	0.303	0.114	0.120	0.481	0.150	0.200	0.293	0.409	0.472
2016									
Health	0.556	0.210	0.250	0.912	0.265	0.339	0.530	0.748	0.850
Education	0.592	0.166	0.309	0.884	0.382	0.469	0.565	0.747	0.879
Security	0.313	0.254	0.057	0.825	0.069	0.085	0.229	0.546	0.783
Sanitation	0.111	0.132	0.023	0.693	0.029	0.040	0.077	0.132	0.193
Transportation	0.150	0.181	0.021	0.730	0.026	0.044	0.085	0.155	0.491
Recreation	0.217	0.158	0.048	0.706	0.059	0.068	0.177	0.318	0.443
Overall index	0.292	0.112	0.117	0.481	0.153	0.189	0.291	0.363	0.479

to 2969 in 2016; an increase of 54%). Despite these facts, the amount allocated to the program "Reduction of accidents and time on the country's roads" decreased from S/. 535 per capita in 2013 to S/. 508 per capita in 2016, at the national level. The public transport plan aims to improve the quality of life in cities. In addition, a policy aimed at public transport planning should establish regulations to protect the rights of users and ensure that the quality of the public transport is maintained [28]. In Table 5, we can observe the average efficiency level of the transportation sector, which decreased from 0.27 in 2013 to 0.19 in 2016 (a 30% drop). In the less populated regions (Tacna, Madre de Dios, and Amazonas), this sector registers the lowest levels of efficiency. This coincides with the results of Fitzova *et al.* [57], who analyzed the efficiency levels of the urban public transport system and concluded that "the principal lesson from this study is that bigger cities with greater population densities are more efficient than smaller cities". The standard deviation also decreased from 0.243 to 0.150. In the recreation sector, some regions such as Arequipa, Lambayeque, and Huánuco experienced slight increases in their level of efficiency, contrary to most regions, which actually showed a reduction, such as Amazonas, Moquegua, and Puno. Table 5 shows that the recreation sector index dropped from 0.283 in 2013 to 0.217 in 2016 (a decrease of 23%).

TABLE 6. Overall efficiency index – Ranking.

