LÍVIA ALADIM MATOSINHOS

ECONOMIC FLUCTUATION AND PUBLIC HEALTH FINANCING IN BRAZIL

Thesis submitted to the Administration Graduate Program of the Universidade Federal de Viçosa in partial fulfillment of the requirements for the degree of *Doctor Scientiae*.

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Co-advisers: Marcelo José Braga
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VIÇOSA - MINAS GERAIS
2022

Ficha catalográfica elaborada pela Biblioteca Central da Universidade Federal de Viçosa - Campus Viçosa

T
M433e
2022

Matosinhos, Lívia Aladim, 1990-
Economic Fluctuation and Public Health Financing in Brazil / Lívia Aladim Matosinhos. – Viçosa, MG, 2022.
1 tese eletrônica (77 f.): il. (algumas color.).

Texto em inglês.
Inclui apêndice.
Orientador: Marco Aurélio Marques Ferreira.
Tese (doutorado) - Universidade Federal de Viçosa, Departamento de Administração e Contabilidade, 2022.
Inclui bibliografia.
DOI: https://doi.org/10.47328/ufvbbt.2023.172
Modo de acesso: World Wide Web.

1. Saúde Pública – Finanças – Brasil. 2. Saúde pública – Administração – Brasil. 3. Ciclos econômicos. I. Ferreira, Marco Aurélio Marques, 1976-. II. Universidade Federal de Viçosa. Departamento de Administração e Contabilidade. Programa de Pós-Graduação em Administração. III. Título.

CDD 22. ed. 362.10981

Bibliotecário(a) responsável: Bruna Silva CRB-6/2552

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APPROVED: December 19, 2022.

Assent:

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Marco Aurélio Marques Ferreira
Adviser

ACKNOWLEDGEMENTS

To God.

To my mother, my husband, Cacau and Costelinha, for the daily support.

To my family, for providing relieving moments.

To the Federal University of Viçosa, PPGADM and IPPDS, for the opportunity to complete the postgraduate course.

To my adviser, co-advisers, professors, staff and colleagues, whose support and friendship were fundamental to complete this journey.

To the Stony Brook University, my host adviser and staff, for the amazing opportunity of conducting part of my research in a cutting-edge environment.

To Viçosa, for these 15 years of personal and professional learning and growth.

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

To the Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG), for granting the scholarship.

To the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), to granting the scholarship.

ABSTRACT

MATOSINHOS, Lívia Aladim, D.Sc., Universidade Federal de Viçosa, December, 2022. **Economic Fluctuation and Public Health Financing in Brazil**. Adviser: Marco Aurélio Marques Ferreira. Co-advisers: Marcelo José Braga and Mateus Pereira Lavorato.

The Brazilian public health system, officially known as Sistema Único de Saúde (SUS), has long been characterized by insufficient funding and irregular flow of resources. The system is jointly financed by the federal, state and municipal governments, but some imbalance is observed as tax revenue is concentrated at the federal level, while health services are mainly provided at the municipality level. The mismatch between financing capacity and the provision of public health services can influence the financial resilience of SUS in the face of external shocks, such as the economic recession that affected Brazil in 2015-2016. In this sense, the present study investigated the relationship between economic fluctuation and public health financing in Brazil. Specifically, three separate yet complementary articles were developed. In the first article, the scientific production on public health and the 2015-2016 economic recession in Brazil was systematically reviewed, revealing a possible gap in the literature due to the lack of applied studies focusing on the influence of the 2015-2016 economic recession on the financing of public health services in Brazil. In the second article, a trend analysis was carried out to evaluate the financial resilience of the SUS to the 2015-2016 economic recession and the results indicate that the crisis may have negatively influenced the evolution of public health financing in most of Brazilian municipalities. In the third and last article, the use of an instrumental variables approach provided evidence that public health financing is pro-cyclical in Brazil. Based on these findings, two main conclusions were made. First, the mismatch between tax revenue and service provision faced by municipalities gives extra importance to intergovernmental health transfers. Second, the pro-cyclical behavior of public health financing may hinder the construction of a financially resilient health system in Brazil.

Keywords: Economic Fluctuation. Public Health Financing. Brazil.

RESUMO

MATOSINHOS, Lívia Aladim, D.Sc., Universidade Federal de Viçosa, dezembro de 2022. **Economic Fluctuation and Public Health Financing in Brazil**. Orientador: Marco Aurélio Marques Ferreira. Coorientadores: Marcelo José Braga e Mateus Pereira Lavorato.

O sistema público de saúde brasileiro, conhecido como Sistema Único de Saúde (SUS) é, há muito, caracterizado pelo fluxo irregular de recursos usualmente escassos. O sistema é financiado conjuntamente pelos governos federal, estaduais e municipais, porém, alguns desequilíbrios são observados devido à concentração da receita tributária no governo federal enquanto os serviços são majoritariamente oferecidos em nível municipal. A incompatibilidade entre a capacidade de financiamento e a provisão de serviços públicos de saúde pode influenciar na resiliência financeira do SUS diante de choques externos, como a recessão econômica que afetou o Brasil em 2015-2016. Nesse sentido, o presente estudo investigou a relação entre flutuações econômicas e o financiamento da saúde pública no Brasil. Especificamente, três artigos foram desenvolvidos. No primeiro artigo, foi desenvolvida uma revisão sistemática sobre a produção científica focada na saúde pública e a recessão econômica de 2015-2016 no Brasil. O segundo artigo desenvolveu uma análise de tendência para a avaliação da resiliência financeira do SUS perante a recessão econômica de 2015-2016 e seus resultados indicaram que a crise possivelmente influenciou negativamente a evolução do financiamento da saúde pública na maior parte dos municípios brasileiros. No terceiro e último artigo, o uso de variáveis instrumentais forneceu evidências de que o financiamento da saúde pública possui um caráter pró-cíclico no Brasil. Baseado nessas descobertas, duas principais conclusões foram obtidas. Primeiramente, o descompasso entre receita tributária e a provisão de serviços enfrentado pelos municípios impõe maior importância às transferências intragovernamentais de saúde. Segundo, o comportamento pró-cíclico do financiamento da saúde pública pode impedir a consolidação de um sistema de saúde financeiramente resiliente no Brasil.

Palavras-chave: Flutuação Econômica. Financiamento Público da Saúde. Brasil.

SUMMARY

GENERAL INTRODUCTION

The access to public and free-of-charge health services is constitutionally guaranteed to each and every person in the Brazilian territory. Since the late 1980s, the country is governed based on the precepts established by the Constitution of the Federative Republic of Brazil, which was promulgated on 5 October, 1988, expanding civil liberties, as well as individual rights and guarantees. Among the reforms introduced by the supreme law, it is worth stressing the definition of health as a universal right and a state responsibility.

As stressed by Castro et al. (2019), the enactment of the 1988 Constitution is a milestone towards universal health coverage in Brazil due to the creation of a unified health system (Sistema Único de Saúde [SUS]). A major goal of SUS is to combat the unequal access to health services observed prior to its institution (Santos, 2018). Since SUS was designed in a federative context, both its management and financing follow a tripartite logic, i.e., competencies are shared between the three spheres of government: federal, state and municipal.

Despite the offer of free-of-charge health services by the public sector, the Brazilian health system is characterized by a public-private mix, in which private health insurance companies have a supplementary role, providing most of the health services already covered by SUS (Santos, Ugá and Porto, 2008). It is worth stressing, however, that most of the population of Brazil exclusively rely on public health services. In fact, only 22% of the Brazilian population were covered by some type of private health insurance in December 2019 (ANS, 2022).

In view of the large share of the population that depends solely and exclusively on public (and free-of-charge) health services, the importance of offering such services by the Government of Brazil is evident. It is noteworthy, however, that some factors still prevent the public sector from guaranteeing full and universal access to health in Brazil. For instance, the problems usually registered in SUS (e.g., the precariousness of healthcare) are exacerbated during economic crises like the one that affected Brazil between 2015-2016 (Watts, 2016).

From 2014 to 2016, there was a decrease of approximately 9% in the gross domestic product (GDP) per capita in Brazil, while the unemployment rate increased from 4.3% to 11.8% during this same period (Barbosa Filho, 2017). Concomitantly with the economic downturn and the consequent boom of the level of unemployment, real

wage decreased (it fell by 4.2% in 2015) and extreme poverty advanced (from 2.8% in 2014 to 3.4% in 2015) throughout the country (Skoufias, Nakamura and Gukovas, 2017).

In addition to the impoverishment of the population, the 2015-2016 economic recession led to a decrease in tax revenue and affected the government budget, thus harming the provision of benefits related to health and social welfare programs (Hone et al., 2019). In fact, Massuda et al. (2018) shows that, in contrast to the continuous growth in government health expenditures per capita observed from 2003 to 2014, this amount decreased by more than 6% for 2015 and 2016, thus exacerbating the historical underfunding and scarcity of SUS resources.

