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Model of performance indicators for the evaluation of state public health expenditures in Brazil

Modelo de indicadores de desempeño para la evaluación del gasto público estatal en salud en Brasil

Modelo de indicadores de desempenho para avaliação dos gastos com saúde pública estadual no Brasil

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Abstract

Objective: To present a proposal on a set of performance indicators that can be used in audits of state audit courts to assess the effectiveness of budget spending on public health.

Methodology: This is quantitative research, with the application of statistical techniques related to *Data Envelopment Analysis* (DEA) in two stages and estimation of linear longitudinal regression models for strongly balanced short panel data*, on the* budget expenditures made in the period from 2015 to 2019 by the States and the Federal District on public health.

Results: It was found that there is no use of performance indicators in the elaboration and execution of Multi-Annual Plans (MAPs) by governments to evaluate the effectiveness of spending on public actions; that the mention of "performance indicators" refers exclusively to percentages to compare what was accomplished in relation to what was predicted; that records of duplicate public actions were found in the MAPs by some entities, and that overvaluation was identified in the records of the resources provided for in most of the MAPs. The degree of statistical explanation of the proposed set of indicators reached an average of 87% of statistical confidence. None of the public entities was 100% effective in the expenditures made. 69% of the auditors of the Courts of Auditors legitimized the set of indicators proposed to evaluate the effectiveness of state public health spending. Finally, it is concluded that the proposed performance evaluation indicators can be used to verify the effectiveness of state public health spending.

Contributions of the study: It presents performance indicators, created by means of a statistical method, to evaluate the effectiveness of spending on state public health, since the specialized literature indicates little or no discussion about it. It indicates that the actions included in the MAPs are not audited by the courts of auditors and that the legislative branch is silent in the supervision between what is foreseen and what is carried out, considering that there are repeated and overvalued actions.

Keywords: Indicators; Performance evaluation; Effectiveness; Public spending.

Resumem

Objetivo: Presentar una propuesta de conjunto de indicadores de resultados que puedan utilizarse en las auditorías de los tribunales de cuentas estatales para evaluar la eficacia del gasto presupuestario en salud pública.

Metodología: Se trata de un estudio cuantitativo, que utiliza técnicas estadísticas relacionadas con el Análisis Envolvente de Datos (DEA) en dos etapas y la estimación de modelos de regresión lineal longitudinal para datos de panel cortos y fuertemente balanceados, sobre el gasto presupuestario en salud pública de los estados y el Distrito Federal entre 2015 y 2019.

Resultados: Se constató que no hay uso de indicadores de desempeño en la elaboración y ejecución de los PPAs por parte de los gobiernos para evaluar la eficacia del gasto en acciones públicas; que la mención de "indicadores de desempeño" se refiere exclusivamente a porcentajes para comparar lo realizado en relación a lo planificado; que se encontraron registros duplicados de acciones públicas en los PPAs de algunas entidades, y que se identificaron sobreestimaciones en los registros de recursos planificados en la mayoría de los PPAs. El grado de explicación estadística del conjunto de indicadores propuestos alcanzó una media del 87% de confianza estadística. Ninguna entidad pública mostró un 100% de eficacia en el gasto. El 69% de los auditores legitimaron el conjunto de indicadores propuestos para evaluar la eficacia del gasto sanitario público estatal. Por último, puede concluirse que los indicadores de

evaluación del rendimiento propuestos pueden utilizarse para verificar la eficacia del gasto sanitario público estatal.

Contribuciones del estudio: Presenta indicadores de desempeño, creados con un método estadístico, para evaluar la eficacia del gasto público estatal en salud, dado que la literatura especializada indica poca o ninguna discusión sobre el tema. Indica que las acciones incluidas en los PPAs no son fiscalizadas por los tribunales de cuentas y que el poder legislativo guarda silencio sobre el seguimiento de lo planificado y lo realizado, considerando que hay acciones repetidas y sobreestimadas.

Palabras clave: Indicadores; Evaluación de resultados; Eficacia; Gasto público.

Resumo

Objetivo: Apresentar proposta sobre um conjunto de indicadores de desempenho que podem ser utilizados nas auditorias dos tribunais de contas estaduais para avaliar a eficácia dos gastos orçamentários com a saúde pública.

Metodologia: Trata-se de uma pesquisa quantitativa, com aplicação de técnicas estatísticas relacionadas a *Data Envelopment Analysis* (DEA) em dois estágios e estimação de modelos longitudinais lineares de regressão para dados em painel curto *strongly balanced,* sobre os gastos orçamentários realizados no período de 2015 a 2019 pelos Estados e Distrito Federal sobre a saúde pública.

Resultados: Constatou-se que não há uso de indicadores de desempenho na elaboração e execução dos PPAs pelos governos, para avaliar a eficácia dos gastos com ações públicas; que a menção sobre "indicadores de desempenho", refere-se exclusivamente a percentuais para comparar o que foi realizado em relação ao que foi previsto; que foram encontrados registros de ações públicas em duplicidade nos PPAs por alguns entes, e que foi identificado superavaliação nos registros dos recursos previstos na maioria dos PPAs. O grau de explicação estatística do conjunto de indicadores proposto alcançou em média 87% de confiança estatística. Nenhum ente público apresentou eficácia em 100% nos gastos realizados. 69% dos auditores dos tribunais de contas legitimaram o conjunto de indicadores proposto para avaliar a eficácia dos gastos com a saúde pública estadual. Por fim, conclui-se que os indicadores de avaliação de desempenho propostos podem ser utilizados para verificar a eficácia dos gastos com a saúde pública estadual.

Contribuições do estudo: Apresenta indicadores de desempenho, criado por meio de método estatístico, para avaliar a eficácia dos gastos com a saúde pública estadual, uma vez que a literatura especializada indica pouca ou nenhuma discussão a respeito. Indica que as ações inseridas nos PPAs não são auditadas pelos tribunais de contas e que o poder legislativo é omisso na fiscalização entre o que é previsto e realizado, considerando que há ações repetidas e superavaliadas.

Palavras-chave: Indicadores; Avaliação de desempenho; Eficácia; Gastos públicos.

1 Introduction

Fiscal and economic crises, pressures to cut spending and social demands have required governments to work to ensure balanced budgets and reduce accumulated public debt. At the same time, these governments are expected to recover economic growth, as well as meet social demands (Peters, 2011; Kickert, 2013; Silva et al. 2018). Due to these pressures to improve public spending performance, some studies discuss the adoption of management accounting tools (Hoque & Adams, 2011; Northcott & Taulapapa, 2012; Sutheewasinnon et al. 2016; Lino & Aquino, 2017).

The literature discusses the lack of control, monitoring and management tools to measure the effectiveness of budget expenditures (Chan, 2002; Van Helden et al. 2008; Joyce, 2012; Santos & Haupp, 2015), as well as the measurement of public spending through performance indicators (PIs) (Rosa et al. 2014; Azevedo & Aquino, 2016; Lino & Aquino, 2017), which shows a research gap.

Faced with the challenge of the government in meeting social demands, economic recovery and/or maintenance, in a scenario where resources are scarce - whether as a result of economic downturn and/or mistaken political actions, this study aims to **propose a set of PIs to evaluate the effectiveness of budget expenditures executed by state governments with health**. To this end, it is intended to first identify the PIs used in the preparation and execution of Multi-Year Plans (MAPs), present and test a set of PIs capable of meeting the proposed objective, and finally, validate the proposed PIs with the auditors of the State Court of Accounts (SCAs).

The U.S. Congress, for example, has established greater national attention on measuring and reporting performance through indicators in governments. In readiness, three states have passed laws requiring performance reporting with the use of indicators by state agencies. Similarly, accredited, regulatory, and oversight institutions—the National Academy of Management, the American Society for Public Administration, the National Association of Governors, and *the Accounting Standards Board* (GASB) - have been taking action to increase performance measurement and accountability of governments.