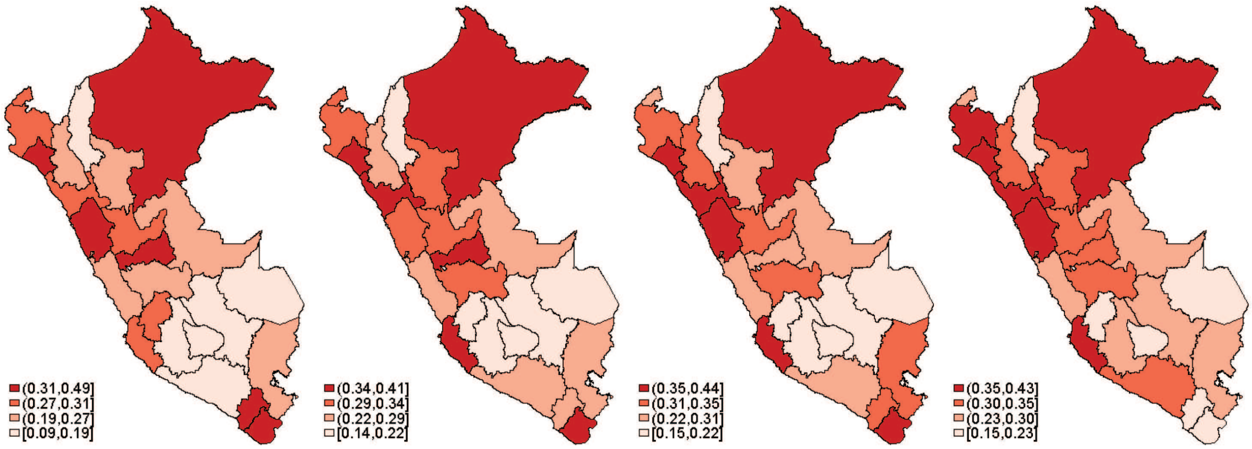
	Overall efficiency index							
Ranking	Region	2013	Region	2014	Region	2015	Region	2016
1	Tacna	0.489	Lambayeque	0.408	Lambayeque	0.439	Lambayeque	0.435
2	Pasco	0.349	Loreto	0.398	Loreto	0.416	La Libertad	0.410
3	Lambayeque	0.325	Tacna	0.386	La Libertad	0.402	Loreto	0.408
4	Loreto	0.318	Pasco	0.386	Ancash	0.364	Piura	0.368
5	Ancash	0.318	La Libertad	0.348	Tacna	0.356	Ancash	0.368
6	Moquegua	0.310	Ica	0.340	Ica	0.353	Ica	0.356
7	Huancavelica	0.303	Piura	0.336	Huánuco	0.351	San Martin	0.349
8	Ica	0.294	Junín	0.329	Piura	0.347	Cajamarca	0.331
9	La Libertad	0.291	Huánuco	0.320	Junín	0.333	Junín	0.323
10	Piura	0.287	San Martin	0.311	Puno	0.323	Huánuco	0.314
11	Huánuco	0.272	Tumbes	0.303	Moquegua	0.310	Pasco	0.305
12	Tumbes	0.268	Ancash	0.300	Cajamarca	0.306	Arequipa	0.301
13	Ucayali	0.263	Moquegua	0.281	Ucayali	0.306	Puno	0.298
14	Junín	0.254	Ucayali	0.278	Pasco	0.304	Tumbes	0.287
15	Puno	0.237	Puno	0.273	Tumbes	0.294	Ucayali	0.267
16	San Martin	0.222	Cajamarca	0.257	San Martin	0.280	Lima	0.244
17	Cajamarca	0.208	Lima	0.239	Arequipa	0.277	Ayacucho	0.242
18	Lima	0.197	Arequipa	0.238	Lima	0.231	Cusco	0.234
19	Arequipa	0.189	Apurimac	0.197	Huancavelica	0.216	Moquegua	0.229
20	Amazonas	0.171	Cusco	0.179	Ayacucho	0.199	Huancavelica	0.218
21	Cusco	0.145	Ayacucho	0.178	Apurimac	0.195	Amazonas	0.217
22	Apurimac	0.141	Huancavelica	0.174	Cusco	0.192	Tacna	0.212
23	Ayacucho	0.127	Amazonas	0.167	Amazonas	0.178	Apurimac	0.182
24	Madre de Dios	0.095	Madre de Dios	0.135	Madre de Dios	0.152	Madre de Dios	0.153

Table 6 shows the overall efficiency rates, ranked in ascending order, for the period 2013–2016. We can observe that the coastal regions have the highest levels of efficiency, with Lambayeque and Loreto being the regions that lead the ranking for the period of analysis. Loreto is the only region in the jungle to have a high level of efficiency, with health and education as the sectors that contribute the most to this important result. On the other hand, Pasco is the only region in the highlands to be among the five regions with the highest level of efficiency. The bottom of the ranking is occupied by the regions of Amazonas, Cusco, Apurimac, Ayacucho, and Madre de Dios, the last one being the region with the lowest level of efficiency, as a result of the poor performance observed in the security and transportation sectors. Figure 1 shows the evolution of the overall efficiency level for the period of analysis. These global results show that, on an average, regional governments perform poorly in managing their resources. Furthermore, the most efficient regions operate at half their capacity. In 4 years, only 0.03 tenths of a percentage point improvement was achieved, from 0.26 in 2013 to 0.29 in 2016 (an inefficiency of approximately 70%). There is a high degree of relative waste of economic resources allocated to the regions. Table A.5 provides the bias and variance of the bootstrap estimates and Table A.6 reports the confidence intervals of the bootstrap estimates, for every sector and every DMU.

4.2. Efficiency determinants: Tobit regression

In this section, we evaluate the possible determinants of the overall efficiency rates calculated in the second stage. To this end, Tobit regression models are used[10]. The explanatory variables are selected according to the

[10]Tobit models are suitable for DEA models, since the efficiency indices (dependent variables) are observations whose values are restricted between 0 and 1 [50].