1. Research problem

In fact, the Brazilian public health system has long been characterized by insufficient funding and irregular flow of resources (Servo et al., 2011). In Brazil, the public health system is jointly financed by the three spheres of government, but service provision is highly decentralized, being mainly offered at the municipality level (Contarato, Lima and Leal, 2019). Nevertheless, it worth noting that the existing (vertical) fiscal imbalance gives a key role to top-down transfers in the financing of public health services (Barros and Piola, 2016).

In this sense, the complex financial/operational arrangement of the Brazilian public health system can be connected to the concept of health systems resilience. Such term refers to the ability of health systems to prepare for adverse shocks, to minimize their negative consequences and to adapt themselves based on the lessons learned during disruptive episodes (Kruk et al., 2015). Considering the heterogeneity of the shocks that can affect health systems, different aspects of resilience can be analyzed, among which the financial one deserves to be highlighted.

In a broader setting, financial resilience is described by Barbera et al. (2017) as the ability of governments to anticipate, absorb, and react to shocks that may adversely impact their finances over time. Specifically in the health systems context, Thomas et al. (2013) defines financial resilience as the preparedness of governments to protect healthcare financing in the occurrence of economic downturns, with emphasis on the funds devoted to the most vulnerable. Therefore, such definitions can be directly connected to the Brazilian reality.

According to Perelman, Felix and Santana (2015), there are two mechanisms through which economic downturns can affect public health services. First, there is the increase in the potential demand for free-of-charge services in response to the increase in the unemployment rate during periods of economic recession. The loss of income related to unemployment status often leads to a transfer of the demand for health services from private providers to the public sector, thus increasing the pressure on the public health system (WHO, 2009).

Secondly, there is the decrease in the financing capacity of the public health system caused by the decrease in tax revenue. The direct impact on public health spending, however, depends on the strategy adopted by governments in the face of economic recessions. In general, progressive governments tend to stimulate the economy during crises, whilst more conservative governments tend to adopt austerity measures (Stuckler and Basu, 2013). The relationship between public spending and economic fluctuation is known as the cyclicality of public spending.

In Brazil, as previously stated, public health services are jointly financed by the federal, state and municipal governments. Moreover, it is worth stressing that the resources destined to finance public health services in Brazil are, in general, legally earmarked. In fact, the Constitution defines an investment floor in public health financing as a percentage of government net current revenue. Nonetheless, rulers are still able to exercise certain influence on the public health budget according to their political preferences.

Considering the politico-institutional background of the Brazilian health system, one can say that the aforementioned theoretical concepts of health systems resilience and cyclicality of government spending are closely connected. In fact, despite the high rigidity of the public budget, government financial responses to economic downturns are expected to exercise some influence on its ability to develop and strengthen a resilient public health system capable of coping with the aforementioned adverse effects of economic recessions.

2. Objectives and hypotheses

Notwithstanding the relevance of the relationship between public health financing and economic fluctuation, applied studies on this theme are virtually non-existent in Brazil. This is true for both the cyclicality of public health spending and the

resilience of the Brazilian public health system. In view of this, the present study aims to investigate the relationship between public health financing and economic fluctuation in Brazil, with emphasis on the economic recession that severely impacted the Brazilian economy between 2015 and 2016.

Specifically, the present study raises two major hypotheses. First, it is assumed that the evolution of public health financing significantly changed in Brazil due to the 2015-2016 economic recession, with heterogenous effects throughout the country. Second, it is hypothesized that public health financing follows a pro-cyclical behavior in Brazil because of the existence of legal mechanisms that condition a major share of the public health budget to follow the direction of the economic fluctuation.

In order to test these hypotheses, this study is composed of three distinct but complimentary articles. Together, they will help in achieving the general objective of investigating the relationship between public health financing and economic fluctuation in Brazil. Separately, each article will help in attaining the following specific objectives: i) to systematically review the literature on the 2015-2016 recession and public health in Brazil; ii) to analyze the resilience of the Brazilian public health system; and iii) to estimate the cyclicality of health spending in Brazil.

Many are the contributions of this study. Mapping the scientific production on economic recession and public health in Brazil may help in indicating literature gaps, leading researchers to focus on under-studied topics. Investigating the financial resilience of the Brazilian public health system may contribute by providing evidence on how economic shocks are connected to changes on health financing. Estimating the impact of economic fluctuation on health financing may aid Brazilian policymakers with regard to the financial management of public health resources.

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ARTICLE 1

Public health and the 2015-2016 economic recession in Brazil:
A systematic review of the literature

Abstract: In the wake of the economic recession that hit Brazil in the mid-2010s and the measures adopted by the public sector in response to it, scholars started to analyze the interconnection between the economic recession and public health in the Brazilian context. As far as is known, however, no (quantitative) systematization of the literature on this topic has been done yet. With this in mind, this article systematically reviewed the documents published on the 2015-2016 economic recession and public health in Brazil. To do so, a quantitative synthesis and a qualitative analysis of the selected literature were carried out, considering articles retrieved from the Scopus and Web of Science databases. The quantitative synthesis was performed by means of a computerized bibliometric analysis, which used the R-package 'bibliometrix'. The qualitative analysis classified the articles investigated in terms of the methodological approach used, the thematic focus, the geographic scope and the relationship of each study with the 2015-2016 economic recession. Quantitative results showed that the scientific production on the topic is concentrated in the last year of analysis (2019), indicating a growing interest in the topic. Complementarily, the qualitative analysis provided evidence on possible gaps in the literature on public health and the 2015-2016 economic recession in Brazil, with the most important one being the lack of applied studies focusing on the financing of public health services. By filling the identified gap, scholars can provide key information to the public sector on the (adverse) effects of economic recession (and austerity measures) on a plethora of factors that are relevant to policymakers and public managers.

Keywords: Economic Recession. Public Health. Brazil. Systematic Literature Review.

Resumo: Na esteira da recessão econômica que atingiu o Brasil em meados da década de 2010 e das medidas adotadas pelo setor público em resposta a ela, estudiosos começaram a analisar a interligação entre a recessão econômica e a saúde pública no contexto brasileiro. Até onde se sabe, no entanto, nenhuma sistematização (quantitativa) da literatura sobre esse tema foi feita ainda. Pensando

nisso, este artigo revisou sistematicamente os artigos publicados sobre a recessão econômica de 2015-2016 e a saúde pública no Brasil. Para tanto, foram realizadas uma síntese quantitativa e uma análise qualitativa da literatura selecionada, considerando artigos extraídos das bases de dados Scopus e Web of Science. A síntese quantitativa foi realizada por meio de análise bibliométrica computadorizada, a qual utilizou o pacote 'bibliometrix' do software estatístico R. A análise qualitativa classificou os artigos investigados quanto a abordagem metodológica utilizada, o enfoque temático, a abrangência geográfica e a relação de cada estudo com a recessão econômica de 2015-2016. Os resultados quantitativos mostraram que a produção científica sobre o tema está concentrada no último ano de análise (2019), indicando um crescente interesse pelo tema. Complementarmente, a análise qualitativa forneceu evidências sobre possíveis lacunas na literatura sobre saúde pública e a recessão econômica de 2015-2016 no Brasil, sendo a mais importante a falta de estudos aplicados com foco no financiamento dos serviços públicos de saúde. Ao preencher a lacuna identificada, os acadêmicos podem fornecer informações importantes ao setor público sobre os efeitos (adversos) da recessão econômica (e das medidas de austeridade) em uma infinidade de fatores relevantes para os formuladores de políticas e gestores públicos.

Palavras-chave: Recessão Econômica. Saúde Pública. Brasil. Revisão Sistemática da Literatura.

1. Introduction

Episodes of economic recession pose a serious threat to public health. A general slowdown in economic activity leads to a rise in unemployment as well as a decline in fiscal capacity (OECD, 2009). Unemployment is associated with a worsening of population health and an increase in the demand for public health services, while the decrease in fiscal capacity often translates into the underfunding of the health system (Hou et al., 2013), since it affects both the mandatory and the discretionary

components of public spending[1]. In other words, both the population health and the health system are negatively affected by a period of economic recession.

The occurrence of adverse economic shocks often leads to the development of applied studies on economic recession and public health. In this context, the 2007-2008 global financial crisis stands out. In fact, there was a worldwide boom in the publication of articles on this topic in the aftermath of the global financial crisis (Margerison-Zilko et al., 2016). It is worth stressing, however, that the impact of the financial crisis was heterogenous around the globe, so that the cross-country distribution of scientific research may have focused on some specific regions.

In fact, as stressed by Acioly and Leão (2011), the pace and intensity with which each country was impacted varied significantly according to the characteristics of local economies and their connection with the global economy. The aforementioned authors also state that, similarly to others developing countries, Brazil recovered from the crisis relatively fast due to the capacity of the government of carrying out counter-cyclical policies, such as the increase of minimum wage, the expansion of credit and the grant of payroll tax exemption to several economic industries.

