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Public health investment, performance and productivity in municipalities in the interior of the state of Bahia

Investimento, desempenho e produtividade da saúde pública nos municípios do interior do estado da Bahia

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Abstract: The objective of this article is to analyze the effect of public investment in health services (low and medium complexity) on the productivity of the single health system in cities of the interior of Bahia with 50,000 inhabitants. The Ordinary Least Squares (OLS) and the Generalized Moments Method (GMM) are adopted as the empirical strategy. The results indicate that public health expenditure has no positive effect on the productivity of health services in the municipalities studied, with a different sign than expected, suggesting that the increase in public health expenditure is accompanied by an inefficient allocation of resources. In addition, the self-financing capacity of the municipalities was found to be more relevant to productivity, from which it can be concluded that the dynamics of municipal revenue allows better conditions for the implementation of health policies, especially those focused on primary care.

Keywords: Public Good; Public Spending; SUS; Welfare.

JEL Classification: H11. H21. H41.

Resumo: Este artigo tem o objetivo de analisar o efeito dos investimentos públicos em serviços de saúde (baixa e média complexidade) sobre a produtividade do Sistema Único de Saúde nos municípios do interior da Bahia com 50.000 habitantes. Adota-se como estratégia empírica o método Mínimos Quadrados Ordinários (MQO) e o Generalizado dos Momentos (GMM). Os resultados indicam que as despesas com saúde pública não afetaram positivamente a produtividade dos serviços de saúde nos municípios estudados, com sinal diferente do esperado, o que sugere que o aumento das despesas públicas destinadas à saúde é acompanhado por uma alocação de recursos ineficiente. Ademais, verificou-se que a capacidade de autofinanciamento dos municípios apresentou maior pertinência para a produtividade, resultado pelo qual se infere que a dinâmica da arrecadação municipal permite melhores condições de execução de políticas de saúde, sobretudo focadas na atenção básica.

Palavras-chave: Bem Público; Gasto Público; SUS; Bem-estar.
Classificação JEL: H11. H21. H41.

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1. Introduction

Important advances have been made in the epidemiological framework of Brazilian public health. According to data from the Brazilian Mortality Table and Epidemiological Demography, a survey carried out by the Brazilian Institute of Geography and Statistics (IBGE, 2017), the infant mortality rate fell from 45.1% in 1991 to 13.3% in 2016, while the life expectancy of Brazilians jumped from 66.4 to 75.8 years. These results are largely due to the expansion of the public primary health care network and the process of expanding the Unified Health System (SUS), which favored the control of infectious, respiratory and parasitic diseases, responsible for the high morbidity records seen throughout the 1990s, especially in the North-Northeast.

Despite these developments, government investment in Brazil's public health system is below the levels seen in both emerging and developed countries. According to the 2017 World Health Statistics (WHS) report published by the World Health Organization (WHO, 2017), only 6.8% of the government's public budget is allocated to public health, a rate that has been falling since 2010. According to the WHO survey, the world average share of investment in health care services in the public budget is 11.7%. If we compare Brazil's performance with the regional average, the share of public spending on public health in Brazil is lower than in the Americas (13.3%), Africa (9.9%), Asia (9.3%), Europe (13.2%), the Mediterranean (8.8%) and the Pacific (12.3%).

In addition to the low share of health spending in the public sector budget, most Brazilian municipalities are experiencing an increase in demand for primary, medium and highly complex clinical services. In the literature, this increase in demand has been associated with diseases caused by the degeneration of the body as a result of ageing and unhealthy living conditions, including heart and circulatory diseases, hypertension, cancer and diabetes (ALMEIDA et al., 2002; DALSTRA et al., 2005; LIMA-COSTA; LOYOLA FILHO; MATOS, 2007; BARROS et al., 2011; REIS; NORONHA; WAJNMAN, 2016; MIRANDA; MENDES; SILVA, 2016). In this sense, even with the progress that has been made, the Brazilian public health system still falls short of the population's needs.

In Brazil, some of the specialized literature has set out to investigate the relationship between public spending and the efficiency of health care and protection services linked to the SUS (GASPARINI; RAMOS, 2004; MENDES, 2005; QUEIROZ et al., 2011; MAZON; MASCARENHAS; DALLABRIDA, 2015). The results documented in this literature show that the increase in public spending on health is not necessarily accompanied by gains in efficiency and quality of the public goods and services provided to society. There is also some research that analyzes the managerial role and fiscal decentralization as preponderant in explaining the efficiency of care services and the dynamics of health system productivity in Brazilian states (TREVISAN; JUNQUEIRA, 2007; ALMEIDA; GASPARINE, 2011). In a study by Ramos et al. (2015), the efficiency of the hospital network is analyzed from the point of view of gains and returns to scale, associating the performance of public health equipment with its administrative sphere and legal nature.