In Brazil, the recognition of the need to evaluate public expenditures is understood by some public entities as imperative, for example: (i) the processing of the Constitutional Amendment Project (PEC - 188) in the Federal Senate - which discusses fiscal adjustment measures applicable to the cost of maintenance of the public machine with the use of PIs; (ii) the recommendation of the Ministry of Planning, Budget and Management (MPBM) on the use of PIs to evaluate and monitor the results of the goals established by governments (Ribeiro, 2002) and; (iii) the document "Technical Performance Indicators for Audits (TPIA)" prepared by the Secretariat for Inspection and Evaluation of Government Programs (SIEGP) - linked to the Federal Court Of Auditors (FCA), and approved by Segecex Ordinance No. 33/2010, with recommendation for use in audits by the Courts of Auditors (CAs).

Research related to health performance measurement in recent decades has provided valuable information for policymakers (Hollingsworth, 2008). They use scientific methods with a predominance in DEA, Stochastic Frontier Analysis (SFA), Malmquist Index (MI) and indicators formed by the quotient of an input and an output. GDP per capita has also been recognized as an explanatory variable in the literature on health performance. The results indicate a positive relationship associated with performance (Halkos & Tzeremes, 2011; Varela et al. 2012; Santos et al. 2014; Samut & Cafri, 2016).

Some advocates of performance evaluation through indicators in the public sector (Epstein, 1992; Uga & Lopes, 2007; TCU, 2010; Barrett, 2012; Allin et al. 2016; Colombi et

al. 2017; Bogoviz et al. 2018; Araújo et al. 2018), suggest that it is not satisfactory for governments to be accountable only for what they spend, but also for what their actions achieve in favor of social welfare.

2 Theoretical Framework

2.1 Evaluation of public expenditures through PIs

Performance in the public sector is not a new concept, since the seminal work of Simon (1937), performance measurement has been considered a criterion that allows managers to identify the effectiveness of the services offered to the population (Roge & Lennon, 2018). For public organizations it is simple to assess how much work has been done, but not how well it has been done, nor whether the work done has been appropriate for the desired purpose. It is in this sense that performance evaluation by indicators gains strength and strength (Ridley & Simon, 1938; Azevedo & Aquino, 2016).

Studies suggest that the inadequacy of performance appraisal in the public sector is due to an unresolved problem in the formulation of what one wants to evaluate (Roge & Lennon, 2018), and that the role of performance appraisal of budget expenditures improves the allocation and execution of public resources (Van Thiel & Leeuw, 2002).

Bovens (2007) suggests that the evaluation of public performance through the budgetary results achieved can promote more effective prevention and inspection mechanisms, and thus, perhaps, prevent corruption and administrative inefficiency in public management and strengthen the legitimacy of the government. In this understanding, Grateron (1999) already stated that one of the methods used to evidence government performance is the use of qualitative or quantitative indicators.

The absence of management methods to assess the effectiveness of expenditures at the state and municipal levels sometimes results in fiscal imbalance, weak accountability and deterioration of public services (Baltaci & Yilmaz, 2006), in addition to threatened economies and the submergence of some countries in continuous budget deficits (Joyce, 2012), and the insecurity of some public managers in using budget results for decision-making (Azevedo & Aquino, 2016).

Smith (1988) suggests that PIs give some leeway to measure and evaluate the performance of public spending, and the application of techniques such as *cluster* analysis, regression analysis, and data efficiency analysis can provide the identification of good public management practices and generate a flow of information to external users more accurately.

Boyne (1997), with the purpose of measuring the performance of the services offered to the population by the local government in the United Kingdom, he used quantitative data extracted from budgets, and found a strong association between the population size of the government and the quality of the services offered, that is, the larger the government in population, the less effective the quality of the services offered.

After consulting the specialized literature (national and international), it was found that most of the studies refer to the assessment of the financial and fiscal health of governments, through closed systems (see Table 1), which corroborates with Rosa et al. (2014), Lino and Aquino (2017). This finding may occur due to access to the data necessary to analyze the performance of public spending.

Despite the efforts of the FCA, partnership with DFID in 1998, creation of SIEGP in 2000, publication of Segecex Ordinance No. 33/2010, approval of TPIA and recommendation

of the use of PIs in audits carried out by CAs, Silva et al. (2018) through an empirical study found that the audit modality carried out by CAs continues to be for legal compliance.

Table 1

Set of closed, near-open, and open PIs found in the literature between 1986-2015

Author	Year	Classification	TA	IA	CL	IR	TDA	BA	RA	SE	AFE
Berne & Schramm		Closed	Finance	X	X						
Hughes & Laverdieri	1986	AO	M	X	X	X					
Campbell & Harrison	1990	AO	M	X	X						
Brown	1993	Closed	Finance	X	X	X					
Alter et al.	1995	Closed	Finance	X			X				
CICA	1997	Closed	Finance	X							
Chaney et al.	2002	Closed	Finance	X							
Kleine et al.	2003	AO	Finance	X	X	X	X				
Groves & Valente	2003	AO	M	X			X				
Afonso et al.	2003	Closed	M	X	X	X	X				
Hendrick	2004	Open	OT	X	X	X		X	X		
Kavanagh	2007	Open	Finance	X			X	X	X		X
Wang et al.	2009	Closed	Finance	X	X			X			
Sohl et al.	2009	Closed	Finance	X	X	X					
Krishnakumar et al.	2010	Open	MT					X		X	
STN	2012	Closed	Finance	X		X	X				
Titu & Bucur	2015	QA	Mathematics	X			X		X	X	

Note: AO - Almost Open; M - Multidisciplinary; OT - Organizational Theory; MT - Macroeconomic Theory; TA – Theoretical Approach; IA - Index Analysis; CL - Comparison between Locations; IR - Index Ranking; TDA - Trend Analysis; BA - Bivariate Analysis; RA - Regression Analysis; SE- Simultaneous Equations; AFE - Analysis of the Fiscal Environment.

Source: *Adapted from Ramsey (2013).*

Deng et al. (2019) they evaluated the performance of public hospitals in twenty local districts in New Zealand in the period from 2011 to 2017, through directional distance function analysis, involving four input variables and three output variables. The results of the variables were used to construct a regression in a balanced data panel with 140 observations. The conclusion of the study indicated the need to reduce the number of doctors, nurses and other employees, as well as the length of hospital stay and an increase in the number of outpatient consultations.

Araújo et al. (2018), they used the "notion of positive and negative solutions and ideas method", evaluated the performance of public inpatient and outpatient consultation services in hospitals in Rio de Janeiro from 2008 to 2013. The results indicated that the most populous and territorial municipalities, as well as those with the largest number of public hospitals, reached the worst levels of hospital performance.

Dantas et al. (2017) they applied the cluster analysis method *through* consolidated evaluation indicators to analyze the performance of resources allocated by 645 municipalities in São Paulo. The results indicated that the management and proper allocation of resources could be more relevant than the total amount of expenditures; that the worst cost-effectiveness values do not necessarily demonstrate high scores on the PIs evaluated; and that the need for information to be treated in an intersectoral manner, with dialogue between the various databases, is latent in the public sector, especially at the local level.

Rossi and Aversano (2015) analyzed Italian municipalities with more than 50,000 inhabitants, with the aim of identifying what type of management tools are implemented in these governments. The results showed that the management tools required by law are prepared

in local governments, even if there is limited use of them in accountability and decision-making, and rarely use this type of information to prepare the budget, set service goals or goals of electoral programs.

Trevisan et al. (2009), by means of PIs, analyzed the financial management of a municipality in the State of Rio Grande do Sul, based on the data collected from the budgetary, financial, and equity balance sheets and the statement of equity variations from 2005 to 2006, and concluded that the municipality is financially rigid - because it excessively concentrates resources in the short term and has a high liquidity ratio. and that the PIs used contribute to transparent disclosures in municipal accounts.

Enoma and Allen (2007), with the objective of outlining safety and security in airport facilities management at an airport in the United Kingdom, developed a set of PIs based on the precepts of the *multi-agency threat and risk assessments program* developed by the Department of Transport and Ministry of the Interior of that country, and concluded that the PIs proposed to measure airport security performance were effective for their purposes. both in the collection of resources and in the fight against terrorist acts and crimes at the airport.