It is worth stressing, however, that the counter-cyclical measures cited above impacted the tax revenue of the Federal Government of Brazil, reducing the amount of intergovernmental fiscal transfers (Aquino and Cardoso, 2017). Ultimately, the successful strategy of recovery from the effects of the global financial crisis was only apparent, since a very particular combination of political and economic factors led the economy of Brazil to an economic recession starting from the mid-2014 (Tupy et al., 2021).

In the wake of the economic recession that hit Brazil in the mid-2010s and the measures adopted by the public sector in response to it, scholars started to analyze the interconnection between the economic recession and public health in the Brazilian context. As far as is known, however, no (quantitative) systematization of the literature on this topic has been done yet. Thus, this article aimed to systematically review the

[1] In Brazil, the access to public and free-of-charge health services is constitutionally guaranteed to each and every person in the national territory. In this context, the supply of public health services cannot be reduced on a discretionary basis. Thus, a lower tax capacity would lead to a decrease in the financing of the public health system and, consequently, a worsening in the quality of the services offered.

documents published on the 2015-2016 economic recession and public health in Brazil.

To this end, a quantitative synthesis and a qualitative analysis of the selected literature were carried out, considering articles retrieved from the Scopus and Web of Science databases. The quantitative synthesis was performed by means of a computerized bibliometric analysis, which used the R-package 'bibliometrix'. The qualitative analysis classified the articles investigated in terms of the methodological approach used, the thematic focus, the geographic scope and the relationship of each study with the 2015-2016 economic recession.

Presumably, this is the first attempt to systematically summarize the literature on economic recession and public health in Brazil via bibliometric analysis. This technique considers a set of mathematical and statistical methods to obtain objective and reliable information about the output of the scientific production on a topic (Fortuna et al., 2020). Some other authors from Brazil also conducted research on similar topics (e.g., Vieira, 2016; Schramm, Paes-Sousa and Mendes, 2018), but such studies focus more on the review of the international literature.

Providing evidence on the state of the art of the scientific research on economic recession and public health in Brazil is of great relevance. Mapping the scientific production on this subject may help in indicating possible gaps in the literature as researchers may favor some topics (e.g., population health) over others (e.g., health financing). Based on the findings of this article, future studies can be developed in order to fill the literature gaps that possibly exist, thus providing technical inputs to rulers and policymakers.

2. Methodology

The investigation followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Page et al, 2021). It was performed a computerized bibliometric analysis for articles retrieved from the Scopus and Web of Science (WoS) databases, two of the most reliable global citation databases. The stages of the systematic review are presented in Table 1. To identify the publications on economic recession and public health, the query performed on both databases accounted for the presence of several synonyms of public health and economic recession in titles, abstracts and keywords.

Table 1. Stages of the systematic review according to the PRISMA protocol

(1) Identification	Records identified through Scopus database searching TITLE-ABS-KEY(("health care" OR "health service" OR "health system" OR "public health") AND ("financial crisis" OR "economic crisis" OR "fiscal crisis" OR "economic recession") AND Brazil) (n = 124)	Records identified through Web of Science database searching TS=(("health care" OR "health service" OR "health system" OR "public health") AND ("financial crisis" OR "economic crisis" OR "fiscal crisis" OR "economic recession") AND Brazil) (n = 43)
(2) Selection	Records after filtering by publication date (2015:2019) and document type (article) (n = 26)	Records after filtering by publication date (2015:2019) and document type (article) (n = 19)
	Records after duplicates removed (n = 27)	
(3) Eligibility	Full-text articles assessed for eligibility (n = 27)	
	Full-text articles excluded for dealing with different topics (n = 9)	
	Studies included in the quantitative synthesis and qualitative analysis (n = 18)	

Source: Elaborated by the author based on Page et al. (2021).

The initial query identified 124 records on the Scopus database and 43 on the WoS database. These results thus went through a screening process, which defined the final sample used in both the quantitative synthesis and the qualitative analysis. Document type was limited to scientific articles as it is expected that the peer-review process may help in ensuring the quality of publications. Additionally, publication date was narrowed to the 2015-2019 period to account for publications on the 2015-2016

economic recession only, thus preventing publications related to the new coronavirus and the COVID-19 pandemic from dominating the investigated sample.

After the aforementioned actions, the number of publications from Scopus and WoS databases decreased to 26 and 19 documents, respectively. After removing duplicates, 27 articles were assessed for eligibility. Of the remaining articles, 9 were discarded since they dealt with topics different from the one addressed in the present study (public health and the 2015-2016 economic recession in Brazil). Ultimately, 18 articles were included in the quantitative synthesis and in the qualitative analysis.

The quantitative synthesis was performed via bibliometric analysis, which was operationalized with the software R (R Core Team, 2019). Specifically, the package 'bibliometrix' (Aria and Cuccurullo, 2017) was used, as it provides several tools for quantitative bibliographic research. The qualitative analysis, in turn, classified the articles investigated in terms of the methodological approach used, the thematic focus, the geographic scope and the relationship of each study with the 2015-2016 economic recession.

3. Results

3.1. Quantitative synthesis

The main quantitative information identified through the bibliometric analysis is presented in Table 2. As detailed in the Methodology section, the final sample comprises 18 articles, which come from 8 different sources (journals). Those articles showed an average citation of 17.72 and were written by 61 authors in total. The bulk of articles are multi-authored (97% of the sample) and there are slightly less than 3.4 authors per article. The number of documents per author is quite low, indicating that the literature on the topic is relatively disperse.

Table 2. Main information about bibliometric analysis

Description	Results
Documents	18
Sources (Journals)	8
Keywords	43

Period	2015 - 2019
Average citations per documents	17.72
Authors	61
Authors of single-authored documents	2
Authors of multi-authored documents	59
Documents per Author	0.30
Authors per Document	3.39

Source: Research results.

The temporal evolution of the scientific production on economic recession and public health in Brazil, considering the pre-specified time-frame, is depicted in Figure 1. The distribution of publications is highly concentrated in the year of 2019. In fact, two-thirds of the studies from the sample investigated were published in the last year of analysis. Such scenario, in which the bibliographic production is skewed right, may indicate that the literature considers not only the crisis alone but also the measures adopted in response to it.

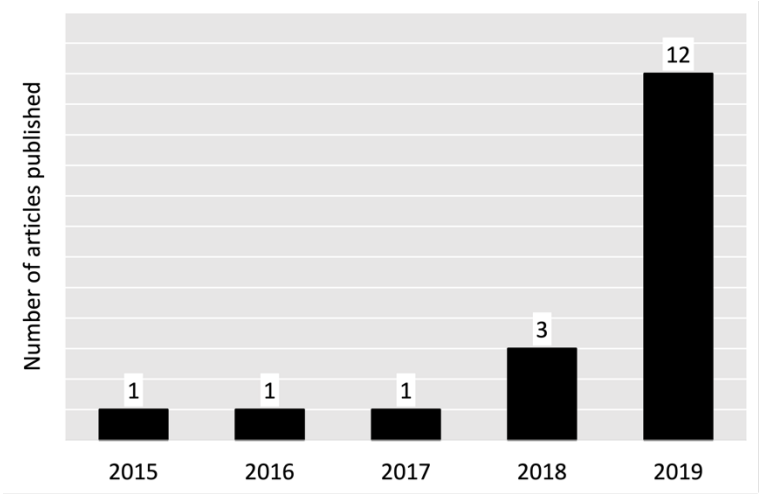

Figure 1. Temporal evolution of articles published, 2015-2019.
Source: Research results.

Table 3 presents the distribution of the articles sampled in terms of their sources, i.e., the journals in which each article was published. In this case, two points worth highlighting. First, the articles analyzed are highly concentrated in one journal, Ciência e Saúde Coletiva, as this source houses more than half of the sample. Second,

the aforementioned journal is the only one published in Brazil. The other seven sources identified are essentially international, what may indicate a certain difficulty in publishing country-specific studies in international outlets.

Table 3. Journals by scientific production, 2015-2019.

Sources	Articles
Ciência e Saúde Coletiva	10
International Journal of Health Services	2
BMJ Global Health	1
Global Public Health	1
Health Promotion International	1
PLOS Medicine	1
The Lancet	1
The Lancet Global Health	1

Source: Research results.

Relevant information is also presented in Table 4, in which the top-5 most cited articles are listed. Three of the five most cited articles were published in international journals, while the other two were published in the only Brazilian journal identified in the sample analyzed. It is worth stressing that, as will be detailed further in the qualitative analysis, the top-2 most cited articles are applied researches that employ statistical/econometric methods to forecast/estimate the impact of the 2015-2016 recession on mortality in Brazil.

Table 4. Top-5 most cited articles, 2015-2019.