Viacava et al. (2004) pointed out that there is no consensual methodology in the international literature for analyzing the performance of public health systems. In turn, Andrade et al. (2017) drew attention to the complexity of carrying out analytical studies for the public health sector, since the variables related to public spending on health have a certain degree of endogeneity, and are often influenced by factors such as: inflation, an increase in the number of procedures consumed due to population growth, the very consequences caused by factors inherent to the health system in the market and the emergence of new goods, new technologies and new medicines.

This research aims to contribute to the discussion in the literature by developing an analysis of the relationship between public investment, performance and the productivity of the public health system in municipalities in the interior of the state of Bahia, based on the work developed by Almeida and Gasparine (2011). To this end, a methodological tool is used to instrument the set of explanatory variables in order to overcome the problem of endogeneity of health sector data reported in the literature. The municipal analysis was chosen due to the prerogative enjoyed by Brazilian municipalities to manage the resources and transfers intended for primary health care management. The state of Bahia was chosen because of the characteristics of the municipal health territories, with low hospital centrality and a high number of municipalities.

The article is organized into five sections, including this introduction. Section 2 presents a characterization of the Brazilian public health system, as well as the state of the literature that underpins the discussion proposed in this research. Section 3 then describes the empirical strategy employed. Section 4 presents and discusses the results. Finally, section 5 outlines the research conclusions.

2. Literature Review

According to the 1988 Federal Constitution, health is a right for all individuals and a duty of the state, which must guarantee it through public policies aimed at reducing the risk of disease and other health problems (BRASIL, 1988). It is on the basis of this normative proposition that the national public health system is established in Brazil's legal-institutional order, when Chapter II, Article 198 of the Constitution defines that public health actions and services will form part of a regionalized, hierarchical network, constituting a single, universal system, organized according to the following guidelines: decentralization, with a single directorate in each sphere of government; comprehensive care, with priority for preventive activities, without prejudice to care services; and community participation.

In the 1990s, the Organic Health Laws were instituted, responsible for regulating the SUS. Federal laws nº. 8.080 and nº 8.142 - both enacted in 1990 - define the responsibilities of the federal entities that make up the system. The first is the municipalization of health services and actions, with a review of political-administrative attributions and the decentralization of resources to municipalities. The second piece of legislation defines the collegiate bodies and instruments for social participation in the management of the SUS. In this way, the transfer of funds to municipalities was linked to the functioning of a Municipal Health Council, a representative, deliberative and supervisory body for municipal management.

According to Carvalho (2013), the Brazilian public health system is made up of a set of programs, actions, services and public equipment aimed at protecting and assisting the health of individuals who demand it. This system is made up of a network of federal, state and municipal public institutions, as well as direct and indirect administration bodies and foundations maintained by the public authorities that are active in the management of public health policies. In a complementary way, philanthropic organizations and private companies, responsible for providing medium and high complexity outpatient and hospital care services, are allowed to participate in agreements with the SUS management bodies in the municipalities, states and/or the union.

The guiding principle of this system, according to Noronha and Pereira (2013), consists of social security, so that health promotion actions supported by the state are universal, equitable and comprehensive. This implies that the SUS has no user restrictions, which guarantees access to all health protection and care actions and services to any individual, Brazilian or not, regardless of gender, race, occupation or other social or personal characteristics. However, the system is based on the principle that the health and social conditions of the individuals requesting care are heterogeneous, and provides differentiated treatment in order to maintain social equity, while maintaining the integrality of care actions.

Table 1: Survey of the literature evaluating public health services

Author	**Object**	**Study area**	**Method**
Zucchi, Del Nero and Malik (2000)	Demand from SP	Brazil	Qualitative
Gasparini and Ramos (2004)	Technical efficiency	Macro-regions	DEA
Mendes (2005)	Efficiency of public spending	Municipalities/SP	MQO
Cesconetto, Lapa and Calvo (2008)	Hospital efficiency	Santa Catarina	DEA
Fonsenca and Ferreira (2009)	Efficiency of SP factors	Minas Gerais	DEA
Almeida e Gasparini (2011)	Productivity dynamics	States	DEA/MQO
Queiroz et al. (2011)	Efficiency of public spending	Municipalities/RN	DEA

Mazon et al. (2015)	Efficiency of public spending	Municipalities/SC	MQO
Ramos et al. (2015)	Hospital performance	Brazil	Description
Andrade et al. (2017)	Efficiency of public spending	Capitals	DEA

Source: Elaborated by the author.