(a) (b) (c) (d)

FIGURE 1. Overall indices. (a) Year 2013. (b) Year 2014. (b) Year 2015. (d) Year 2016.

existing literature and refer to three different aspects: (i) economic and financial, (ii) demographic, and (iii) political components. The economic and financial aspects include the fiscal autonomy variable (percentage of revenues collected in relation to the allocated budget), which measures the degree of solvency and capacity of regional governments to generate their own resources; the per capita budget variable, which evaluates the management capacity of the regional governments [97]; and the capital stock per worker [26], introduced to evaluate whether workers' productivity influences the efficiency of their respective governments. Regarding the demographic aspects, the variable density is included in the regression [47, 51, 71, 77]. In addition, the second mandate variable is included, which takes into account the possible influence of political factors on the efficiency of regional governments, being a dichotomous variable that will take the value of 1 in those regional governments where their presidents have been re-elected in 2014, and 0 otherwise [50]. Finally, the variable citizen perception is included, which takes into account the opinion of the population regarding the public management of the regional government[11].

Table 7 presents the results of the Tobit regression. Both economic variables, fiscal autonomy and capital stock per worker, show a positive relationship with respect to the efficiency index. The positive relationship between fiscal autonomy and overall efficiency highlights the importance of increased tax collection in the performance of governments in managing their economic resources. On the other hand, the per capita budget negatively affects the performance of regional governments. Having large amounts of resources does not ensure their efficient usage. The density variable shows a positive and significant value, which is in accordance with existing literature, leading us to conclude that in regions with less dispersed populations, a more efficient provision of goods and services is facilitated, due to the lower cost of provision that this implies. The political variable titled second mandate presents a positive relationship, but it is not significant. We also observe that the citizen perception variable is positive and significant, indicating that the population's perception of the management of regional governments influences the efficiency levels. Finally, Prob $>$ chi2 tests the null hypothesis that all of the regression coefficients are simultaneously equal to zero. The p-value of 0.0000 would lead us to conclude that at least one of the regression coefficients in the model is not equal to zero.

[11]This variable represents the percentage of the adult population that considers that the public management of the regional government is good or very good.

TABLE 7. Tobit regression.

	Coef.	Std. Error	t	p-value	95% Conf. Interval	
Fiscal Autonomy	0.0673	0.2674	2.52	0.0210	0.1235	0.0111
Budget per capita	−0.3075	0.0196	−15.67	0.0000	−0.3487	−0.2663
Population density	0.2031	0.0141	14.42	0.0000	0.1735	0.2326
Second mandate	0.0039	0.0191	0.28	0.781	−0.0250	0.3300
Capital stock per worker	0.1734	0.0200	8.66	0.0000	0.1313	0.2155
Citizen perception	0.0743	0.0306	2.43	0.0260	0.0100	0.1385
const	0.3232	0.0111	29.12	0.0000	0.2999	0.3465
sigma*	0.0214	0.0030			0.0151	0.0278

Notes. 0 left-censored observations, 24 uncensored observations, 0 right-censored observations. Prob > chi2 = 0.000, AIC = −100.32, BIC = −90.895, Cox-Snell/ML = 0.916. (*)It represents the standard error of the regression and it is comparable with RMSE from the OLS regression.

5. Conclusions and future work

The analysis of efficiency in the usage of economic resources by regional governments is a fundamental aspect in the examination of the public sector, especially since public entities face the challenge of improving their productivity on a continuous basis (Charles, Gherman, & Paliza, [33]). In economic terms, an evaluation that considers only the effectiveness in achieving the objectives, and not the efficiency in achieving these objectives, is of little use, given that the resources that governments draw from society and manage are essentially scarce. In this sense, this study analyzes the efficiency of public spending of the 25 regional governments of Peru, taking the Results-Based Budget (RBB) as a frame of reference, which represents a public management strategy that allows linking the allocation of budgetary resources to goods-services (products) and results in favor of the population, with the characteristic of allowing these to be measurable. The RBB framework examines both aspects, effectiveness and efficiency, when considering the amounts allocated to the different budget programs, as well as the objectives set for each of these programs.