Harley (1985) used PIs to analyze health management in England, Wales and Northern Ireland, specifically in relation to mental illness and disability. The results showed that the hospitals and services offered are unsatisfactory; there is strong resistance to the adoption of PIs by employees; there are hospitals with a high proportion of beds occupied with patients diagnosed as non-urgent; There is a waiting list for care for more than a year and there is a high mortality rate in surgical care.

The evaluation of political or social programs involves the construction of methodologies capable of gathering consistent criteria and indicators that provide managers with relevant information about the policy or program analyzed, supporting decision-making in several areas (Macedo & Damasceno, 2013). The importance of performance evaluation is related to the effectiveness of public spending and the quality of services, in addition to measuring the performance of State actions and disseminating the results achieved (Costa & Castanhar, 2003; Ramos & Schabbach, 2012). Although, despite the technical difficulties, performance measurement must be incorporated into the management culture so that the quality of services and application of resources improve in government (Pollitt, 1986).

3 Research Methodology

The scope of analysis of this study includes the Brazilian state public health, and the indicators used to analyze the effectiveness of expenditures are shown in Table 2. The subvariables, which are expected to be reduced, have assumed *input* status because they are classified in the literature as undesirable output (Silva, 2007; Gomes et al. 2010; Cook et al. 2014).

The public health variable, shown in Table 2 and manipulated in this study, represents the relationship between the budget expenditure and its effectiveness. This variable is in harmony with the literature review. However, their inputs and outputs are similar to the suggestions of Sohl et al (2009) and Kavanagh (2007), in which "population", "budget", "hospital admissions" and "infant mortality" correspond to the inputs, and "number of health facilities", "doctors", "family health teams", "medical consultations" and "hospital beds", the outputs. It is worth noting that the subvariables "hospital admissions" and "infant mortality" assumed the status of undesirable outputs.

The population and sample used comprise the 27 Brazilian Federative Units (FUs). Regarding the data of the subvariables contained in Table 2, we collected from the databases

of the Brazilian Institute of Geography and Statistics (BIGS), the National Treasury Secretariat (NTS), the Ministry of Health (MH) and the Transparency Portals of each state, corresponding to the period 2015 to 2019. The choice of the period will be due to the fact that it precedes the pandemic period related to COVID-19. The inclusion of the pandemic period would result in distortions in the results, having seen large investments by the federal government in the states, a particular occurrence in the pandemic period.

Table 2

Research variables used in the research

Variable	Subvariates/Indicators	Measures	References
Public health	Committed budget (i-dessau) = ***input***	R$ per capita por Estado	Berne & Schramm, (1986); Campbell & Harrison, (1990); Sohl et al., (2009).
	Total population (pop_tot) = ***input***	Quantity by State	Kleine et al., (2003); Hendrick, (2004); Kavanagh, (2007); Sohl et al. (2009); Wang et al., (2009).
	Hospital beds (i-leisau) = ***output***		Groves & Valente, (2003); Kavanagh, (2007); Titu & Bucur, (2015)
	Medical consultations (i-consau) = ***output***		Hendrick, (2004); Kavanagh, (2007); Titu & Bucur, (2015); Cinaroglu & Baser, (2016)
	Hospital admissions (i-intsau) = ***input***		
	Medical (i-medsau) = ***output***		
	Qte health facilities (i-esasau) = ***output***		
	Family health teams (i-esfsau) = ***output***		
	Infant mortality (i-imortsau) = ***input***	% by State	Hendrick, (2004); Kavanagh, (2007); Titu & Bucur, (2015); Cinaroglu & Baser, (2016)

Source: *Survey data.*

At the BIGS, data were collected regarding the estimated total population (pop-total) and region of each entity (Reg). In the NTS, the amounts referring to committed expenses (i-dessau), through the Summary Reports of Budget Execution (SRBE). In the MH, the number of consultations (i-consau) and hospitalizations performed (i-intsau), number of beds available for hospitalizations of any nature (i-leisau), number of physicians (i-medsau), number of health facilities (i-esasau), number of family health teams (i-esfsau), infant mortality rate (i-mortsau). And finally, on the Transparency Portal, the Budget Laws (BLs) and MAPs to identify the evaluation indicators used, in the absence - the annual monitoring reports of the health departments.

The operational logistics of the research described in Figure 1 consist of the fulfillment necessary to establish the feasibility of the subvariables, in which the database was built and organized - indispensable for the manipulation of the subvariables. Then, with the help *of specialized statistical* software (Stata 15), the results of the survey were presented to the auditors of the CAs for validation of the indicators. The CSs were chosen to validate the IDs used because they audit government accounts, the basis of this research.

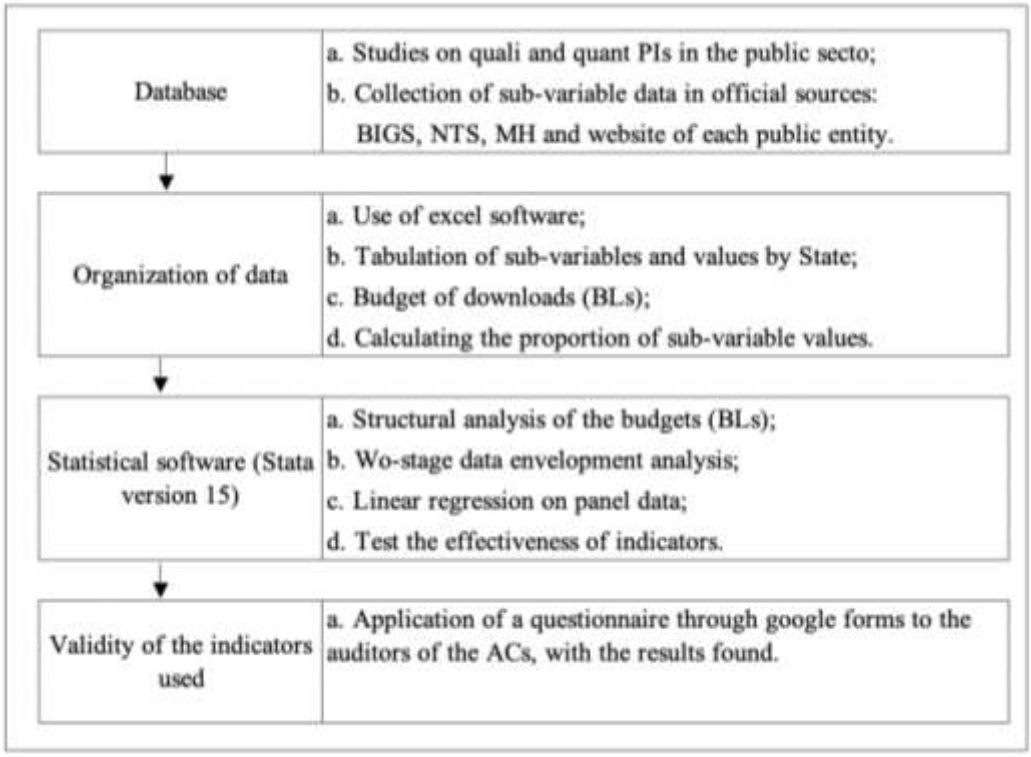

Figure 1 *Operational logistics for constructing the proposed PIs*
Source: *Survey data.*

3.1 Data Analysis Procedures

The statistical techniques applied in this study were the *two-stage Data Envelopment Analysis* (DEA) (Simar & Wilson, 2007) and the estimation of linear longitudinal regression models, because it has an annual periodicity and the number of individuals is greater than the number of periods (Fávero & Belfiore, 2017), according to the mathematical expressions (e1), (e2) and (e3). The choice of this technique was based on the fact that individuals (FU) vary over time, and the central focus is on a quantitative dependent variable, and involves the Ordinary Least Squares (OLS) Method.