3. Empirical Strategy

This section is organized into two subsections, the first of which presents the study area, the database and the variables selected for analysis, while the second subsection describes the econometric methodology used and the empirical models estimated to obtain the results.

3.1 Study area, database and analysis variables

Bahia is the largest state in Brazil's Northeast Region and the fourth most populous in the country, according to data from the 2010 Demographic Census (IBGE, 2010). It is made up of 417 municipalities, regionalized into 28 health territories and nine macro-regions (North, West, Central-North, Central-East, North-East, East, South-West, South and Far South), according to the Ministry of Health's Regionalization Master Plan (PDR) (BRASIL, 2013). According to Teles, Ferreira and Coelho (2017), the RDP is the instrument that organizes care and orders the health regionalization process in order to promote greater access for the population to all levels of health care. Due to the large territorial extension of the state of Bahia (552,000 km^2), these health territories are marked by significant population heterogeneity, which makes their healthcare structure disparate. For this reason, this research only considered 372 municipalities with a population of up to 50,000 inhabitants, in order to avoid distortions in the analysis and to circumvent the cases of outlier municipalities.

The data used to calculate the productivity of the municipal public health system was obtained from the Ministry of Health's Health Information Module - TABNET for 2010, as this was the year in which information was available for all the municipalities in the sample. Data on the inputs and outputs of the health system were used. To obtain the productivity of the health system, the indicator proposed by Lovell (1993) and adapted by Cesconetto, Lapa and Calvo (2008) was used as a reference:

$$PdSP = \frac{\sum_{k=1}^{N} \mu_m u_m}{\sum_{k=1}^{N} v_n x_n} \quad (1)$$

Where $\mu_m \geq 0$ is the generated quantity of the health service m, $\sum \mu_m > 0$; $x_n \geq 0$ is the quantity consumed of the input n, $\sum n > 0$; $\mu_m \geq 0$ corresponds to the usefulness of the health service m in the composition of the useful production of the SUS; and $n \geq 0$ equals the usefulness of input n in the composition of the total number of attendances.

Table 2 describes the set of explanatory variables selected, indicating their respective source. The variables were chosen to represent different dimensions relevant to the quality of health services already documented in the economic literature. In this sense, based on Gasparini and Ramos (2004), Mendes (2005), Almeida and Gasparini (2011) and Mazon et al. (2015), variables were selected to analyze the federative dimension of public spending, socioeconomic variables that reveal pressure on the health system and control variables capable of correcting any endogenous problems. The definition of the dependent variable sought to calculate total productivity, which is the ratio between the weighted sum of the products generated by the resources consumed, i.e. the gains from inpatient and outpatient clinical care in relation to expenditure on municipal public health factors. Based on Lovell (1993), PdSP is defined as the ratio between useful production and useful consumption, i.e. the gain generated by each resource used, i.e. associated with meeting expenses.

Table 2: Description of the variables that make up the database

Variable Instrument	Indicator	Composition	Source
PdSP	Public health productivity	Ratio of inpatient and outpatient clinical care (excluding exams and other specialized procedures) and expenditure on municipal public health factors	SIAB
Dmsp	Municipal expenditure on public health	Municipal expenditure on public health	RIPSA
Rf	Fiscal responsibility	Ratio of own tax revenue (RTP) to total revenue	STN
Caf	Self-financing capacity	Ratio of RTP to total budget expenditure	STN
T	Government transfers	Income from government transfers (state and union)	STN
Y	GDP *per capita*	State GDP *per capita*	IPEA
Atd	Services	Outpatient care, consultations and tests of low and medical complexity	RIPSA
Prof	Health professionals	Proportion of professionals working in municipal public health (doctors, nurses and dentists)	RIPSA
Lei	Beds	Proportion of hospital beds available in the public network per inhabitant	RIPSA

Pop	Population	Number of inhabitants in the municipality	IBGE
Pob	Poverty rate	Proportion of poor by state in the Northeast region	SEI
Urb	Degree of urbanization	Percentage of urban population	SEI
E	Illiteracy rate	Percentage of people aged 15 and over who cannot read and write	SEI
Lix	Garbage collection fee	Proportion of population covered by waste collection	-
$Dummy_{Mun}$	Dummy Municipalities	Municipality >30,000 inhabitants	-
$Dummy_{H}$	Dummy Hospital	Existence of a hospital (scale in public health services)	-
$Dummy_{T}$	Dummy Transfers	T > 23,220,561.01 (sample mean of variable T)	-
$Dummy_{Y}$	GDP dummy	Y >100.000	-

Source: Elaborated by the author.