A two-stage Data Envelopment Analysis (DEA) model is used to measure the level of efficiency using the bootstrapping approach for non-parametric models. The analysis is thus carried out in the first stage by individually considering the different functions (health, education, security, sanitation, transportation, and recreation) of the regional governments. In the second stage, all individual indices of the functions considered in the first stage are aggregated to generate an indicator representing the overall efficiency level. In addition, we evaluate the determinants or factors that influence the performance of the regional governments in the provision of goods and services under their jurisdiction. Overall, the results show a general stagnation in the levels of efficiency of spending assigned to regional governments during the study period, going from 0.26 in 2013 to 0.29 in 2016. The level of 0.29 registered in 2016 indicates that, on average, the current provision of local goods and services could be provided with 71% fewer resources. At the sectoral level, results differ significantly between regions and between sectors. While sectors such as health and security showed improvements during the period of analysis, the sanitation and transportation sectors experienced declines in their efficiency indices. At the regional level, the most efficient regions are located on the coast, with the exception of Loreto, to the detriment of its mountain and jungle counterparts. On the exogenous variables that affect the efficiency index, both the level of fiscal autonomy and the capital stock show a positive relationship with respect to the efficiency index. The population density variable shows a positive and significant value. It leads us to conclude that in regions with less dispersed populations, a more efficient provision of goods and services is facilitated, due to the lower cost of provision that this implies.

The performed analysis offers further insights from both a methodological point of view and an empirical one. Some of them are driven by the limitations of the analysis itself. One weakness of the two-stage DEA method that we use in this paper is that its application requires assuming the separability condition, *i.e.*, exogenous variables only affect the probability of being more or less efficient and not the shape of the frontier (see, *e.g.*, [69]). In this regard, the separability condition should be tested [43] or some alternative approaches, which do not assume this condition, could be applied. See, for example, the conditional nonparametric model proposed by Cazals *et al.* [29] and extended by Daraio and Simar [42], which offers a solution based on the use of a probabilistic formulation which allows for a nonparametric estimation of the efficiency measures by incorporating the effect of the exogenous variables in a single stage.

Furthermore, this study considers only a limited typology of services that are directly provided or financially supported by regional governments, leaving aside other functions, and indicators of the functions considered, that need to be analyzed. The Results-Based Budget (RBB) framework has programs associated with each of these functions, with their designated objectives, as well as other indicators of those already analyzed. Another aspect to consider is the form of aggregation of the individual indices of each function to build a general indicator. We generate the overall efficiency index by using a weighted average, considering as a weight for each efficiency index the percentage of expenditure in each sector in relation to the total expenditure. However, there are other methodologies that could be applied such as "rules of thumb", "benefit of the doubt" or Shannon's entropy approach. Finally, another limitation of the study is related to the model used. Although the DEA methodology is one of the most used and effective according to the literature, it is also possible to make use of more advanced models, which have the advantage of a higher level of precision in the calculation of efficiency indices. [74] and [62] propose the use of multiple objective functions in the calculation of the efficiency indices. Lastly, another future research avenue could be the use of productivity change indices instead of efficiency scores to evaluate the performance over time of Peruvian regional governments.

Appendix A.

Table A.1. Descriptive statistics – Year 2013.

INPUTS*									
	Mean	St. dev.	Min.	Max.	Percentiles				
					10	25	50	75	90
Education									
Learning achievements	430.8	124.0	248.7	753.9	272.7	325.8	421.7	508.4	618.5
Access to education	10.0	12.3	0.3	54.8	1.5	2.2	6.1	12.3	29.7
Health									
Articulated nutritional program	75.1	37.3	31.1	199.2	37.3	49.1	68.3	85.0	126.7
Maternal and neonatal health	61.9	24.0	35.5	112.8	36.8	40.8	56.3	86.4	102.0
Security									
Crime reduction	85.9	56.7	3.7	267.7	13.0	46.0	80.2	107.8	155.4
Sanitation									
National Sanitation Program	176.4	67.0	55.7	340.5	83.4	130.7	159.6	220.6	277.7
Transportation									
Land Transportation	535.8	642.0	75.8	3244.2	91.7	170.7	341.4	637.2	1089.3
Recreation									
Recreation and Culture	11.9	12.5	1.1	45.8	2.1	3.8	5.9	17.3	38.0

Table A.1. Continued.