In order to identify the most appropriate estimation, considering the expected *outputs*, the fixed and random effect estimates were performed, as well as the Breusch-Pagan LM (*Lagrange multiplier*), Chow's F and Hausman's robust tests, and it was found that the Random-effects estimation was the most appropriate, since the theta value got closer to 1. It is noteworthy that the results obtained by the fixed effects estimation (*within)* and POLS estimation (*Pooled Ordinary Least Square*) were farther from 1. For this reason, the longitudinal regression model for short panel data with random estimation was the most appropriate statistical method. This estimation simultaneously considers the variations *within* and *between*.

$$Y_{it} = \alpha_i + \beta 1.\ X1_{it} + \beta 2.\ X2_{it} + ... + \beta_k.\ Xk_{it} + \varepsilon_{it} \quad (e1)$$

$$Y_{it} = b1.\ X1_{it} + b2.\ X2_{it} + ... + b_k.\ Xk_{it} + (a_i + \varepsilon_{it}) \quad (e2)$$

That is:

Health: $i\text{-dessau}_{it} = \alpha_i + \beta 1.i\text{-leisau}_{it} + \beta 2.i\text{-consau}_{it} + \beta 3.i\text{-intsau}_{it} + \beta 4.i\text{-esfsau}_{it} + \beta 5.i\text{-medsau}_{it} + \beta 6.i\text{-estsau}_{it} + \beta 7.i\text{-imortsau}_{it} + \varepsilon_{it}$ (e3)

Where:

The term α_i captures the behavior of individual effects between individuals and presents mean α, and variance σ2α (variance *between*), and ε_{it} referring to the behavior of idiosyncratic error terms with mean zero and variance σ2Ɛ (*variance within*), i.e., the variations of errors within the individual himself (Cameron & Trivedi, 2009).

In order not to generate multicolonality between the subvariables, as well as possible distortions of results outside the statistical curve, the values were corrected by the inflation index (IPCA) until 12/31/2019 (Boyne & Chen, 2007). Then, each variable was transformed into a factor using the criteria presented in the "mathematical ratio" column (see Table 3). Soon after, the efficiency of each entity was calculated using the DEA in two stages with the objective of admitting it to the composition of the aggregate indicator (Titu & Bucur, 2015). In this understanding, Kleine et al (2003) and Kloha et al (2005) suggest that the analysis of efficiency is inseparable when it comes to measuring effectiveness.

Table 3

Mathematical ratio of health variables

State Public Health			
Variable	Mathematical Ratio	Variable	Mathematical Ratio
i-dessau	Budget ÷ total population	i-esfsau	Family health teams ÷ total population x 1000
i-consau	Consultations ÷ total population	i-medsau	Physicians ÷ total population x 1000
i-intsau	Hospitalizations ÷ total population x 1000	i-estsau	Healthcare facilities ÷ total population x 1000
i-leisau	Beds ÷ total population x 1000	i-mortsau	Deaths in the 1st year of life ÷ live births x 1000

Source: *Survey data.*

The two-stage DEA, in addition to evaluating the relative efficiency, builds an efficiency frontier with the most efficient individuals, identifies the good practices that can be used as a *benchmark (*TCU, 2009), and generates more robustness to the results, because in the first stage the efficient individuals are identified (equal to 1), and in the second stage, this result is ratified or not by means of regression (P>|Z|), and uses efficiency as the dependent variable.

Regarding the estimation of the linear longitudinal model by random regression effect for short panel data, the dependent variable was the expenditure committed to health (see expression e3). Regarding the validation process of the indicators used, with the auditors of the SCAs, it took place in two stages, necessary to clarify any doubts regarding the completion (response) of the questionnaires, and to reach a greater number of participants.

In the first stage, a pre-test was carried out involving 7 volunteers (2 CA auditors; 1 employee of the MCASP study group of the NTS 1 professor of public universityin accounting and public management; 2 doctoral students in accounting and mathematics; and 1 secretary of health of the state government) with the purpose of identifying, adjusting and resolving possible doubts about the objective and scope of the questionnaire.

In the second stage, prior contact was made with the offices of the presidency of all Brazilian CAs by *e-mail*, to send the questionnaire to the auditors of external accounts,

specifically to those involved with budgetary, financial and state government audits. The questionnaire was then sent directly to the office of the presidency for referral to the relevant auditors. 20 questionnaires were returned and 19 were validated. Of those validated, at least one CA from each region was identified.

To identify the use of PIs in the 2016-2019 MAPs of the FUs, the planned and carried out actions were analyzed, exclusively on health. Considering the number of actions included in each MAP, it was decided to analyze individually the similar actions among the entities, which served as a sample (see Table 4). It is worth mentioning that most MAPs are structured in axes, programs, actions, objectives, agencies, executing units, budget units, products, physical and financial goals. For the purpose of verifying the results achieved, when not included in the MAP carried out, the monitoring and control reports of public policies of each entity were used.

Table 4

Sample of planned and carried out actions contained in the 2016-2019 MAPs on public health

Share	Description (planned vs. realized)	Share	Description (planned vs. realized)
A1	Amount committed to health spending	A7	Hiring doctors and technicians
A2	Percentage impact of spend on MAP	A8	Training and professional qualification
A3	Beds available	A9	Maintenance and renovation of physical health units
A4	Inpatient and outpatient admissions	A10	Construction and expansion of a physical health unit
A5	Expansion in medical care	A11	Acquisition of vehicles and equipment
A6	Infant mortality rate	A12	Other Similar Actions

Source: *Survey data.*

Actions A1-A12 correspond to the common actions found in all MAPs analyzed. Through them, the objectives, executing and budgetary units, responsible agencies, physical and financial goals, and final products were identified.

4 Results

4.1 PIs used in the 2016-2019 MAPs

It was identified that 59% of the entities spent more than the values foreseen in the MAPs (Action A1), with emphasis on the entities Bahia (BA), Piauí (PI) and Rio Grande do Sul (RS) - on average 45%. In contrast, Santa Catarina (SC), Rio de Janeiro (RJ) and Minas Gerais (MG) spent less than expected, on average 41%. Surprisingly, 63% of the entities did not present the results achieved in actions A7, A4, A3, A6 and A9 - with greater emphasis on A7 and A4. It is worth noting that action A7 achieved better results in 37% of the entities, especially those located in the Midwest and Southeast regions (1.9 physicians per thousand inhabitants). However, the World Health Organization (WHO) suggests 2.5 doctors per 1,000 inhabitants.

Still regarding the lack of registration of the results carried out in the MAP, the entity Rio Grande do Norte (RN) did not record the result of the actions listed in Table 4 in 90%. In addition, 52% of these actions were planned in duplicate. Similarly, the entities Sergipe (SE) and Amapá (AP) limited themselves to describing only the actions, without any mention of goals and measurement indicators. The exception occurred in action A1 by the AP entity.

Regarding action A4, little or no attention was given by most of the entities regarding the registration of prediction and realization in the MAPs.

It is possible that this behavior is a reflection of the absence of legal obligation and punctual debates in the legislative chamber and CAs. Likewise, because it is not used for decision-making by government managers. This, perhaps, may characterize the absence of responsibility of governments in the preparation and execution of MAPs. These findings contribute to Azevedo and Aquino (2017), when they suggest that possible inconsistencies in the public budget are caused by defects in the preparation by public managers, often prepared by outsourced collaborators without any involvement in the political plans.

The significant differences, overvalued and undervalued, between the monetary values foreseen and realized in the MAPs, show the lack of commitment of managers in their preparation and execution. This finding reinforces the hypothesis that the MAP is prepared only for the purpose of legal compliance, as stated by Silva et al., (2018).

Regarding the use of PIs in the MAPs, both in the preparation and in the execution, it was found that only "indicators" were mentioned to present the degree of accomplishment in relation to what was foreseen for each action. This mention indicates only the percentage carried out, i.e., no public entity uses PIs to evaluate the effectiveness of health-related actions in MAPs. This diagnosis corroborates the maxim that "public managers and CAs do not evaluate the effectiveness of expenditures and investments made by governments in public health" (Silva et al., 2018).

4.2 Proposed PIs to Assess the Effectiveness of Health Spending

Titu and Bucur (2015) suggest that PIs are capable of establishing parameters or goals to evaluate the performance of a government, and can be constructed in two formats: (i) adoption of a set of indicators, in the form of a mathematical or statistical formula, resulting from the manipulation of the time function with the application of an average value of a certain efficient interval; (ii) probabilistic manipulation of results from low , medium and high levels of Likert scale. This study adopted the first format (i).