Paper	TC	TC per Year
Rasella et al. (2018), PLOS Medicine	97	19,4
Hone et al. (2019), The Lancet Global Health	68	17
Santos and Vieira (2018), Ciência e Saúde Coletiva	27	5,4
Watts (2016), The Lancet	27	3,857
Paes-Sousa et al. (2019), Ciência e Saúde Coletiva	22	5,5

Note: TC denotes Total Citations. TC per Year considers the number of citations each article had until October 2022 (date the query search was performed).

Source: Research results.

The sample was analyzed in terms of authors' institutional affiliation as well. When considering the geographical distribution of the institutions the collaborating authors were working by the time of articles' publication, only four countries were identified: Brazil, the United Kingdom, Canada, and the United States (Table 5). As expected, Brazil concentrates the greatest number of authors (n = 48, 78.7%), followed by the United Kingdom (n = 7, 11.5%), Canada (n = 3, 4.9%) and the United States (n = 3, 4.9%).

Table 5. Geographical distribution of authors by the time articles' publication

Country	Authors	
	Number	Sample's share
Brazil	48	78.7%
United Kingdom	7	11.5%
Canada	3	4.9%
United States	3	4.9%
Total	61	100%

Source: Research results.

Among the universities and research institutions represented in the analyzed sample, the Oswaldo Cruz Foundation (Fiocruz) stands out as the one that houses the greatest number of authors, as can be seen in Table 6. Fiocruz is a public institution for research and development in biological sciences, being linked to Brazil's Ministry of Health. Although its headquarters are located in the city of Rio de Janeiro, the institution has several research units spread throughout the country.

Table 6. Top-5 institutions in terms of authors' affiliation by the time of articles' publication

Institution	Country	Authors	
		Number	Sample's share
Oswaldo Cruz Foundation (Fiocruz)	Brazil	22	36.1%
University of São Paulo (USP)	Brazil	7	11.5%

McGill University	Canada	3	4.9%
University of Campinas (Unicamp)	Brazil	3	4.9%
King's College London	United Kingdom	3	4.9%
Total		61	100%

Source: Research results.

Probably due to the decentralization of Fiocruz activities, there are, in the analyzed sample, authors who conduct their research activities in units other than the institution's headquarters (Rio de Janeiro). For instance, the analysis identified authors linked to the René Rachou Institute (Fiocruz Minas Gerais), the Gonçalo Moniz Institute (Fiocruz Bahia), and the Leônidas & Maria Deane Institute (Fiocruz Amazônia), which are located in different regions of the country: Southeast, Northeast and North, respectively.

Lastly, the most relevant keywords used in the articles analyzed are depicted in the word cloud below (Figure 2). The larger the word, the greater the number of times it was used as a keyword. Accordingly, the most relevant keywords within the analyzed sample are Brazil and crisis (n = 3 for each), followed by public health, health systems, health inequalities, austerity, oral health, health policy and primary health care (n = 2 for each of them). Thus, it is observed that these words are, in general, generic terms on the subject analyzed.

Figure 2. Word cloud of author's keywords.

Source: Research results.

As a complement to the analysis of the word cloud of authors' keywords, the temporal dynamics of the choice of the most frequently used keywords in the articles that make up the analyzed sample are also presented (Table 7). As with the time of articles' publication, most of the keywords were used in 2019 only. Considering the first years of analysis, it is evidenced that the initial focus of the studies was on health inequalities. Only in the last years of analysis that the focus seems to have shifted to the issue of health financing and austerity.

Table 7. Temporal dynamics of the top-10 authors' keywords

Keyword	Year				
	2015	2016	2017	2018	2019
Public policy	0	0	0	1	4
Brazil	1	0	0	0	2
Crisis	0	0	0	0	3
Healthcare financing	0	0	0	0	3
Austerity	0	0	0	1	1
Health inequalities	2	0	0	0	0
Health policy	0	0	0	0	2
Health systems	0	0	0	0	2
Oral health	0	0	0	0	2
Primary health care	0	0	0	0	2

Source: Research results.

3.2. Qualitative analysis

In qualitative terms, the 18 articles that make up the investigated sample (see Appendix) were classified according to the methodological approach used, the thematic focus, the geographic scope and the study's relationship with the 2015-2016 economic recession. In total, four distinct methodological approaches were identified: literature review, case study, descriptive study, and applied study. Most of the sample is composed of descriptive studies (n = 7; 38.9%). Of these, four are qualitative and three are quantitative. Following are the categories of applied studies (n = 4; 22.2%) and case studies (n = 4; 22.2%). Among the analyzed case studies, three are

qualitative and one is quantitative. Lastly, there are the literature reviews (n = 3; 16.7%).

Regarding the geographic scope of the studies, it is noteworthy that most of the sample focuses on Brazil as a whole (n = 11; 61.1%). Among the four case studies identified, three analyze the city of Rio de Janeiro, while one is a comparative case study between Brazil and England. The literature reviews rely on international studies to analyze possible scenarios for Brazil. When it comes to the relationship of sampled articles with the 2015-2016 economic recession, the vast majority of studies (n = 13; 72.2%) consider the (possible) impacts of the crisis on a diversity of factors. Applied studies, for example, analyzed the impact of the economic recession on the performance of health services, health status and mortality rate.

In terms of the thematic focus, the analyzed studies can be divided into three large groups. The first comprises articles whose analysis focus lies on the financing of public health services (n = 7; 38.9%). The second group, in turn, includes studies focusing on population health status (n = 6; 33.3%). Finally, the third group comprises articles aimed at analyzing the provision and performance of public health services (n = 5; 27.8%). Among the articles focusing on public health financing, there is no applied study. In fact, most studies that relate the 2015-2016 economic recession to public health financing in Brazil are descriptive (5 out of 7 studies). The other two studies focusing on health financing are a quantitative case study and a literature review.

Conducting qualitative descriptive analyses, Lima (2019) and Watts (2016) focus on the austerity measures implemented by the Government of Brazil in response to the 2015-2016 crisis. Watts (2016) points out that the crisis and the austerity measures exacerbated several problems usually observed in the Brazilian health system (SUS), such as the scarcity of resources (both human and financial), bureaucracy and infrastructure problems. Lima (2019), in turn, states that the austerity measures implemented in response to the crisis placed SUS in imminent danger, as it would be reversing the social gains previously achieved (since re-democratization).

Contarato et al. (2019), Rossi et al. (2019) and Padilha et al. (2019) conducted quantitative descriptive researches. Analyzing trends and regional patterns of health revenues and expenditures in Brazilian states between 2006 and 2016, Contarato et al. (2019) identified growth in net current income per capita, with declines in specific years of crisis (the global financial crisis in 2007-2008 and the Brazilian economic recession in 2015-2016). The authors also identified that, even in times of economic

crisis and decreased revenues, health expenditure per capita presented a growth trend during the analyzed timeframe.

Rossi et al. (2019), on the other hand, analyzed the effects of the economic crisis and the corresponding austerity measures specifically on the financing, provision and use of public oral health services in the period from 2003 to 2018. The authors observed that federal fund-to-fund transfers presented an increasing trend until 2010, showing some stability from then on. The offer of public oral health services, however, decreased during the investigated period.

Also working on the issue of health financing, but with a greater focus on the governance of the health system, Padilha et al. (2019) analyzed public data covering the period from 2014 to 2018. The results reveal a reduction in federal resources, specifically for regional healthcare networks; increased legislative and judicial interference in health resources, due to the evolution of parliamentary amendments and lawsuits; and changes in the SUS regionalization guidelines.

Still regarding the studies that focused on the financing of health services, the articles by O'Dwyer et al. (2019) and Santos and Vieira (2018) are highlighted. The former consists in a quantitative case study regarding the effects of the 2015-2016 crisis on revenues and expenditures, the provision of services, and health and performance indicators of the city of Rio de Janeiro. The authors identified that revenues and expenses were reduced, the provision of services shrank, bureaucracy increased, and, in general, health and performance indicators remained within the parameters previously reported.

The latter, in turn, analyzes the likely implications of the austerity policy implemented in Brazil on guaranteeing the right to health, with a focus on the financing of the Brazilian public health system (SUS). Santos and Vieira (2018) investigate the effects of the Brazilian austerity policy from an international perspective, based on evidence produced in different contexts, which were identified through a literature review. The authors indicate that the austerity measures implemented in the country are not universal, unequally affecting different groups of the society.

Analyzing the articles that focus on the relationship between the economic recession of 2015-2016 and the population health, it is clear that most applied studies fall in this group. In fact, three of the four applied studies that make up the sample analyzed in the present investigation evaluated the effects of the crisis on certain aspects of the health condition of the Brazilian population. Specifically, impacts on

health status and well-being (Sousa et al., 2019), adult mortality (Hone et al., 2019), and child morbidity and mortality (Rasella et al., 2018) are considered.