OUTPUTS	Mean	St. dev.	Min.	Max.	Percentiles				
					10	25	50	75	90
Education									
Students with satisfactory level	22.9	11.2	4.7	53.5	11.3	14.9	20.6	26.5	42.5
Access to primary education	93.5	1.7	88.7	96.3	91.5	92.3	93.7	94.7	95.9
Access to secondary education	81.2	7.5	64.6	94.1	69.0	76.0	83.7	87.2	89.1
Health									
Chronic child malnutrition (%)	20.0	10.2	2.9	42.4	4.6	9.7	22.1	27.6	32.3
Infant mortality (%)	13.0	3.6	5.3	19.0	7.4	10.1	13.8	15.9	17.6
Security									
Crime rate (per 1000 inhab.)	81.1	41.0	17.6	172.4	26.6	47.9	72.6	114.1	151.3
Fault rate (per 1000 inhab.)	70.8	39.7	10.6	143.8	23.6	34.3	72.6	97.2	129.4
Sanitation									
Population – potable water (%)	54.2	21.3	23.5	89.7	25.6	33.7	50.4	75.4	86.2
Population – sewage system (%)	55.5	18.0	28.2	88.8	30.1	40.1	52.7	69.8	83.2
Transportation									
Paving of roads	0.2	0.1	0.1	0.3	0.1	0.1	0.2	0.2	0.2
Accidents rate	1978.1	3424.2	272.5	162 48.4	365.4	594.2	920.1	1573.5	5822.9
Recreation									
Libraries (%)	47.3	20.4	9.1	98.4	23.1	34.2	41.6	61.4	81.8
Sports facilities (%)	92.5	5.9	76.2	100.0	84.1	88.7	93.8	97.2	100.0
Recreational facilities (%)	56.5	18.0	27.3	98.4	34.2	43.9	52.1	70.2	87.0

Notes. [(*)]Amounts allocated (soles) to each budget program in per capita terms.

Table A.2. Descriptive statistics – Year 2014.

	Mean	St. dev.	Min.	Max.	Percentiles				
					10	25	50	75	90
INPUTS*									
Education									
Learning achievements	473.6	155.8	258.6	826.5	265.1	340.1	444.8	581.6	741.0
Access to education	22.7	23.6	1.0	81.1	2.2	4.9	11.9	33.7	68.8
Health									
Articulated nutritional program	85.6	50.0	37.0	259.3	39.5	53.2	66.5	91.7	161.7
Maternal and neonatal health	63.9	25.6	35.6	124.8	39.3	42.4	52.8	87.5	101.9
Security									
Crime reduction	120.9	57.8	49.4	234.8	60.7	72.6	95.6	162.6	228.2
Sanitation									
National Sanitation Program	187.8	86.8	48.9	424.2	79.0	116.3	181.7	245.1	313.4
Transportation									
Land Transportation	502.1	387.4	88.4	1886.8	111.2	232.9	469.8	631.5	960.2
Recreation									
Recreation and Culture	22.8	15.4	3.0	63.2	6.6	8.3	18.7	33.5	45.0
OUTPUTS									
Education									
Students with satisfactory level	33.0	11.7	9.0	60.9	18.0	25.9	30.3	38.4	53.1
Access to primary education	93.4	1.9	88.3	97.1	90.8	92.3	93.4	94.7	96.3
Access to secondary education	82.4	6.6	68.6	91.1	71.5	78.0	82.9	87.0	90.9
Health									
Chronic child malnutrition (%)	18.7	9.2	3.7	35.0	4.5	8.7	20.2	25.8	31.5
Infant mortality (%)	11.8	3.5	4.0	18.0	6.5	9.8	12.0	14.8	17.0
Security									
Crime rate (per 1000 inhab.)	87.6	39.9	29.3	165.5	34.0	58.0	80.1	113.9	157.0
Fault rate (per 1000 inhab.)	78.0	47.9	17.6	212.2	23.4	33.5	74.5	107.7	151.9
Sanitation									
Population – potable water (%)	52.6	22.2	15.3	91.1	24.2	30.0	53.8	72.8	86.5
Population – sewage system (%)	56.1	18.9	24.3	89.8	29.6	41.7	53.2	70.6	87.3
Transportation									
Paving of roads	0.7	0.2	0.5	1.0	0.5	0.6	0.7	0.8	1.0
Accidents rate	2406.2	5323.3	176.7	27 492.6	279.9	842.5	1038.0	1777.3	4001.5
Recreation									
Libraries (%)	46.9	20.3	9.1	98.4	24.4	33.7	41.3	60.8	81.8
Sports facilities (%)	94.0	5.7	81.0	100.0	84.5	90.1	95.4	99.8	100.0
Recreational facilities (%)	57.8	19.0	27.3	98.4	34.0	43.7	50.3	75.3	87.9

Notes. (*)Amounts allocated (soles) to each budget program in per capita terms.