First, we analyzed the statistics described in Table 5, corresponding to 135 *cross-sections* in the 2015-2019 period. It is noteworthy that all individuals (public entities) presented data regarding the variables listed.

Table 5

Descriptive analysis of the PIs used to verify the effectiveness of health spending

Pis	Note	Mean	Std. Dev	Min.	Max
Individuals	135	14	0,7	1	27
Periods	135	14	1,4	2015	2019
i-dessau	135	R$ 615	R$ 341	R$ 301	R$ 2,765
i-leisau	135	4,1	1,3	2,7	17,2
i-consau	135	4,8	2,4	0,8	11,0
i-intsau	135	56,6	9,9	33,5	90,3
i-esfsau	135	25,0	8,2	5,4	57,6
i-medsau	135	1,9	0,6	0,9	3,5
i-estsau	135	1,4	0,5	0,6	2,5
i-imortsau	135	14,5%	3,9%	7,8%	23,5%

Source: Survey data

The lowest and highest *per capita values of* the *i-dessau* indicator were found in the states of Maranhão (MA) and the Federal District (DF) in 2015. The AP entity obtained less than one consultation (*i-consau*) per person per year (0.8) in 2015, while SC was better, 11 consultations per person in 2019. It is important to note that the Unified Health System (SUS) suggests 2 to 3 annual consultations per person.

In the same order of analysis, regarding the number of physicians (i-medsau), health establishments (i-estsau) and infant mortality (i-imortsau), the following entities stand out: MA, Amazonas (AM), Espirito Santos (ES), RS and SC, in which:

- MA obtained the worst result in the doctor/patient ratio (i-medsau), less than one (0.9) physician for every thousand people in 2015. The WHO recommends 2.5 doctors per 1,000 people. However, in 2019, the RS entity achieved the best result (3.5 physicians for each group of one thousand people);
- In 2017, AM achieved the worst result in health facilities (i-estsau) for every thousand people (0.6 - establishments). SC, on the other hand, obtained the best result: 2.5 in 2019;
- ES had the best infant mortality rate (i-imortsau) in 2019, equivalent to 7.8%. In contrast, AM achieved the worst result (23.5% in 2015).

Then, the efficiency of each entity was calculated by means of the DEA in two stages, with the objective of admitting in the composition of the proposed PIs. In order to validate the results of the efficiency indicated in the first stage, the regression from the second stage was calculated, in which "efficiency" was used as the dependent variable. The results are presented in Table 6.

Table 6
Second-stage regression of health PIs

Efficiency	Observed Coef	Bootstrap Std. Err.	with	P>| Z|	Percentils 95% Interval	
I_dessau	-.0000366	.0000858	-0.43	0.006	-.0001951	.0001459
I_intsau	-.0062352	.0032516	-1.92	0.005	-.0124784	.0006404
I_imortsau	-.0317963	.0103762	-3.06	0.002	-.0541608	-.0114596
O_leisau	.0528696	.0407366	1.30	0.019	.0334035	.1331391
O_consau	.0019126	.0285318	0.07	0.034	-.0484356	.0730275
O_esfsau	.0127348	.0045052	3.83	0.005	.0043020	.0217599
O_medsau	.0722795	.0910098	0.79	0.042	-.2781227	.0926578
O_estsau	.1075563	.1058239	1.02	0.030	-.1042652	.3419758
_cons	1.198.418	.3049563	3.93	0.000	.5622094	1.761.135
/sigma	.783993	.0139354	6.42	0.000	.0280193	.0836914
Wald chi2	61,65					
Prob > chi2	0.0001					

Note: I = input; O = output.
Source: *Survey data.*

The result of the regression (second stage) confirms the efficiency (first stage) for all variables, due to the statistical correlation (P>|Z|) of the dependent variable "efficiency" in relation to the independent variables at the 95% significance level.

Once the efficient results were known, the statistical calculations of the longitudinal regression model were carried out for short panel data with random estimation, in which the ID "*i-dessau*" assumed the dependent classification, and the others*, "i-leisau, i-consau, i-intsau, i-esfsau i-medsau, i-estsau* and *i-imortsau*" independent. These random effects modeling estimates the parameters contained in the expression (e3) by means of the OLS method, which

can also be obtained by the expression (e4), in which the transformation parameter θ_i is presented in the expression (e5).

$$(Y_{it}-\theta_i.\bar{Y}i)=a.(1-\theta_i)+b_i.(X1_{it}-\theta_i.X1_{it})+b2.(X2_{it}-\theta_i.X2_{it}-\theta_i.X2_{it})+...+bk.(Xk_{it}-\theta_i.Xk_{it})+a_i.(1-\theta_i)+(\varepsilon_{it}-\theta_i.\varepsilon_i). \quad (e4)$$

$$\theta_i = 1-\sqrt{\frac{\sigma\text{^}2\varepsilon}{ti.\sigma^2\varepsilon+\sigma^2\varepsilon}} \quad (e5)$$

That is
the result is equal to the *theta* value in Table 7, where:

$$\theta_i = 1 - \sqrt{\frac{(104.5789)^2}{5.(299.55963)^2+(104.5789)^2}} = \mathbf{0,84574252}$$

Table 7
Regression data in a state public health panel

i-dessau	coef.	Std. Err.	with	P>|Z|	(95% Conf. Interval)	
i-leisau	14.16852	9.945042	1.42	0.015	-5.323407	33.66044
i-consau	-47.36577	19.88447	-2.38	0.017	-86.33861	-8.392936
intsau	-8.244754	3.208415	-2.57	0.010	-14.53313	-1.956376
i-esfsau	1.903156	4.358115	0.44	0.046	-6.638592	10.4449
i-medsau	-63.06776	89.99675	-0.70	0.048	-239.4581	113.3226
i-estsau	536.7029	69.90351	7.68	0.000	399.6945	673.7112
i-imortsau	10.91511	11.27043	0.91	0.033	-11.17453	33.00474
cons	423.6858	282.8293	1.50	0.013	-130.4493	978.221
sigma_u = 299.55963 prob > chi2 = 0.0000		sigma_e = 104.5789 **wald chi (7) = 86.80**			rho=.89136335 (fraction of variance due to u_i)	
theta =.84574252 ⇐		number obs = 135				

Source*: Survey data.*

The degree of statistical explanation *(wald chi2* = 86.8%) demonstrates the robustness of the regression model estimation given in a panel proposed to evaluate public health expenditures (see expression e3). This result indicates approximately 87% confidence in the results presented.

Then, the results of the individuals who presented efficiency equal to 1 were extracted from each period analyzed, to be used as *benchmarking* based on the arithmetic mean (Titu & Bucur, 2015) as shown in Table 8.

Table 8

Benchmarking of statistical results to evaluate health expenditures

Variables	2015	2016	2017	2018	2019	Result
Individuals	13	14	11	12	12	12
Sample	49%	52%	41%	45%	45%	47%
i-dessau R$	634	601	516	593	526	577
i-intsau	56,8	55,7	56,5	56,9	57,4	56,7
i-mortsau	13,8	12,9	12,1	11,5	10,9	12,3
i-leisau	4,7	4,9	4,1	4,1	3,9	4,4
i-consau	5,1	5,2	6,2	6,4	7,2	6,0
i-esfsau	25,3	21,6	27,0	22,5	23,3	23,8
i-medsau	2,2	2,2	2,3	2,3	2,5	2,3
i-estsau	1,5	1,6	1,6	1,6	1,9	1,7

Source: *Survey data.*

On average, 47% of the entities presented efficient results in the period analyzed. These results were used as a parameter for the construction of the proposed PIs (see Table 9). The result column, shown in Table 8, represents the parameter used to indicate the PIs in the evaluation of the effectiveness of health expenditures in state governments.

It was observed that none of the entities showed efficacy in the expenditures executed, that is, they spent more than the *suggested per capita* values . It is noteworthy that the PIs "*i-mortsau*" and "*i-intsau*" suggest the lower the better (see Table 9).