Using logistic regression models, Sousa et al. (2019) evaluated changes in health status and well-being before (2009-2013) and during (2015-2017) the political-financial crisis in Brazil and its association with the social determinants of health inequality. The results obtained indicate that there was a significant deterioration in well-being during the crisis, with a 29% decline in the prevalence of individuals who responded that they were thriving in life.

Based on a longitudinal analysis (regression model with panel data and fixed effects), Hone et al. (2019) evaluated the relationship between changes in the level of unemployment in Brazilian states and mortality among adults in the period from 2012 to 2017. The results indicate that the increase of 1 p.p. in the unemployment rate is associated with an increase of 0.50 deaths per 100,000 inhabitants per quarter, considering all causes of mortality. The authors also state, based on their estimates, that between 2012 and 2017, the higher level of unemployment observed was responsible for more than 30,000 excess deaths.

Rasella et al. (2018), on the other hand, developed and validated a microsimulation model to predict the economic crisis and the effects of austerity measures (reduction in the coverage of the Bolsa Família Program and the Family Health Strategy) on the mortality of children up to 5 years old. The authors identified that maintaining the levels of social protection provided by the PBF and the ESF would be associated with an infant mortality rate 8.5% lower in 2030 than in the expected scenario (maintenance of austerity measures). That is, austerity measures would be associated with the occurrence of approximately 19,700 additional deaths among children under 5 years of age.

4. Discussion

As the time period analyzed is relatively short, comprising the five years between 2015 and 2019, the number of articles that make up the analyzed sample is also relatively small. In fact, if the number of articles analyzed is divided by the number of years considered, is it observed an average production of less than four articles per year on the topic of interest. It should be noted, however, that two-thirds of the articles analyzed were published in 2019 only.

The temporal concentration of publications in the last year of analysis, identified through bibliometric analysis, raised the hypothesis that such a scenario would be associated with the analysis not only of the crisis itself, but also of the (austerity) measures implemented by the government in response to it. This assumption was confirmed through qualitative analysis, which showed that most of the articles studied in fact take into account in their analysis the responses of the Brazilian Government to the adverse effects of the economic recession.

Another relevant point highlighted in the quantitative synthesis concerns the concentration of articles that make up the sample analyzed in a specific journal: *Ciência e Saúde Coletiva* (Science and Public Health). This journal, edited by the Brazilian Association of Collective Health (Abrasco), stands out for its interdisciplinarity around the general theme of public health, comprising topics such as primary health care, evaluation of health services, epidemiology, information and communication in health, health policies, health planning, health management, among others.

The fact that the journal *Ciência e Saúde Coletiva* covers several topics may explain the concentration of articles in this outlet. On the other hand, however, this concentration on the only journal of the analyzed sample that is edited by a Brazilian institution may indicate a relative difficulty in publishing studies on the subject in international journals, which, in general, have a greater impact factor and greater reverberation in the academy and in the formulation/management of public policies.

A more detailed analysis of the articles that make up the investigated sample makes it possible to explain the concentration of studies in terms of publication journal (*Ciência & Saúde Coletiva*) and the time of publication (2019). In that year, the aforementioned journal launched a special issue (v. 24, n. 12), whose theme was "*The Crisis and Health: Implications for Policy, Management and Care*". In fact, exactly half of the articles analyzed in the present study were published in this thematic issue.

Regarding the most relevant articles, a clear trend is identified. First, the two most cited articles were published in high-impact international journals, which may be associated with the higher volume of citations in these studies. Second, as detailed in the qualitative analysis, these two articles are essentially epidemiological in nature, in which quantitative methodologies are used to measure the effects of the economic recession on mortality (adult and infant) in Brazil.

5. Final remarks

The present study systematically reviewed the literature on public health and the 2015-2016 economic recession that plagued the Brazilian economy. Following the PRISMA guidelines, a sample of 18 peer-reviewed articles was constructed, which was later screened and analyzed both in quantitative and qualitative terms. The quantitative synthesis, carried out using bibliometric tools, showed that the scientific production on the topic is concentrated in the last year of analysis (2019), indicating a growing interest in the topic.

In fact, the qualitative analysis provided evidence on possible gaps in the literature on public health and the 2015-2016 economic recession in Brazil. Perhaps, the most important one is the lack of applied studies focusing on the financing of public health services. The fact that no applied investigation on the relationship of the economic recession and the financing of the Brazilian public health system is astonishing since the access to health services by the population is constitutionally guaranteed in Brazil.

Nevertheless, descriptive studies from the analyzed sample indicate that the 2015-2016 economic recession is negatively related to public health financing. Furthermore, the applied studies, which focus mainly on epidemiology issues, provide evidence that corroborate the negative impact of the economic recession to the health status of the population. This fact reinforces the need of filling the existing literature gap as the financing of public health services may be seen as a mechanism for the impact of the recession on health status.

This is especially relevant in the context of Brazil since most of the population can only access health services that are freely provided by the public sector. Therefore, public resources devoted to the provision of health services may be interpreted as inputs used in a production function. Agents like policymakers and public health managers would then use such production function to achieve the desired outcome, which is the general improvement of the health status of the population.

Ultimately, the findings of this study are important both to scholars and to policymakers and public managers. By filling the existing gap in the literature, scholars can provide key information to the public sector on the (adverse) effects of economic recession (and austerity measures) on a plethora of factors that are relevant to policymakers and public managers. For instance, results from applied researches on

the economic fluctuation-public health relationship may provide technical subsidies against (or not) the use of austerity measures.

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APPENDIX 1A

Table 1A. Characterization of the studies analyzed.

Article	Methodological approach	Geographic scope	Thematic focus
Agostini et al. (2019)	Descriptive study (qualitative)	Brazil	Health services
Contarato et al. (2019)	Descriptive study (quantitative)	Brazil	Financing
Duncan et al. (2015)	Case study (qualitative)	Brazil/England	Health services
Gómez et al. (2018)	Descriptive study (qualitative)	Brazil	Population health
Hone et al. (2019)	Applied study (fixed effects)	Brazil	Population health
Krawczyk et al. (2017)	Case study (qualitative)	Rio de Janeiro	Health services
Lima (2019)	Descriptive study (qualitative)	Brazil	Financing
Martins et al. (2019)	Applied study (statistical process control)	Brazil	Health services
Melo et al. (2019)	Case study (qualitative)	Brazil	Health services
O'Dwyer et al. (2019)	Case study (quantitative)	Rio de Janeiro	Financing
Padilha et al. (2019)	Descriptive study (quantitative)	Brazil	Financing
Paes-Sousa et al. (2019)	Literature review	International	Population health
Probst et al. (2019)	Literature review	International	Population health

Rasella et al. (2018)	Applied study (microsimulation)	Brazil	Population health
Rossi et al. (2019)	Descriptive study (quantitative)	Brazil	Financing
Santos and Vieira (2018)	Literature review	International	Financing
Sousa et al. (2019)	Applied study (logistic regression)	Brazil	Population health
Watts (2016)	Descriptive study (qualitative)	Brazil	Financing

Source: Research results.

ARTICLE 2

Financial resilience of public health systems: The case of Brazilian municipalities

Abstract: Financial resilience refers to the ability of governments to anticipate, absorb, and react to shocks that may impact their finances over time. In the public health context, financial resilience corresponds to the ability of health systems to protect the funds for health care in the face of economic downturns. In the mid-2010, the Brazilian public health system was exposed to a severe economic recession that compromised public revenue throughout the country. With this in mind, the present study investigated if the Brazilian public health system is financially resilient to economic shocks. To this end, a trend analysis was conducted. Considering that public health services are mainly provided by local governments in Brazil, municipalities were taken as the units of analysis and three time series were constructed for each of them (2000-2014, 2000-2016, and 2000-2019). Specifically, the analysis applied a multi-step approach. First, the Mann-Kendall test was performed for each municipality of Brazil in order to identify if trends do exist. Then, the Theil-Sen estimator was used to obtain the magnitude of existing trends. After that, trend differences were calculated for each municipality. Finally, the Wilcoxon signed-rank test was applied to test if the difference in medians was statistically significant. The results obtained show that the 2015-2016 recession may have negatively influenced the evolution of public health financing in most of Brazilian municipalities as approximately 20-25% of the analyzed locations proved to be financially resilient. Considering the composition of public health financing, the results led to the conclusion that intergovernmental health transfers seem to be more resilient to the economic shock originated by the 2015-2016 recession than municipal health resources.

Keywords: Financial Resilience. Public Health System. Brazil. Trend Analysis.