The sample used contained 372 observations. The endogenous variable (PdSP) had a standard deviation of 4.09, with a minimum of 0.06 and a maximum of 52.07. Of the explanatory variables, Y had the highest standard deviation in magnitude, as shown in Table 3.

Table 3 - Descriptive statistics of the variables included in the analysis

Var/Inst	Descriptive Statistics			
	Average	**Maximum**	**Minimum**	**Standard Deviation**
PdSP	3,92	52,07	0,06	4,09
Dmsp	4.561.782,35	61.645.148,69	1.010.133,78	3.934.426,52
Dmsp(-1)	4.347.984,08	51.196.785,64	1.182.646,63	3.350.318,71
Dmsp(-2)	4.135.169,75	44.055.055,21	226.678,98	3.063.159,23
Rf	0,04	0,37	0,01	0,03
Caf	0,05	0,42	0,01	0,04
T	23.220.561,01	334.685.701,52	4.650.918,04	20.035.557,11
Y	127.807.306,78	5.323.913.785,00	17.237.423,00	308.414.366,28
Atd	65.860,86	1.540.703,00	319,00	99.737,75
Prof	44,53	263,00	4,00	33,88
Lei	29,72	147,00	0,00	26,80
Pop	17.842,89	49.325,00	2.612,00	9.569,55
Pob	67,21	87,07	46,07	6,89

Urb	0,52	1,00	0,12	0,19
E	47,20	77,40	19,10	8,59
Lix	57,38	99,38	14,35	18,41
N	372	372	372	372

Source: Research data.

3.2. Econometric methodology and study variables

The Ordinary Least Squares (OLS) method and the Generalized Method of Moments (GMM) were used to estimate the equations. This option has the advantage of dealing directly with the endogeneity and non-linearity of the parameters, which means that the municipal units analyzed are not necessarily homogeneous, a necessary aspect in non-parametric analyses adopted in other studies. OLS is used to obtain estimates that minimize the sum of the squares of the regression residuals, in order to maximize the degree of fit of the model to the observed data. In linear terms, the regression model starts from a set of hypotheses so that the specification of the deterministic relationship between the dependent variable (y) and the independent variables (x) is consistent and efficient. According to Greene (2011), the six assumptions of the linear regression model are: linearity, full rank, exogeneity of independent variables, homoscedasticity and non-autocorrelation, random data generation and normal distribution of disturbances.

However, it is not always possible to guarantee all the hypotheses of the OLS linear regression model. Particular cases include the violation of the hypothesis of exogeneity of the independent variables, which implies that $E [\varepsilon_i | x_{j1}, x_{j2}, ..., x_{jk}] \neq 0$. This indicates that the expected value of the disturbance observed in the sample is a function of the independent variables. In this way, it is understood that the independent variables will be able to transmit information to the error, ε_i. There is also heteroscedasticity, in which the regression disturbances do not have infinite variance and are correlated with the other disturbances, ε_i.

To test for heteroscedasticity in the estimated models, White's (1980) specification test was used, which consists of regressing the squares of the residuals on the independent variables, their squared values and cross-products, whose hypotheses are: $H_0: Var\ (\varepsilon_t) = \sigma^2$ and $H_1: Var\ (\varepsilon_t) = \sigma_i^2$. Based on Koenker (1981), models with heteroscedasticity will be re-estimated using the HAC standard error robustness method. The Breusch-Pagan test will be applied to check whether the error variances are homoscedastic (H_0) or a multiplicative function of one or more variables (H_1). To overcome these problems, the GMM will be used, as it has proven to be suitable for generating efficient and consistent estimates when endogeneity, non-linearity (HANSEN, 1982) and heteroscedasticity are detected (WOOLDRIDGE, 2001). It minimizes the quadratic form under the conditions of the sample moment, using a quadratic weighting matrix to calculate the estimator, $E[\varepsilon|X] = \sigma^2\Omega = \sum$. Ω is a positive definite matrix, whose disturbances are heteroscedastic when they have different variations and are correlated through the observations, which instrument the endogenous exogenous variables.