Table A.3. Descriptive statistics – Year 2015.

	Mean	St. dev.	Min.	Max.	Percentiles				
					10	25	50	75	90
INPUTS*									
Education									
Learning achievements	543.5	173.5	314.2	908.0	324.5	395.9	526.1	634.0	858.1
Access to education	37.9	42.7	1.3	176.9	3.7	12.1	26.5	42.8	117.9
Health									
Articulated nutritional program	90.7	46.5	36.7	214.8	40.4	59.5	78.1	91.8	173.6
Maternal and neonatal health	74.8	30.7	42.1	140.0	43.2	51.6	63.3	90.6	132.3
Security									
Crime reduction	130.2	56.5	60.3	285.0	61.8	86.3	123.7	167.2	215.3
Sanitation									
National Sanitation Program	165.8	98.9	31.5	363.6	45.5	83.8	140.9	262.9	319.7
Transportation									
Land Transportation	486.3	413.8	51.9	2039.7	102.6	195.9	386.4	707.1	893.3
Recreation									
Recreation and Culture	12.5	7.5	3.6	33.8	4.2	6.7	10.0	18.2	22.5
OUTPUTS									
Education									
Students with satisfactory level	36.6	11.5	11.9	65.8	22.1	28.9	35.9	41.9	54.0
Access to primary education	91.6	2.5	86.4	95.1	87.1	89.3	92.3	93.5	94.5
Access to secondary education	82.4	5.8	68.7	91.4	72.8	79.0	82.0	87.4	90.1
Health									
Chronic child malnutrition (%)	16.7	7.7	2.6	34.0	4.7	9.4	17.7	22.6	24.1
Infant mortality (%)	12.0	2.8	7.9	15.5	8.5	9.0	11.8	15.5	15.5
Security									
Crime rate (per 1000 inhab.)	79.8	42.7	23.4	183.4	25.2	36.8	77.2	116.8	139.0
Fault rate (per 1000 inhab.)	76.1	53.4	17.8	229.0	22.9	36.7	64.0	91.8	169.2
Sanitation									
Population – potable water (%)	53.4	22.1	18.5	92.2	22.1	31.3	54.0	74.2	86.9
Population – sewage system (%)	59.6	17.7	32.9	92.3	37.7	45.7	57.1	73.9	88.1
Transportation									
Paving of roads	0.2	0.1	0.1	0.3	0.1	0.1	0.2	0.2	0.3
Accidents rate	2139.1	3005.2	211.2	15 562.1	473.8	674.2	1211.5	2193.2	4393.6
Recreation									
Libraries (%)	49.2	21.2	9.1	96.9	26.3	33.7	42.7	64.9	85.6
Sports facilities (%)	95.2	4.6	83.3	100.0	87.2	92.4	96.9	99.0	100.0
Recreational facilities (%)	54.4	20.3	18.2	96.9	30.0	36.8	47.8	71.5	88.3

Notes. (*)Amounts allocated (soles) to each budget program in per capita terms.

Table A.4. Descriptive statistics – Year 2016.