Resumo: A resiliência financeira diz respeito à capacidade dos governos de antecipar, absorver e reagir a choques que possam impactar suas finanças ao longo do tempo. No contexto da saúde pública, a resiliência financeira corresponde à capacidade dos sistemas de saúde de proteger os fundos de saúde frente a recessões econômicas. Em meados da década de 2010, o sistema público de saúde brasileiro foi exposto a

uma grave recessão econômica que comprometeu as receitas públicas por todo o país. Pensando nisso, o presente estudo investigou se o sistema público de saúde brasileiro é financeiramente resiliente a choques econômicos. Para tanto, foi realizada uma análise de tendências. Considerando que no Brasil os serviços públicos de saúde são prestados principalmente por governos locais, os municípios foram tomados como unidades de análise e três séries temporais foram construídas para cada um deles (2000-2014, 2000-2016 e 2000-2019). Especificamente, a análise aplicou uma abordagem de múltiplas etapas. Primeiramente, o teste de Mann-Kendall foi aplicado em cada município para identificar a existência de tendências. Em seguida, o estimador de Theil-Sen foi utilizado para obter a magnitude das tendências existentes. Depois disso, as diferenças de tendência foram calculadas para cada município. Por fim, o teste de Wilcoxon foi aplicado para testar se a diferença nas medianas era estatisticamente significativa. Os resultados obtidos mostram que a recessão de 2015-2016 pode ter influenciado negativamente a evolução do financiamento público da saúde na maioria dos municípios brasileiros, tendo em vista que cerca de 20-25% das localidades analisadas foram consideradas financeiramente resilientes. Considerando a composição do financiamento público da saúde, os resultados levaram à conclusão de que as transferências intergovernamentais de saúde parecem ser mais resistentes ao choque econômico originado pela recessão de 2015-2016 do que os recursos municipais de saúde.

Palavras-chave: Resiliência Financeira. Sistema Público de Saúde. Brasil. Análise de Tendência.

1. Introduction

Resilience is broadly defined as the ability to succeed after facing some difficulty (Miller and Brown, 2003). However, since it started to be adopted by academics as a research construct, the term has been adapted to different research topics. Frequently used in areas like ecology, engineering and psychology to analyze the recovery capacity of systems towards external stress (Barasa, Cloete and Gilson, 2017), resilience is still considered as a relatively new topic in the analysis of health systems (Kruk et al., 2017).

From the time of its adoption by global health scholars, the resilience construct has been improved and evolved. In fact, researchers have been focusing on evaluating the vulnerabilities of health systems as well as suggesting approaches to mitigate them. The provision of health services—in addition to the daily challenges faced for the maintenance of such services—is exposed to external stress events and extreme challenges, which are broadly defined as shocks (Hanefeld et al., 2018).

The shocks that can hit health systems are diverse and resulting from multiple factors. They can be related to disease outbreaks as the Ebola virus disease in Africa (Barker et al., 2020; Kruk et al., 2015; Ling et al., 2017), economic crises (Russo et al., 2017; Thomas et al., 2013), and climate change (Ebi et al., 2018; Hess, McDowell and Luber, 2012; Ridde et al., 2019). Moreover, early evidence of the responses of health systems to the COVID-19 pandemic, considering the perspective of resilience, have been released (Haldane et al., 2021; Massuda et al., 2021).

As a relatively new topic of research, the resilience of health systems still has a very broad definition (Turenne et al., 2019). In fact, the concept of resilience is usually adapted to different situations as required. Kruk et al. (2015) define health system resilience as “the capacity of health actors, institutions, and populations to prepare for and effectively respond to crises; maintain core functions when a crisis hits; and, informed by lessons learned during the crisis, reorganize if conditions require it”.

Gilson et al. (2017) stress that the idea of resilience in the context of health systems must go beyond the response to eventual shocks, considering, in turn, the multiple challenges regularly faced by systems. Following these viewpoint, Barasa, Cloete and Gilson (2017) present the notion of everyday resilience. For these authors, health system resilience cannot be resumed to the capacity of bouncing back from shocks since resilience incorporates absorptive, adaptive and transformative strategies.

Considering the heterogeneity of shocks nature, the local contexts and the ways health systems function, resilience can be analyzed by different perspectives. Notably, the main pillars for resilience analysis comprehend the building blocks of health systems[2]: service delivery; health workforce; health information systems; access to

[2] Regarding the health system strengthening agenda, a health systems framework was formulated by the WHO describing health systems in terms of six building blocks. It’s believed that improving those building blocks and managing the interaction between them must strengthen and improve health systems.

essential medicines; financing; and leadership/governance (WHO, 2010). The use of these blocks to analyze the outcomes and impacts of shocks provides lessons on strategic responses and possible resilience achievements.

Focusing on the financial building block, it is worth highlighting the definition proposed by Thomas et al. (2013) on the financial resilience of health systems, as the authors characterize it as “the protection of funds for health care, and particularly that of the vulnerable, in the face of economic contraction”. In fact, considering a broader context, Barbera et al. (2017) describes financial resilience as the ability of governments to anticipate, absorb, and react to shocks that may impact their finances over time.

In the wake of the developments of the global financial crisis and following the description presented by Barbera et al. (2017), some scholars started to investigate in depth the notion of governmental financial resilience (e.g., Steccolini, Jones and Saliterer, 2017; Barbera, Guarini and Steccolini, 2020; Barbera et al., 2021; Saliterer et al., 2021; Coyle and Ferry, 2022). In general, emphasis has been given to local governments due to their greater vulnerability to external shocks. It is noteworthy, however, that such studies primarily focus on the financial resilience of the government as a whole and not on a specific and important area such as public health.

For countries like Brazil, where the access to healthcare is a fundamental right, the perspectives of Thomas et al. (2013) and Barbera et al. (2017) are essentially tied. In fact, the Brazilian current Constitution defines that the public health system (SUS) must guarantee integral, universal and free-of-charge access to healthcare for all citizens. As the poor and most vulnerable usually rely exclusively on public services (World Bank, 2009), a financially resilient health system would guarantee the provision of health services even in the event of external shocks.

Along with the basic principles and the guidelines of SUS, the Constitution also defines the way public health services are funded in Brazil. In specific terms, the supreme law introduced the notion of tripartite funding of public health services, which is intrinsically linked to the idea of fiscal federalism. From the enactment of the Constitution in 1988 onwards, public healthcare started to be jointly funded by the Federal Government, the Federal District, states and municipalities.

On the one hand, it is up to the Federal Government, the Federal District, and the states to concurrently legislate on healthcare. On the other hand, the bulk of public health services are provided to citizens by local governments – with technical and

financial cooperation from its respective state and the Federal Government. Such structure, characterized by shared management and local service provision, seeks to maximize efficiency in resource use.

The manner in which public health is funded and operationalized in Brazil may be connected to the theoretical background of fiscal federalism, especially the notion of fiscal imbalance, which arises as the fiscal capacity is concentrated on the federal government, whilst service provision is concentrated on local governments due to decentralization (Duarte et al., 2009). Recognizing the existence of both vertical and horizontal imbalance, fund-to-fund transfers can be seen as a strategy aimed at combating vertical fiscal gaps between different levels of governments as well as the heterogeneity observed across governments within the same level.

The regulation on resources allocation to healthcare was ratified by the Constitutional Amendment N. 29. It defines the floor for the funding of public health services by states and municipalities at 12% and 15% of their net current revenue, respectively. However, no similar regulation was instated for the Federal Government within the scope of this Amendment (Campelli and Calvo, 2007), thus favoring the discretionary use of resources and the prevalence of political arrangements as coalition presidentialism has prevailed in Brazil since the 1980s.

As a consequence of the initial failure in establishing a floor for the funding of public health services by the Federal Government, there was a substantial growth in the participation of states and municipalities in the total funding of public health services in Brazil. The mismatch between the fiscal capacity and legal responsibilities within the scope of SUS put subnational governments in a position of great economic and financial vulnerability.

The problems that have long plaguing the Brazilian health system are worsened by economic shocks like the 2015-2016 recession (Watts, 2016). However, given the way this system is structured, the effect of adverse events may vary at the local level. As previously defined, resilient health systems are less vulnerable to external shocks. Therefore, considering that SUS is composed of several local health systems, resilience may vary as well.

With this in mind, the present study sought to answer the following question: *Is the Brazilian public health system resilient, at the municipality level, to economic shocks?* Thus, two hypotheses were initially raised. First, it was assumed that there was a change in the evolution of public health funding due to the 2015-2016 recession

that affected the Brazilian economy. Second, it was expected that these changes varied among municipalities.

In order to answer the research question, a trend analysis was conducted. According to Helsel et al. (2020), trend analysis can be succinctly defined as the process of modeling the behavior of a given variable over time. Such analysis can be conducted when it is known that some event may influence the central tendency of the variable of interest and/or when time-series are available for different locations and comparing them is an objective.

Taking Brazilian municipalities as the unit of analysis, three time series were constructed for each location. Initially, it was considered the pre-recession period, with the series covering the 2000-2014 years. Posteriorly, two complementary series were built from the addition of new time periods to the initial series. The recession and post-recession periods were added, leading to the 2000-2016 and 2000-2019 series.