In this article, the weighting matrix has been chosen so that the estimates are robust, taking into account the existence of heteroscedasticity and autocorrelation. In order to deal with the possible endogeneity of the independent variables, a common problem in public health data series, a set of instruments correlated with the explanatory variables but independent of the error term was adopted. These instruments deal with aspects related to the dependence on the trajectory of public resources and the scale of health facilities, which are commonly pointed out in the literature. The Hansen test (1982) was used to check the validity of this set of instruments. Under the null hypothesis H_0 that all the instruments are valid, the specification test seeks to elucidate the occurrence of model identification. That is, the existence of an asymptotically chi-squared distribution, where the degree of freedom is equal to the number of restrictions. In terms of statistical inference, the lower the statistical significance of the test, the greater the probability of rejecting H_0, indicating the non-validity of the instruments adopted. The models were also tested for (under)specification - omitted or redundant variables.

Three econometric equations were defined, with equation 1 estimated using OLS and GMM and equations 2 and 3 using OLS alone, as specified below. The dummies and interactions in equations 2 and 3 were used as instruments in the three models estimated by GMM.

- Set of estimates:

A description of the variables can be found in Table 2.

$$PdSP = \alpha + \beta_1 DMSP + \beta_2 RF + \beta_3 CAF + \beta_4 T + \beta_5 Y + \beta_6 ATD + \beta_7 PROF + \beta_8 LEI + \beta_9 POP + \varepsilon \tag{2}$$

$$PdSP = \alpha + \beta_1 DMSP + \beta_2 RF + \beta_3 CAF + \beta_4 T + \beta_5 Y + \beta_6 ATD + \beta_7 PROF + \beta_8 LEI + \beta_9 POP + \beta_{10} DMSP * T + \varepsilon \tag{3}$$

$$PdSP = \alpha + \beta_1 DMSP + \beta_2 RF + \beta_3 CAF + \beta_4 T + \beta_5 Y + \beta_6 ATD + \beta_7 PROF + \beta_8 LEI + \beta_9 POP + \beta_{10} DMSP * T + D_m \mathrm{M} + D_m \mathrm{H} + D_m \mathrm{T} + D_m \mathrm{Y} + \varepsilon \tag{4}$$

4. Results and discussion

The results of the OLS econometric estimations are shown in Table 4, in order to assess the sign, statistical significance, magnitude of the different estimated coefficients and the tests carried out. Three public health productivity models were estimated, with statistical significance of 1%, but with the presence of heteroscedasticity. To correct for this, the models were estimated using the HAC robustness method, maintaining heteroscedasticity. However, model 2 showed an improvement in the probability of the RF, CAF and T variables. It should be noted that in both models all the variables were significant, but at different levels. Only the Dmsp, Rf, Prof and Lei variables had different signs than expected, indicating that increased spending and input expansion do not necessarily result in higher productivity.

The results corroborate the empirical evidence in the literature, which suggests inefficient spending as an explanation. The results found by Mendes (2005), for example, show that planning and management instruments have significant limitations in many municipalities, mainly due to the heterogeneous political and cultural context. Corroborating this behavior is the lack of an agreed process for redefining management functions and competencies in the social area, as well as the absence of strict counterparts in terms of planning full health care and controlling targets.

In this sense, it can be inferred that the increase in budget spending on public health services in municipalities in the interior of Bahia is not a deterministic element in improving the productivity and quality of health care services, suggesting that the management of resources is proving to be preponderant in improving the efficiency of the system. This result is reinforced when analyzing the interaction between Dmsp and T, whose coefficient result indicates that the increase in government transfers to municipalities has a minimal effect on municipal public health expenditure, resulting in little productivity gain. In all the estimated models, the dummies (municipality, hospital, average transfers and population) were not significant, suggesting standardization of the results for the group of municipalities analyzed, considering the binary hypotheses chosen.

Table 4 - Estimation of public health productivity in the municipalities of inland Bahia, by OLS

Variable	Estimation Without Robustness			Robust Estimation		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
C	3.375184*	3.505362*	3.390019*	3.375184*	3.505362*	3.390019*
	(.2437182)	(.2552366)	(.3605142)	(.2551618)	(.2795504)	(.2953361)
Dmsp	-7.07e-07*	-7.57e-07*	-7.53e-07*	-7.07e-07*	-7.57e-07*	-7.53e-07*
	(8.30e-08)	(8.79e-08)	(9.00e-08)	(1.13e-07)	(1.30e-07)	(1.36e-07)
Rf	-253.862***	-2.601.179***	-2.552.004***	-25.3862***	-26.01179**	-2552004***