	Mean	St. dev.	Min.	Max.	Percentiles				
					10	25	50	75	90
INPUTS*									
Education									
Learning achievements	577.2	169.0	329.9	1006.8	349.2	426.7	573.0	667.7	831.4
Access to education	39.9	46.0	1.3	177.1	2.9	11.4	23.0	59.3	133.5
Health									
Articulated nutritional program	90.1	40.9	40.2	181.7	42.6	59.8	80.2	97.2	159.2
Maternal and neonatal health	85.6	56.1	45.0	322.7	47.5	53.7	68.0	99.0	130.1
Security									
Crime reduction	143.2	58.6	65.8	269.5	72.9	102.0	122.4	167.1	244.6
Sanitation									
National Sanitation Program	170.2	92.7	23.7	370.5	66.6	84.2	174.0	239.3	322.7
Transportation									
Land Transportation	508.7	412.2	53.3	1944.7	71.5	275.1	407.4	732.6	1044.2
Recreation									
Recreation and Culture	17.3	12.6	2.9	42.1	5.0	7.1	12.2	30.7	38.7
OUTPUTS									
Education									
Students with satisfactory level	39.7	11.4	15.1	70.6	24.1	33.2	40.7	44.7	55.9
Access to primary education	94.0	1.4	91.5	96.7	91.8	93.1	94.2	94.9	96.2
Access to secondary education	82.5	5.6	71.0	90.6	72.5	78.8	83.2	87.3	89.6
Health									
Chronic child malnutrition (%)	15.5	7.8	2.3	33.4	4.8	7.6	15.9	20.4	25.4
Infant mortality (%)	10.3	1.3	8.0	11.6	8.3	8.7	11.1	11.6	11.6
Security									
Crime rate (per 1000 inhab.)	87.1	45.7	27.0	170.5	31.9	43.5	89.1	120.9	167.1
Fault rate (per 1000 inhab.)	81.0	59.1	9.4	243.0	22.8	35.3	68.4	96.2	191.9
Sanitation									
Population – potable water (%)	54.3	21.5	19.2	93.0	24.3	37.1	55.6	72.3	86.5
Population – sewage system (%)	61.2	17.6	33.0	93.6	39.4	45.1	59.5	76.2	88.7
Transportation									
Paving of roads	0.2	0.1	0.1	0.3	0.1	0.1	0.2	0.2	0.3
Accidents rate	2969.0	6482.2	185.9	33 523.6	416.0	829.4	1381.7	2524.7	4631.1
Recreation									
Libraries (%)	47.8	20.3	9.1	97.9	25.7	32.9	42.1	61.7	83.0
Sports facilities (%)	93.9	4.8	80.2	100.0	86.7	90.9	94.6	97.5	99.3
Recreational facilities (%)	56.2	18.4	24.3	97.9	33.4	40.1	52.8	71.5	86.1

Notes. (*)Amounts allocated (soles) to each budget program in per capita terms.

TABLE A.5. Boostrap estimates: bias and variance.

Region	Health		Education		Security		Sanitation		Transportation		Recreation	
	Bias	Variance	Bias	Variance	Bias	Variance	Bias	Variance	Bias	Variance	Bias	Variance
Amzonas	0.022	0.018	0.018	0.013	0.063	0.200	0.014	13.073	0.018	6.492	0.032	0.488
Ancash	0.051	0.004	0.004	0.005	0.041	0.377	0.027	3.962	0.080	0.528	0.041	0.450
Apurimac	0.019	0.036	0.036	0.019	0.074	0.068	0.011	24.916	0.014	17.640	0.018	3.562
Arequipa	0.166	0.010	0.010	0.004	0.011	2.732	0.047	1.417	0.039	1.508	0.022	1.249
Ayacucho	0.019	0.035	0.035	0.024	0.161	0.036	0.020	7.848	0.026	3.255	0.056	0.187
Cajamarca	0.031	0.008	0.008	0.009	0.230	0.021	0.013	15.659	0.035	2.214	0.051	0.207
Cusco	0.047	0.013	0.013	0.008	0.027	0.482	0.018	9.361	0.018	7.279	0.020	3.727
Huancavelica	0.016	0.025	0.025	0.014	0.160	0.014	0.008	41.238	0.016	16.546	0.018	2.248
Huanuco	0.037	0.011	0.011	0.007	0.175	0.013	0.016	10.342	0.015	9.928	0.070	0.105
Ica	0.134	0.007	0.007	0.016	0.019	1.224	0.059	0.874	0.394	0.026	0.044	0.503
Junin	0.069	0.008	0.008	0.006	0.053	0.128	0.045	1.477	0.037	2.317	0.104	0.118
La Libertad	0.071	0.003	0.003	0.027	0.036	0.354	0.042	1.681	0.061	0.632	0.047	0.383
Lambayeque	0.154	0.011	0.011	0.003	0.021	2.063	0.074	0.576	0.270	0.033	0.294	0.022
Lima	0.214	0.019	0.019	0.004	0.022	2.163	0.307	0.033	0.034	1.848	0.042	0.621
Loreto	0.056	0.010	0.010	0.009	0.102	0.109	0.047	1.485	0.116	0.157	0.098	0.059
Madre de Dios	0.057	0.051	0.051	0.010	0.015	1.581	0.089	0.411	0.007	44.161	0.044	0.252
Moquegua	0.093	0.030	0.030	0.028	0.023	1.760	0.017	10.891	0.042	1.854	0.013	3.629
Pasco	0.051	0.078	0.078	0.040	0.314	0.020	0.010	24.897	0.234	0.091	0.017	5.545
Piura	0.071	0.008	0.008	0.015	0.047	0.240	0.047	1.401	0.039	1.479	0.083	0.316
Puno	0.053	0.004	0.004	0.013	0.119	0.028	0.014	15.456	0.026	6.220	0.018	3.607
San Martin	0.059	0.006	0.006	0.005	0.094	0.041	0.018	10.233	0.028	2.741	0.048	0.225
Tacna	0.271	0.027	0.027	0.011	0.019	1.460	0.060	0.879	0.012	28.056	0.014	2.912
Tumbes	0.069	0.163	0.163	0.022	0.014	2.694	0.069	0.669	0.045	1.160	0.171	0.072
Ucayali	0.031	0.009	0.009	0.008	0.128	0.139	0.035	2.519	0.012	14.822	0.134	0.092