The present study relied on a multi-step approach. First, the Mann-Kendall test was performed for each municipality of Brazil in order to identify if trends do exist. Then, the Theil-Sen estimator was used to obtain the magnitude of existing trends. After that, trend differences were calculated for each municipality. Finally, the Wilcoxon signed-rank test was applied to test if the difference in medians was statistically significant.

Investigating the financial resilience of the Brazilian health system to the 2015-2016 recession contributes to the literature by providing a piece of evidence on how economic shocks can be connected to spatial and temporal changes in healthcare funding. As stated by Hanefeld et al. (2018), learning from adverse shocks during the recent past provides important insights and opportunities for understanding how to make health systems more resilient.

In fact, as states by Steccolini, Jones and Saliterer (2017), looking to the recent economic volatility through the conceptual lens of resilience is of great importance for connecting researches focused on the financial responses of governments with researches focused on the role of management capacities in facing and absorbing adverse shocks. The relevance of governmental financial resilience studies is even more important in a context of rising unemployment, continuously changing policies and scarcity of resources.

2. Methodology

In this study, trend analysis was applied to investigate the financial resilience of the Brazilian public health system to the 2015-2016 economic recession. Trends were detected using the Mann-Kendall test (Mann, 1945; Kendall, 1955) and their magnitudes were obtained by the Theil-Sen estimator (Theil, 1950; Sen, 1968). Considering the Wilcoxon signed-rank test (Wilcoxon, 1945), it was investigated if municipal pre-recession (2000-2014) trends in public health financing statistically changed when recession (2015-2016) and post-recession (2017-2019) periods were added.

2.1. Mann-Kendall test

The Mann-Kendall test is based on the sign difference between the combinations of successive data measurements (Şen, 2017). The test statistic S is given by

$$S = \sum_{i<j} \operatorname{sgn}(x_j - x_i), \tag{1}$$

where x_i and x_j denote the value of the variable of interest for the successive years of i and j, respectively. The sign function works as follows

$$\operatorname{sgn}(x_j - x_i) = \begin{cases} +1 \text{ if } x_j > x_i \\ 0 \text{ if } x_j = x_i \\ -1 \text{ if } x_j < x_i \end{cases}. \tag{2}$$

As shown, the S statistic is computed as a sum of integer values. A positive value of S indicates the existence of a positive trend, while a negative value provides evidence of a negative trend. The statistical significance of the trend is tested by comparing the standardized test statistic $Z_{MK} = S/\sqrt{V(S)}$ with the standard normal variate $Z_{\alpha/2}$ (Hamed and Rao, 1998). When the level of significance is set at 5%, for example, the null hypothesis of no trend is rejected if $|Z_{MK}| > 1.96$.

2.2. Theil-Sen estimator

The Theil-Sen estimator is based on the calculation of slopes for all possible pairs of time series data points (Helsel et al., 2020). For each of these pairwise comparisons, a slope b is computed as

$$b = \frac{x_k - x_i}{k - i} \text{ for } k > i, \tag{3}$$

where x_i and x_k denote the value of the variable of interest for the years of i and k, respectivelly.

For a series with n time periods, a total of $N = n(n-1)/2$ slopes are computed. The trend magnitude calculated using the Theil-Sen estimator corresponds to the median of all these slopes. When the median of b is positive (negative), there is an increasing (decreasing) trend. In the case of no trend, a given value of the variable of interest has the same chance to be greater or smaller than another given value, and, consequently, the median value approximates zero (Şen, 2017).

2.3. Wilcoxon signed-rank test

The Wilcoxon signed-rank test is a non-parametric alternative to the paired *t*-test, being appropriate when differences are non-normally distributed (McDonald, 2014). It tests the null hypothesis that a random variable $D = X_1 - X_2$ has median zero. If X_1 and X_2 have the same distribution, then the distribution of D is symmetric about zero. Therefore, the Wilcoxon signed-rank test is also described as a test of the hypothesis that two distributions are the same, i.e., $H_0: X_1 \sim X_2$ (StataCorp, 2021).

As detailed by Sprent and Smeeton (2007), the Wilcoxon signed-rank test works as follows. First, each paired difference $d_i = x_i - y_i$ is calculated. Second, absolute values of paired differences are ranked in ascending order. Third, each rank is labeled with the sign of its original paired difference. Forth, the sum of positive ranks and the sum of negative ranks are calculated. Fifth, the smallest of these sums is taken as the test statistic. Sixth, significance is assessed by using tables of critical values for the Wilcoxon sign-ranked test.

2.4. Empirical implementation

The analysis was conducted using the statistical software R (R Core Team, 2020). Both the Mann-Kendall test and the Theil-Sen estimator were implemented with the package 'modifiedmk' (Patakamuri and O'Brien, 2020). In order to address autocorrelation issues, the Mann-Kendall test was executed considering the Yue and Wang (2004) variance correction approach. The Wilcoxon signed-rank test, in turn, was implemented with the 'wilcox.test' function of the built-in package 'stats' (R Core Team, 2020).

2.5. Data

The data used in this article were gathered from the website of the Health System Performance Assessment Project (PROADESS, *Projeto de Avaliação do Desempenho do Sistema de Saúde in portuguese*). Annual data on the financing of public health services were collected for 5,569 Brazilian municipalities[3], considering the period between 2000 and 2019. The lower bound of the interval is due to data availability, while the upper bound was imposed in order to avoid the influence of the COVID-19 pandemic on the results.

Specifically, data on public health financing comprise municipalities' own financial resources devoted to healthcare and intergovernmental financial transfers made under the SUS. The main variable of interest – public health municipal financing – was obtained by summing the aforementioned variables at the municipality level. All variables are expressed in per capita terms and were deflated using the Extended National Consumer Price Index (IPCA), being exhibited in 2019 values.

Table 1 presents some descriptive statistics – mean and standard deviation – for the variables used in the present study. It is evidenced that, on average, municipalities' own resources account for a larger share of public health financing than intergovernmental transfers. This is true irrespective of the year considered. For both municipalities' own resources and intergovernmental transfer – and, consequently, for

[3] Officially, Brazil has 5,570 municipalities, with Brasília (national capital) being classified as one of them. For financing purposes, however, Brasília – and the Federal District as a whole – has a different classification and, therefore, follows a distinct financing rule. In this sense, Brasília was not considered in the analysis.

public health financing – it is also detected a break (2015) on what seems to be an upward trend.

Table 1. Descriptive statistics

Year	Municipalities' own resources		Intergovernmental transfers		Public health municipal financing	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
2000	166.38	135.08	102.58	72.26	268.96	154.45
2001	190.11	141.18	111.55	69.35	301.65	159.93
2002	222.71	163.03	117.85	103.70	340.56	218.13
2003	240.60	166.36	110.99	66.55	351.59	184.61
2004	258.43	184.67	130.73	73.95	389.16	205.44
2005	297.50	194.18	142.11	75.34	439.61	213.02
2006	334.60	219.73	167.04	88.25	501.64	245.70
2007	359.42	227.23	169.71	84.58	529.14	244.63
2008	404.36	249.31	187.57	91.99	591.93	268.73
2009	392.84	242.69	199.95	95.88	592.79	259.53
2010	419.58	263.56	215.53	101.87	635.11	279.77
2011	460.31	281.79	232.21	107.82	692.53	297.52
2012	481.76	307.23	272.36	119.04	754.12	333.70
2013	501.91	310.50	271.87	124.00	773.78	344.72
2014	528.63	330.07	291.88	131.15	820.51	365.76
2015	496.89	303.77	263.96	122.72	760.86	331.09
2016	501.30	305.05	305.93	134.13	807.23	349.41
2017	517.64	310.58	297.78	137.36	815.41	355.15
2018	509.55	311.26	380.90	179.70	890.45	391.14
2019	538.80	332.50	351.42	167.75	890.22	389.93

Source: Research results.

3. Results

The results of the Mann-Kendall test are presented in Figure 1. Municipalities colored in gray are those with insufficient data for the period under analysis. Out of the 5,569 municipalities available for investigation, 473 were disregarded, comprising

roughly 8.5% of the initial sample. Visual inspection suggests that most of these municipalities are in the North and Northeast regions of Brazil. Indeed, northern and northeastern Brazil account for 115 (24.3%) and 227 (48%) of excluded municipalities, respectively.