	-1.386.514	-1.383.574	-1.416.916	1.182.482	-1.293.333	1.444.898
Caf	197.865***	2.158.239***	212.382***	19.7865***	21.58239**	212382***
	-1.114.572	-1.116.963	-1.139.189	9.037.527	9.969.182	1.096.074
T	7.68e-08*	5.70e-08**	5.67e-08**	7.68e-08*	5.70e-08*	5.67e-08*
	(2.10e-08)	(2.40e-08)	(2.46e-08)	(2.32e-08)	(2.09e-08)	(2.10e-08)
Y	2.37e-09**	1.77e-09***	1.84e-09***	2.37e-09**	1.77e-09***	1.84e-09***
	(9.30e-10)	(9.94e-10)	(1.03e-09)	(8.67e-10)	(9.51e-10)	(1.10e-09)
Atd	.0000382*	.0000382*	.0000382*	.0000382*	.0000382*	.0000382*
	(1.12e-06)	(1.12e-06)	(1.13e-06)	(3.82e-06)	(3.90e-06)	(3.93e-06)
Prof	-.0317098*	-.029772*	-.0291738*	-.0317098*	-.029772*	-.0291738*
	(.005764)	(.005865)	(.0060693)	(.0076729)	(.0079386)	(.0084402)
Lei	-.0443001*	-.0454235*	-.0456949*	-.0443001*	-.0454235*	-.0456949*
	(.0051945)	(.0052248)	(.0053055)	(.0047578)	(.0048421)	(.0048384)
Pop	.0001087*	.0001315*	.0001401*	.0001087*	.0001315*	.0001401*
	(.0000196)	(.0000238)	(.0000307)	(1.79e-05)	(1.76e-05)	(2.70e-05)
Dmsp*T		6.03e-16***	5.84e-16		6.03e-16***	5.84e-16
		(3.60e-16)	(3.77e-16)		(3.58e-16)	(3.79e-16)
DummyMun			-.2216312			-.2216312
			(.4910611)			(.6665061)
DummyH			-.1098634			-.1098634
			(.3451293)			(.3168053)
DummyT			-.0879896			-.0879896
			(.3742752)			(.293401)
DummyY			-.0008752			-.0008752
			(.3253586)			(.2610938)
R^2	0.800373	0.801912	0.802104	0.8003725	0.8019116	0.8021038
R^2 Ajuste.	0.795409	0.796424	0.794343	0.7954094	0.7964244	0.7943432
F-White	7.905612	8.133120	4.998215	-	-	-
P-White	0.000000	0.000000	0.000000	-	-	-
F-Breusch	-	-	-	6.516986	6.041492	4.473159
P-Breusch	-	-	-	0.000000	0.000000	0.000000
F-Ramsey	54.43860	57.29196	58.14458	54.43860	57.29196	58.14458
P-Ramsey	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Jq. Bera	00003687	00003815	00003927	00003687	00003815	00003927
Prob-JB	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Prob-F	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

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Note: *1%, **5% and ***10% of statistical significance.

The standardized estimation of public health productivity in the municipalities in the interior of Bahia (Equation 1) was carried out in order to identify the exogenous variable with the greatest capacity to explain the PoHS. The results reported in Table 5 point to Caf as the variable that offers the best explanation for the performance of the PoSP, given the magnitude of its coefficient. Therefore, it is assumed that municipalities with better self-financing capacity tend to improve the performance of health care services. This shows that not only municipal tax collection is important, but also the management of resources in the sense of making the municipal budget compatible with health expenditure as a whole is important for the efficiency of the municipal public health system. Furthermore, the municipalities in the sample concentrate primary health care services, which explains their greater dependence on the municipal budget. With the exception of Rf and Caf (5%), all the estimated coefficients were significant at 1% probability.

Table 5 - Standardized estimation of public health productivity in the municipalities of inland Bahia, by OLS

Variable	Standard Model	Variable	Standard Model
C	-1.883877 (1.270759)	Y- standard	5.86E-10* (2.15E-10)
Dmsp- standard	-1.75E-07* (2.75E-08)	Atd- standard	9.45E-06* (9.61E-07)
Rf- standard	-6.283712** (2.886003)	Prof- standard	-0.007849* (0.001851)
Caf- standard	4.897649** (2.146704)	Lei- standard	-0.010965* (0.001110)
T- standard	1.90E-08* (5.87E-09)	Pop- standard	2.69E-05* (4.57E-06)
R2	0.800373	R2 Adjusted	0.795409
F-Breusch	6.516986	P-Breusch	0.000000
F- Statistical	161.2642	Prob-F	0.000000

Note: *1%, **5% and ***10% statistical significance. Estimated using the robust method.