These PIs indicate minimum parameters, according to the statistical model represented by the expression e3.

(**Health**: $i\text{-}dessau_{it} = \alpha_i+\beta1.i\text{-}leisau_{it}+\beta2.i\text{-}consau_{it}+\beta3.intsau_{it}+\beta4.i\text{-}esfsau_{it}+\beta5.i\text{-}medsau_{it}+\beta6.i\text{-}estsau_{it}+\beta7.i\text{-}imortsau_{it}+ \varepsilon_{it}$). (b3)

The PIs listed in Table 9, with the exception of *i-imortsau* and *i-intsau*, indicate that "the higher the better" results. It is worth noting, considering the suggested (integrated) model, that the results of the PIs should be analyzed as a whole, and not individually.

Table 9

Proposed PIs to Calculate the Effectiveness of State Public Health Spending

Indicator	Value	Composition	Indicator	Value	Composition
i-dessau	= or > R$ 577	Annual budget ÷ Total population	i-esfsau	= or > 23.8	Average number of annual family health teams x 1000 ÷ Total population
i-consau	= or > 6.0	Annual number of consultations ÷ Total population	i-medsau	= or > 2.3	Annual number of physicians x 1000 ÷ Total population
i-estsau	= or > 1.7	Average number of physical space annual health ÷ Total population	i-imortsau	= or < 12.3	Number of deaths 1 life per year x 1000 Number of live births per year ÷

i-leisau	= or > 4.4	Average number of beds per year ÷ Total population	i-intsau	= or < 56.7	Number of annual hospitalizations x 1000 ÷ Total population

Source: *Survey data.*

4.3 Analysis of expenditures executed in state public health in the period 2015 to 2019

The results of the expenditures executed by each entity, based on the proposed PIs (shown in Table 9), are shown in Table 10. The 'indication' line suggests the parameter values for each indicator.

The northern region had the highest *per capita* spending in the period, and achieved the worst results in almost all PIs. The highlight was Roraima (RR). This region spent on average twice as much as the indicated amount *(i-dessau)* and was unable to improve the indicators related to hospitalizations (*i-intsau*), infant mortality (*i-imortsau*), available beds (*i-leisau*), number of consultations *(i-consau), number of doctors* (i-medsau) and number of physical health facilities (*i-estsau*). There was a slight improvement in the number of family health teams (*i-esfsau*). The results suggest that the expenditures undertaken by these governments were not effective.

Table 10

Result of per capita expenditures by each entity x proposed PIs - 2015 to 2019

Region	Ufs	I-Dessau	I-Intsau	i-imortsau	I-Leisau	I-	i-esfsau	i-medsau	i-estsau
Indication →		**= $> 577**	**= < 56.7**	**= < 12.3**	**= > 4.4**	**= > 6.0**	**= > 23.8**	**= > 2.3**	**= > 1.7**
North	AND	1.047	52,8	16,4	3,5	2,5	29,1	1,6	1,0
	AP	931	57,4	22,1	2,8	1,0	20,7	1,1	0,7
	PA	309	57,5	15,7	3,4	1,8	25,7	1,1	0,8
	TO	1.026	51,9	15,4	3,6	2,0	38,3	1,7	1,4
	AM	1.256	74,9	17,0	3,7	2,2	22,1	1,9	1,3
	RR	1.163	74,9	18,7	3,0	2,4	22,4	1,4	0,6
	RO	657	66,8	19,6	4,8	3,5	24,8	1,6	1,6
Northeast	PB	331	46,8	15,4	4,3	4,8	36,3	1,8	1,5
	PI	491	69,0	18,6	5,4	4,3	43,3	1,6	3,4
	ON	512	57,4	12,2	4,4	3,9	26,9	1,8	0,9
		473	41,3	15,5	3,2	5,1	29,6	2,7	1,5
	THAT	359	54,3	13,8	3,9	4,1	27,8	1,5	1,2
	BUT	306	63,1	20,3	4,0	2,1	35,5	1,0	0,8
	BA	447	55,9	16,6	3,8	3,1	27,7	1,7	1,1
	To the	353	52,1	18,5	3,7	4,4	28,7	1,8	1,0
	RN	402	45,7	14,1	4,2	5,0	28,9	1,8	1,3
Midwest	DF	1.696	53,0	10,3	7,1	4,9	15,9	1,6	1,3
	GO	574	55,1	14,5	4,6	5,1	21,1	2,0	1,4
	MT	445	56,8	16,5	4,3	3,0	24,5	1,7	1,7
	MS	419	62,7	13,6	3,8	5,1	26,7	2,9	1,7
Solth	PR	438	73,3	9,0	4,6	8,0	18,7	2,6	2,1
	RS	497	67,0	9,4	5,2	5,8	15,9	3,3	2,1
	SC	437	67,8	8,9	4,1	9,6	23,1	2,9	2,3
Southeast	IS	667	61,0	8,5	3,8	9,0	20,1	2,0	1,7
	RJ	321	39,9	11,1	4,3	4,6	14,5	1,8	1,3
	SP	513	53,5	9,6	3,7	10,0	10,8	2,6	1,6
	MG	400	58,7	10,5	3,9	6,2	24,4	2,8	1,9

Source: *Survey data.*

The Northeast region, despite having a *per capita* expenditure lower than the suggestion, achieved 100% efficacy only *in the i-esfsau indicator (*number of family health

teams), and 33% in the *i-intsau* indicator (hospitalizations) - referring to the PI, PE (Pernambuco) and MA entities. On the other hand, it was ineffective in the other PIs - emphasis on the MA entity.

In the Midwest region, the *per capita expenditures* (*i-dessau*), with the exception of the DF entity - which spent on average three times more than the indicated value, lower than the suggestion. The other PIs, except *i-consau* (consultations), achieved an average of 50% efficacy.

In the southern region, with the exception of PIs *i-intsau (hospitalizations) and i-esfsau* (family health teams), the results achieved were effective. It is worth noting that per capita expenditures (*i-dessau*) were, on average, lower than the suggestion.

In the southeast region, the PIs *i-leisau (*beds*)* and *i-esfsau* (number of family health teams) were ineffective. Regarding the results achieved in *i-medsau* (number of physicians) and *i-estsau* (physical establishments), the entities ES, RJ and São Paulo (SP) were ineffective. On the other hand, for the *i-intsau PIs* (hospitalizations), the ES and MG entities were ineffective. In general, the ES and RJ entities achieved the worst results, especially ES.

In summary, the results shown in Table 10 indicate that the RR achieved the worst performance in all indicators, despite having spent on average twice as much as the suggested per capita value . Similarly, it can be seen with the AP and AM entities. In contrast, the entities Paraná (PR), RS and MG presented median performances (75% efficacy of the PIs). As for the analysis by region, the worst performances were found in the North (100%) and Northeast (89%) regions. It is noteworthy that the entities in these regions spent more than the suggested amount - especially RR, Acre (AC) and Tocantins (TO), on average, twice as much.

With regard to the effectiveness of the set of proposed PIs (see Table 9), the analysis presented here stands out, and consequently, the specific information in the field that requires a review of the actions taken in view of the results achieved, for example, number of physicians, consultations and hospitalizations. According to this understanding, the DF spent an average of three times more than the suggested per capita value and only reached 25% efficacy of the indicators, specifically in terms of number of beds and infant mortality (see Table 10).

Based on the set of suggested indicators, it is possible to make interventions or adjustments in actions for the current period or for subsequent periods, as is the case of the RR, AC and OT entities, which spent more than the suggested values (two or three times more) and achieved the worst results.

Regarding the effectiveness of the expenditures made, it was found that: the RR entity reached 0% of effectiveness; AP, AM and Rondônia (RO) achieved 12% efficacy; the entities AC, Pará (PA), TO, Ceará (CE), MA, BA, DF, Goiás (GO) and Mato Grosso (MT) reached 25% efficacy; the entities Paraíba (PB), PI, PE, Alagoas (AL), RN, ES and RJ reached 37%; the SE and Mato Grosso do Sul (MS) entities achieved 50% efficacy; the SC and SP entities achieved 62% efficacy; and PR, RS and MG reached 75%.