TABLE A.6. Boostrap estimates: Confidence intervals.

Region	Health		Education		Security		Sanitation		Transportation		Recreation	
	LB	UB	LB	UB	LB	UB	LB	UB	LB	UB	LB	UB
Amzonas	0.305	0.358	0.343	0.405	0.201	0.301	0.032	0.053	0.043	0.071	0.130	0.193
Ancash	0.678	0.801	0.583	0.694	0.141	0.208	0.056	0.095	0.144	0.234	0.137	0.207
Apurimac	0.225	0.267	0.282	0.334	0.299	0.426	0.022	0.038	0.024	0.039	0.050	0.078
Arequipa	0.713	0.975	0.788	0.978	0.047	0.067	0.087	0.141	0.087	0.143	0.081	0.121
Ayacucho	0.229	0.271	0.342	0.431	0.484	0.739	0.039	0.065	0.060	0.099	0.210	0.313
Cajamarca	0.450	0.526	0.468	0.563	0.628	0.955	0.029	0.049	0.069	0.112	0.199	0.297
Cusco	0.413	0.505	0.489	0.590	0.112	0.159	0.036	0.060	0.039	0.063	0.049	0.076
Huancavelica	0.258	0.300	0.355	0.424	0.653	0.929	0.018	0.030	0.025	0.040	0.061	0.092
Huanuco	0.418	0.499	0.470	0.557	0.680	0.966	0.035	0.059	0.034	0.057	0.281	0.416
Ica	0.748	0.980	0.665	0.974	0.074	0.106	0.120	0.202	0.535	0.805	0.132	0.202
Junin	0.549	0.680	0.554	0.673	0.216	0.304	0.092	0.156	0.068	0.111	0.276	0.428
La Libertad	0.820	0.976	0.625	0.977	0.138	0.199	0.086	0.145	0.133	0.215	0.150	0.226
Lambayeque	0.716	0.969	0.809	0.977	0.064	0.098	0.141	0.232	0.585	0.953	0.594	0.888
Lima	0.659	0.974	0.789	0.975	0.063	0.095	0.566	0.916	0.081	0.134	0.119	0.183
Loreto	0.499	0.614	0.431	0.511	0.274	0.414	0.089	0.147	0.281	0.466	0.373	0.556
Madre de Dios	0.294	0.392	0.403	0.480	0.062	0.089	0.171	0.286	0.017	0.027	0.181	0.268
Moquegua	0.407	0.559	0.405	0.539	0.070	0.107	0.033	0.056	0.077	0.125	0.048	0.071
Pasco	0.266	0.359	0.417	0.594	0.587	0.919	0.023	0.039	0.326	0.523	0.040	0.062
Piura	0.549	0.680	0.619	0.850	0.173	0.251	0.092	0.153	0.087	0.143	0.174	0.276
Puno	0.656	0.776	0.516	0.665	0.471	0.671	0.029	0.048	0.038	0.060	0.049	0.076
San Martin	0.565	0.683	0.544	0.640	0.382	0.540	0.033	0.055	0.067	0.111	0.192	0.284
Tacna	0.620	0.962	0.703	0.974	0.070	0.101	0.111	0.181	0.019	0.031	0.053	0.079
Tumbes	0.231	0.342	0.475	0.640	0.052	0.075	0.131	0.218	0.098	0.160	0.352	0.550
Ucayali	0.446	0.522	0.513	0.618	0.245	0.393	0.068	0.112	0.028	0.046	0.308	0.474

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