The GMM was adopted because it relaxes the hypothesis of heteroscedasticity and deals with possible problems of data inbreeding. Three estimations were carried out (Equation 1), using different instruments, with model 3 obtaining the best fit, with the statistical variables being significant at the 1% level. There was no change in signs compared to the OLS estimations. The negative signs of the Dmsp variable (ranging from -6.49 to 6.77) indicate that an increase in public health expenditure is associated with negative productivity. The same was true for the Rf variable (-29.34; -24.43; and, -25.27). This result indicates that the need to maintain proportionality between revenue and public spending is detrimental to the productivity of health care services, which is, in a way, related to the decentralization of the SUS, which places greater responsibility on municipalities, which is not accompanied by greater autonomy in terms of revenue collection.

The input variables Prof and Lei also showed a negative coefficient (average of 0.03 and 0.04, respectively). It can be inferred from this result that the availability of health professionals or hospital beds, when combined with the lack of advanced health care instruments, such as medium and high complexity diagnostic and treatment technology, results in inefficiency in the system, resulting in a reduction in the productivity of health care services. GDP also followed the same pattern, given the positive relationship between the Y and PdSP variables. On the other hand, the Atd variable showed a positive and significant relationship with the productivity of the municipal public health system in the interior of Bahia, indicating that access to services has a positive association with the productivity of the health system.

The Caf and T variables showed a positive sign and were statistically significant, confirming the argument that increasing budget capacity favors the system's productivity. This is because investments in related areas, such as education, are important for the health of residents. However, the population showed a small but positive relationship with the productivity of the health system. These results are in line with Fonseca and Ferreira (2009) and Gasparini and Ramos (2004) and Almeida and Gasparini (2011), as they point out that the federative dimension is important in determining productivity, as the regionalization of health services resulting from access to resources contributes to gains in scale in terms of the equipment available to the SUS.

Table 6 - Estimation of public health productivity in the municipalities of the interior of Bahia, by GMM

	Model 1	Model 2	Model 3
C	3.319.906*	3318655*	3321468*
	(0.201372)	(0.201326)	(0.189766)
Dmsp	-6.65E-07*	-6.77E-07*	-6.49E-07*
	(1.06E-07)	(9.92E-08)	(8.77E-08)
Rf	-29.34586*	-24.43252**	-25.27967*
	(-1125262)	(-1002541)	(-9188852)
Caf	21.60488**	17.42870**	18.01923*
	(-8562783)	(-7568144)	(-6822696)
T	7.37E-08*	7.24E-08*	6.89E-08*
	(2.34E-08)	(2.27E-08)	(2.16E-08)
Y	2.18E-09**	2.43E-09*	2.35E-09*
	(8.54E-10)	(8.24E-10)	(7.40E-10)

Atd	3.99E-05*	3.99E-05*	3.93E-05*
	(3.67E-06)	(3.66E-06)	(3.54E-06)
Prof	-0.033744*	-0.030584*	-0.031595*
	(0.007221)	(0.006906)	(0.005360)
Lei	-0.046033*	-0.044185*	-0.043925*
	(0.004282)	(0.004129)	(0.003968)
Pop	0.000112*	0.000102*	0.000104*
	(1.77E-05)	(1.66E-05)	(1.34E-05)
R^2	0.798627	0.798279	0.798914
R^2 Ajust.	0.793620	0.793264	0.793914
Hansen	0.398483	0.561183	0.845060
Instruments	12	16	20

Note: *1%, **5% and ***10% statistical significance. Instruments specified (1) Dmsp, Rf, Caf, T, Y, Atd, Prof, Lei, Pop, Dmspt1, Dmspt2; (2) Dmsp, Rf, Caf, T, Y, Atd, Prof, Lei, Pop, Dmspt1, Dmspt2, Lpob, Lurb, Le, Llix; (3) Dmsp, Rf, Caf, T, Y, Atd, Prof, Lei, Pop, Dmspt1, Dmspt2, Lpob, Lurb, Le, Llix, Dummyh, Dummymun, Dummyt, Dummyy.

The following sets of instruments were defined and specified as follows: Model 1: Dmsp, Rf, Caf, T, Y, Atd, Prof, Lei, Pop, Dmspt1, Dmspt2; Model 2: Dmsp, Rf, Caf, T, Y, Atd, Prof, Lei, Pop, Dmspt1, Dmspt2, Lpob, Lurb, Le, Llix; Model 3: Dmsp,Rf, Caf, T, Y, Atd, Prof, Lei, Pop, Dmspt1, Dmspt2, Lpob, Lurb, Le, Llix, Dummyh, Dummymun, Dummyt, Dummyy. The instruments were valid according to the Hansen test, with model 3 showing the best results. In both models, the variables were statistically significant, especially model 3, where all the coefficients were significant at the 1% probability level.