4.4 Legitimization of the proposed PIs to evaluate state public health expenditures

The process of legitimizing the suggested PIs to assess the effectiveness of health expenditures occurred through the analyses carried out by auditors of the state audit courts, on the scope and reach of the aforementioned indicators, presented in the form of a google forms questionnaire. It is worth noting, based on the *Likert* scale, 1 is equal to "strongly disagree", 2 "partially disagree", 3 "indifferent", 4 "partially agree", and 5 "strongly agree". In this process, it was presented to the auditors responsible for auditing the accountability of the state

governments, the collection of data, the indicators used, the statistical methods and the results achieved.

Table 11 and Figure 2 show the results of the answers to the questionnaires referring to the suggested PIs to assess the effectiveness of state public health spending. On average, 69% of the respondents agreed with the PIs shown in Table 9.

Table 11

Legitimation Result of Proposed PIs

	Description	Escala *Likert*				
		1	**2**	**3**	**4**	**5**
1	Average per capita spending on state public health	5%	37%	5%	53%	-
2	Average number of beds in state public health for each group of 1,000 people	5%	16%	5%	63%	11%
3	Average number of state family health teams for each group of 1,000 people	-	26%	-	63%	11%
4	Quantitative average of medical consultations performed per group of one thousand people	-	21%	5%	63%	11%
5	Average number of physicians in the state public health system for each group of 1,000 people	11%	26%	-	47%	16%
6	Quantitative average of health facilities in the state public network for each group of one thousand people	11%	16%	5%	53%	16%
7	Quantitative average of hospitalizations in the state public health system for each group of one thousand people	5%	21%	11%	53%	11%
8	Average infant mortality rate in the state public health system	-	11%	-	63%	26%
Total average response in Likert scale format		5%	21%	5%	54%	15%
Result in cumulative percentage "disagree" and "agree"		**26%**		**5%**	**69%**	

Source: *Survey data.*

However, some suggestions were made for some indicators by the respondents, namely: (i) for indicator 1 - "involve in the calculation basis the per capita budget expenditure actually spent"; (ii) for indicator 2 - "consider information from other countries in the calculation basis"; (iii) for indicator 3 - "involve the variable patient satisfaction in the calculation composition"; (iv) for indicator 4 - include patient satisfaction in the construction of the indicator", as well as "periodically review the results of this indicator, because physicians can speed up consultations and not focus on quality"; (v) for indicator 5 - "include the distribution of doctors by geographical regions", as well as "compare with other European countries"; (vi) for indicator 6 - "include the size of the establishment by geographical regions", as well as "compare with other European countries"; (vii) for indicator 7 - include "quality of care", as well as "by type of hospitalizations".

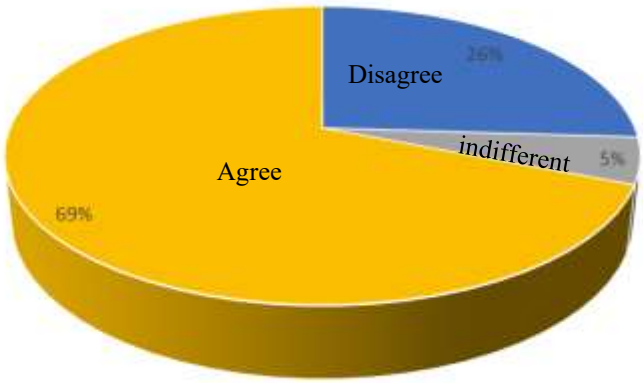

Figure 2 *Outcome legitimizing PIs proposed to health*
Source: *Survey data.*

5 Discussions of Results

This study started from the research gap on the evaluation of the performance of public expenditures through indicators, which was suggested by Rosa et al (2014), when they stated little or no literary discussion regarding the verification of the effectiveness of budget expenditures in central governments, despite the PEC, 188 (Constitutional Amendment Project) in progress in the National Congress. In this proposal, the study defends the thesis that the proposed PIs, if used by auditors of the courts of auditors in the audits of accountability of state governments, as well as by the academic community, provide to verify the effectiveness of budget execution in an objective way in achieving the goals set in government plans.

The process of legitimizing the suggested PIs to evaluate the effectiveness of health expenditures, focusing on this statement, the study was structured on the problem and proposed research objectives, in which it identifies, constitutes, evaluates and legitimizes indicators capable of identifying the effectiveness of health budget expenditures in state governments. Therefore, it characterizes its originality, fosters discussions of a literary nature and suggests an instrument of a practical nature.

5.1 Identification of the PIs used in the planned and realized MAPs

Through the analyses carried out in these government planning and management instruments, whose objective was to identify the performance indicators used both in the forecast and in the execution, it was found that there is no application of any performance indicators in health expenditures from public actions. There is only a percentage of accomplishment between planned and actual.

Based on the results presented, it is pertinent to affirm the lack of commitment and responsibility of governments and legislative chambers in the fulfillment of the actions and goals evidenced in each MAP. The monetary values foreseen in the MAPs do not seem to be consistent when compared to the realized values. There are actions described without quantified information, as well as the absence of goals, as is the case of the SE and AP entities. Transcribed repetitions of public actions were observed, as is the case of the RN entity. Overvaluation and

undervaluation of monetary values listed in MAPs were found if considered with the realized, as is the case of the entities CE, SC, PI, RS and AP.

These findings may occur due to the lack of supervision, both by the competent bodies and by the population. It is prudent to highlight the absence of normative regulation on internal practices in the preparation of the MAP, as well as being subject to audit inspection by the courts of auditors. By analogy, it is possible that this practice is a consequence of agents involved in the preparation of MAPs not being the ones who operationalize them, as suggested by Azevedo and Aquino (2016).

In the general context, there is no structural standardization of MAPs among public entities, little or no commitment is identified in their preparation, as well as in the analyses for approval in the legislative chamber. There seems to be only legal compliance, and the pursuit of the established goals is fragile. Not only, but also, the labels identified in the MAPs as indicators, are nothing more than an indication of percentages to monitor the degree of compliance between the forecast and the execution of the action taken.

Thus, it is ratified that no performance indicators used in the elaboration and execution of public health MAPs in Brazilian state governments were identified.

5.2 Measuring the effectiveness of the proposed set of PIs to assess state public health expenditures

The set of indicators proposed to evaluate the effectiveness of health expenditures, represented by equation (e3), offers a degree of statistical explanation corresponding to approximately 87%. The application of the DEA in two stages, concomitant with regression for panel data, contributes to greater robustness of the results achieved (Simar & Wilson, 2007; Fávero & Belfiore, 2017).

It is observed through the descriptive analysis (see Table 5) that higher budget expenditures *per capita* is not a passport to achieve effectiveness in the results achieved, for example, the DF entity with the highest prominence in the descriptive analysis, achieved efficiency in 60% of the period and achieved ineffective results in 75% of the suggested indicators. This result confirms the suggestions of Burkhead and Hennigan (1978), when they indicate that the analysis of efficiency in public management is inseparable without observing effectiveness, that efficient results are antagonistic to effective results.

Still based on Burkhead and Hennigan (1978), for example, in contrast to the DF entity, the MA entity obtained the lowest expenditure and achieved 80% efficiency. However, again, it was ineffective at 76%. This result contradicts the suggestion of TCU (2018) when it suggests that relative efficiency provides good practices that can be used as *benchmarking*.

As for the results in Table 7, corresponding to regression with random estimation for panel data, among other information, it indicates that the increase in one statistical unit in budget expenditure has a negative impact on the average number of consultations, hospitalizations and physicians, 47%, 8% and 63% respectively. This means statistically, relative to 87% of the degree of explanation, that increasing budget expenditures in order to justify exclusively specific actions in these variables, does not guarantee the achievement of effectiveness in the corresponding indicators (Fávero & Belfiore, 2017).