The coefficients of determination of the equations, R^2 and adjusted R^2, were close for both models estimated by GMM. This result reinforces that socioeconomic factors and control variables influence the productivity and efficiency of public health services, converging with the evidence reported by Gasparini and Ramos (2004) and Almeida and Gasparini (2011). Although similar, it is important to point out that the study carried out by these authors uses a different methodology, as it focuses on calculating relative efficiency, but whose evidence is similar to that found.

The omitted variable test indicates that only models 2 and 3 have jointly significant PoS. It was found that in both models the explanatory variables are not jointly insignificant, indicating that there are no redundant variables in the model specification. The results of both tests are reported in Table 7.

Table 7 - Test for omitted and redundant variables in the models estimated by GMM

Difference in J-statistics	Test					
	Omitted Variable*			Redundant Variable**		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3

Value	1.840.18	4.865.44	5.633.47	2.825.463	2.909.437	3.239.603
df	1	1	1	9	9	9
Probability	0.1749	0.0274	0.0176	0.0000	0.0000	0.0000

Note: *H0: PDS are not jointly significant **H0: DMSP RF CAF T Y ATD PROF LEI POP are jointly insignificant. Specified instruments: DMSP, RF, CAF, T, Y, ATD, PROF, LEI, POP, DMSPT1, DMSPT2.

The omitted variable test indicates that only models 2 and 3 have jointly significant PoS. In both models, the explanatory variables are jointly significant and there is no redundancy.

Conclusion

The aim of this article was to analyze the effect of public investment in low and medium-complexity health services on the productivity of the Unified Health System in municipalities of 50,000 inhabitants in the interior of Bahia. Econometric estimations were carried out using OLS and GMM in order to identify the effect of public health expenditure and the structure of care on municipal productivity in primary health care. The results indicate that public health expenditure did not have a positive effect on the productivity of health services in the municipalities studied, with a different sign than expected, which suggests that the increase in public expenditure on health is accompanied by an inefficient allocation of resources. This result is corroborated by the instrumentalization of health expenditure gaps. As these are small municipalities, it is understood that the supply of certain types of health care goods and services can generate inefficiencies of representative scale, given the cost disadvantages that municipal governments accumulate when there is an increase in the municipal primary health care structure beyond local demand.

Another explanation for this result is related to achieving universal and comprehensive public health care in Brazil. This is because many of the municipalities analyzed, due to their size and location, do not have a reasonable supply of medium-complexity health care facilities, whose "repressed demand" is displaced to more centralized municipalities. In the absence of inter-regional arrangements between these municipalities, the increase in demand for health goods and services in the receiving municipalities is not compensated proportionally. Therefore, even if there is an increase in budget spending on public health, this increase may prove insufficient to increase productivity.

The self-financing capacity of local governments showed a greater connection with the magnitude of municipal public health productivity, a result from which it can be inferred that the dynamics of municipal revenue allow for better conditions for implementing health policies, especially those focused on primary care. According to Constitutional Amendment 29 of 2000, the tripartite management of the SUS determines a minimum percentage for the investment of own resources in health. State governments must allocate at least 12% of their revenue to health, while municipalities must guarantee at least 15%. Therefore, it is reasonable to assume that the greater the municipal revenue capacity, the greater the ability of local governments to increase the budget allocated to the area. In line with other studies, this result suggests that the ability to self-finance can lead to gains in scale, due to the ability to offer more sophisticated health goods and services, in order to increase the efficiency of spending, explained by the relationship between public resources and the productivity of low and medium complexity.

Per capita income does not prove to be a relevant control for productivity, nor does the volume of government transfers which, although positive, reported very small coefficients, corroborating the literature. This can be explained by the fact that the municipalities analyzed have a high degree of income concentration, favored by agribusiness and the counterparts of constitutional transfers, which do not necessarily guarantee a greater allocation of resources for health services, as they are not their own revenues.

Despite these conclusions, some questions remain unanswered, such as the role that fiscal decentralization and state governments play in the productivity of public goods and services in municipal health care. Studies with a broader range of data should also be carried out, which was not possible in this study due to the lack of data on the public budget in some of the municipalities analyzed. State comparisons also constitute a relevant future agenda for study. It is believed that these results will be useful for policy management, planning and the regionalization of health goods and services.

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