In this context, the indicators suggested to verify the effectiveness of health expenditures, based on the variables in Table 9 and the mathematical expression e3, constitute an instrument for verifying effectiveness, with approximately 87% statistical explanation, which can be used by auditors, as suggested by Berne and Schramm (1986), Brown (1993),

Kleine et al. (2003), Hendrick (2004), Kloha et al. (2005), Kavanagh (2007), Wang et al. (2009), Titu and Bucur (2015), Cinaroglu and Baser (2016).

The adoption of tools that make it possible to evaluate the performance of public accounts by competent bodies encourages the challenge of public managers in the search for better results (Berne & Schramm, 1986; Brown, 1993). Similarly, the literature suggests that performance indicators help in adjusting and maintaining the objectives and goals established in public institutions (Chaney et al. 2002; Kleine et al. 2003; Groves & Valente, 2003; Hendrick, 2004; Wang et al. 2007; Kavanagh, 2007; Sohl et al. 2009), as well as in the evaluation of budget expenditure performance (Campbell & Harrison, 1990; CICA, 1997; Krishnakumar et al., 2010; Titu & Bucur, 2015; Cinaroglu & Baser, 2016). The results found in this research, through the statistical instruments used, ratify the robustness listed in the literature, regarding the results achieved with the application of the adopted technique.

5.3 Analysis of expenditures executed in state public health in the period 2015 to 2019

To evaluate the effectiveness of the proposed indicators (see Table 9), we used the results obtained for each variable pertinent to the set of indicators, referring to the public entities involved in this study, corresponding to the period 2015-2019. The results show that none of the entities were 100% effective in the application of budgetary resources in health. However, some have shown average efficacy, between 50% and 75%. However, it is relevant to highlight that the central point of the indicators is the measurement of results and the punctual information of the area that needs intervention, whether in the aspect of adjustment or maintenance.

The result produced by each indicator generates information for the public manager in the direction and formulation of public action to improve or maintain the evidenced result. Likewise, to evaluate and provision for future periods. These proposed indicators offer operationalization in a simple and effective way, because they enable easy understanding, low cost of operation, *feedback* to the manager and user, are based on official information (data) and are also capable of promoting comparative and temporal analyses (Behn, 2003; Arnaboldi et al. 2015; Allin et al. 2016; Araújo et al. 2018).

With regard to the performance of the set of indicators to evaluate the effectiveness of spending on state public health, the analysis presented here stands out, and consequently, the specific information from the field that needs to be reviewed in view of the results achieved, for example, number of doctors, consultations and hospitalizations. Also as an example, the DF spent an average of three times more than *the suggested per capita* value and only reached 25% effectiveness of the indicators, specifically, in the number of beds and infant mortality. Through the results indicated by the set of proposed indicators, it is possible to make interventions or adjustments to actions for the current period or for subsequent periods.

Wang et al. (2009) suggest that the pertinent diagnosis to evaluate the effectiveness of performance indicators is anchored in their readiness to generate timely information to assist in decision making. In this context, the proposed indicators enable timely information, temporal analyses and punctual indications that need interventions or maintenance, since it achieves comparability of results between entities and periods, and generates information about the action that needs intervention.

Considering that the set of performance evaluation indicators shows punctually where it is appropriate to intervene and/or maintain the actions practiced, as is the case of the RR, AC and OT entities that spent two or three times more than the suggested values, and achieved the

worst results, it can be assessed that the PIs contribute in a timely manner in measuring the effectiveness of spending on state public health.

5.4 Legitimization of the proposed PIs to evaluate state public health expenditures

The legitimization of the indicators occurred through a *Google Forms* questionnaire sent to the auditors of the state audit courts of the 27 federated entities, responsible for auditing the accountability of governments.

The results achieved (see Figure 2) show that 69% of the auditors legitimized the application of the PIs to evaluate the effectiveness of state public health spending. However, 26% disagree with the proposed indicators, based on the following comments: (i) not using the amount actually paid as a *per capita reference* ; (ii) not to use parameters from other countries, especially European ones; (iii) not using the level of patient satisfaction; (iv) not including a reductive parameter for quick consultations, without quality; (v) not include temporary distribution of specialist physicians from other entities; (vi) not having considered the physical size of the health units for consultations; (vii) not having separated the types of hospitalizations. In view of the evidence listed by the auditors regarding the questionnaire, it was observed that the inclusion of the contributions listed in items (i to vii) does not make the results presented unfeasible. However, they are pertinent and contributive in future research. For example, on item (i) - using the amount paid instead of the pledged, would reflect on the undervaluation of expenses, considering that the committed amounts include the amounts paid and the remaining payables processed and unprocessed in the periods.

6 Conclusion and Recommendations

The general objective of this study was to present a proposal for a set of PIs to evaluate health expenditures in Brazilian state governments. To achieve this objective, the study used literary concepts on performance evaluation with the use of indicators in public management, financial and social data of the States and the Federal District for the period from 2015 to 2019. In addition, it applied the two-stage DEA statistical technique and linear longitudinal regression model estimation for strongly balanced short panel data. As well as a *checklist* to identify the PIs used by public entities and a *google forms* questionnaire with the CAs to legitimize the proposed indicators.

The results indicate that the proposed set of PIs reached, on average, 87% of the degree of statistical explanation. As well as comprehensibility and ease of application by CA auditors in the evaluation of the effectiveness of budget expenditures executed by state governments in public health. These findings advance and complement literary studies, as well as foster discussions on the topic in question.

Regarding the first specific objective, to identify the performance indicators used for public health in the planned and implemented MAPs, referring to the period from 2016 to 2019, the results suggest: (i) lack of structural standardization of MAPs among the entities; (ii) lack of commitment to the preparation and monitoring of MAPs; (iii) lack of analysis of the effectiveness of state government spending on health by the legislative chambers, when presenting accountability; (iii) there are no performance indicators used in the preparation and monitoring of MAPs related to state public health; (iv) the labels identified in the MAPs as indicators correspond exclusively to percentages used to monitor the degree of compliance between the forecast and the execution of actions taken.

Regarding the second specific objective, to measure the effectiveness of the set of PIs through budget execution by the States and the Federal District in the period from 2015 to 2019,

it was found that the use of efficiency analysis to measure the performance of public management, as recommended by some researches, judges partial adherence. This is because the results suggest that of the 30% of the entities that presented efficiency, only 13% were effective in 75%, and that none was effective in 100% in relation to the suggested indicators, although some presented median efficacy between 40% and 50%. It was also identified entities that spent two or three times more than the values proposed by the indicators, and only achieved efficacy up to 25%. These indicators, in addition to evidencing the performance of expenditures, score the actions that need interventions and generate timely information, temporal analysis and comparability between public entities. It is easy to operate, understand, and low cost.

Finally, regarding the third and last specific objective, the legitimacy of the sets of performance indicators with the auditors of the SCAs, the results show that on average 70% of the auditors of those responsible for auditing the public accounts of the governments, agree with the scope and objective of the proposed indicators to evaluate the effectiveness of public spending on health.

In view of the above facts, it is concluded that: (i) the proposed set of PIs, with a degree of statistical explanation in 87%, contribute to the evaluation of the effectiveness of public spending on health. Including, with timely information for decision-making by public managers; (ii) the performance indicators provided for in the MAPs are mere percentage labels used to monitor the degree of accomplishment of the planned action; (iii) the effectiveness of the indicators in terms of their measurement is based on the disclosure of the performance of expenditures, the generation of timely information, the temporal and comparative analysis, and the ease of application and comprehensibility; (iv) the degree of legitimacy of the indicators by the auditors reached an average of 70%; (v) it is confirmed that performance indicators are capable of assessing the effectiveness of public spending, as well as can be used by auditors in audits of the accountability of state governments.

As a limitation of this research, the absence of qualitative variables in the basis of the construction of the set of performance evaluation indicators is presented, as well as the number of quantitative variables used; the limitation of the period analyzed, considering the existence of political ideologies between governments and parties. And as recommendations for future research, it is suggested: (i) to measure the effectiveness of the indicators proposed in municipal governments; (ii) based on the methods applied in this study, construct indicators with qualitative and quantitative variables to evaluate infrastructure expenditures in state or municipal governments; To compare ideological political influences between governments regarding the effectiveness of spending on the same public entities in different periods.

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