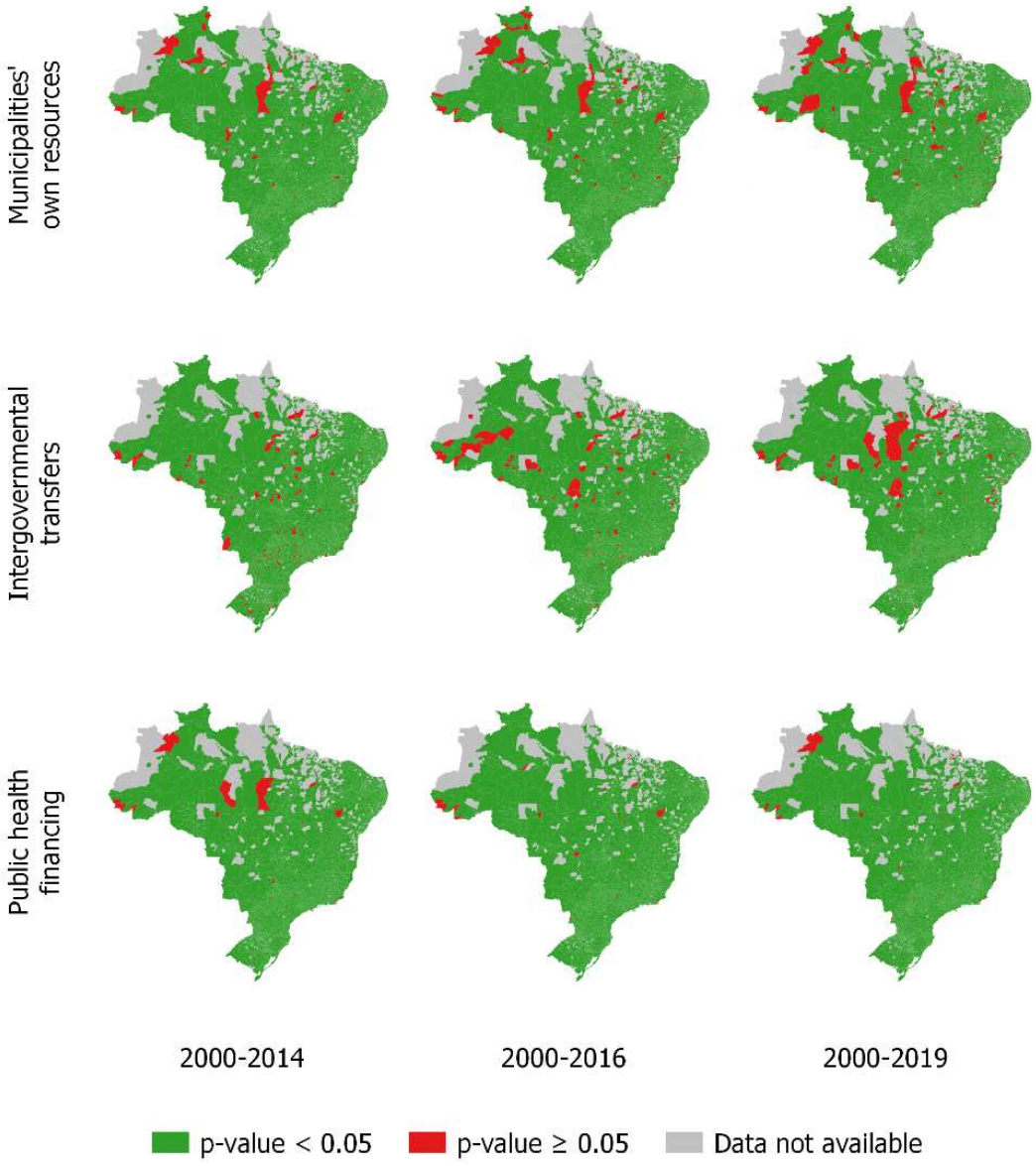

Figure 1. Results of the Mann-Kendall test for trend identification in public health municipal financing, Brazil.

Source: Elaborated by the author based on research results.

Statistically significant[4] trends were found for most of the municipalities with complete information for the period studied. As the visual inspection of Figure 1 suggests, the number of municipalities for which trends were detected using the Mann-Kendall test tends to vary according to the variable analyzed as well as the timeframe considered. For municipalities' own financial resources devoted to healthcare, for example, the number of statistically significant local trends seems to decrease as more years are included.

In specific, the proportion of municipalities for which the Mann-Kendall test detected statistically significant trends is as follows. For municipalities' own resources, it is 98.7% for the 2000-2014 timeframe, 98.2% for 2000-2016, and 97.8% for 2000-2019. For intergovernmental transfers, in turn, the share is 97% for 2000-2014 interval, 97.5% for 2000-2016, and 98.1% for 2000-2019. Lastly, for public health municipal financing, the percentage is practically constant around 99.4%.

Having found the municipalities for which trends do exist, the next step involved analyzing trends magnitude. To this end, Figure 2 depicts the results of the Theil-Sen estimator. First, it is worth highlighting the fact that positive trends were estimated for virtually all studied municipalities. This is true irrespective of the variable analyzed and the timeframe considered. Intergovernmental transfers presented more negative local trends than municipalities' own resources, even though the proportion do not even reach 0.5% of the sample.

[4] As a matter of parsimony, the statistical significance of the Mann-Kendall test was set at the 5% level.

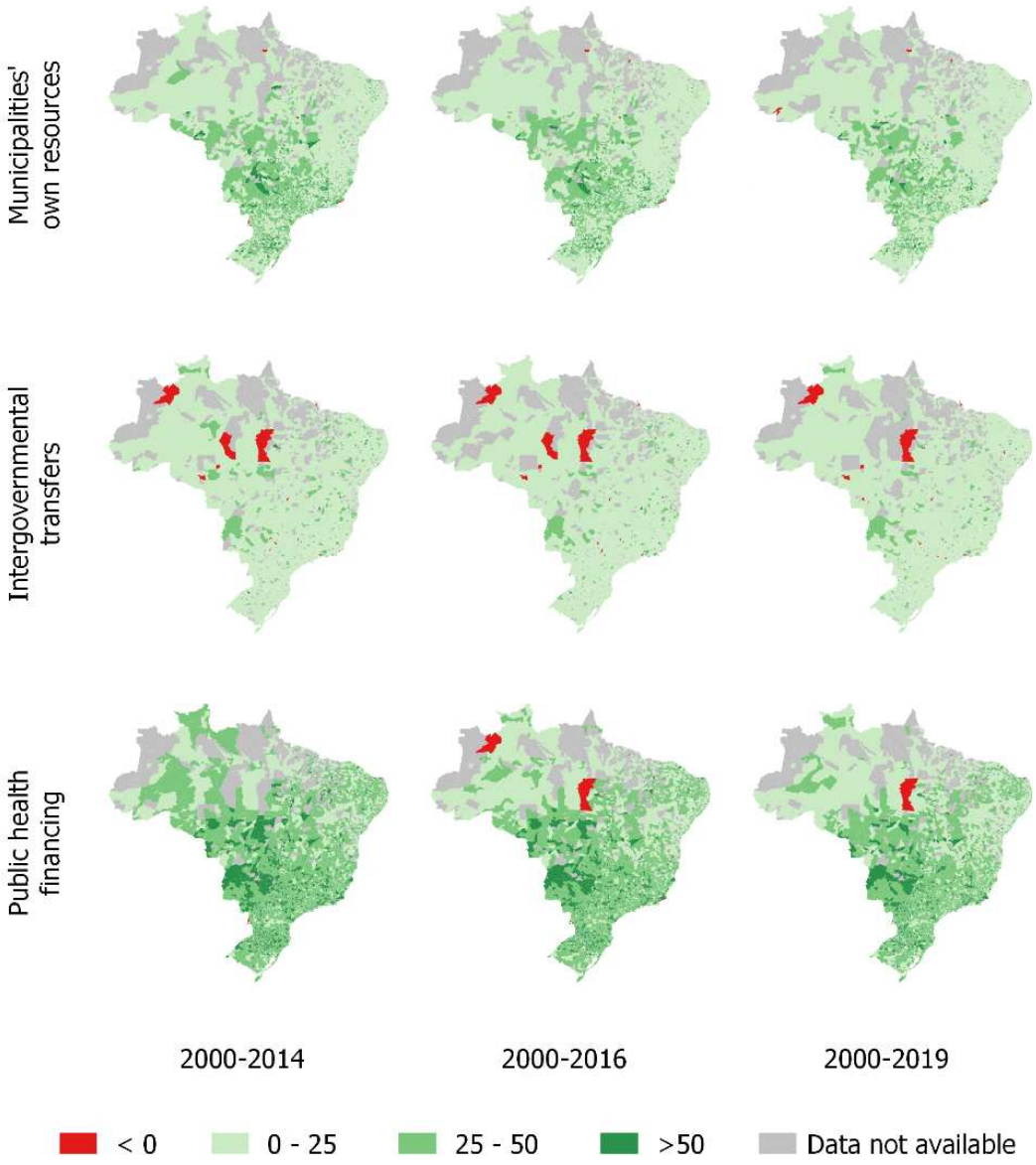

Figure 2. Results of the Theil-Sen estimator for the calculation of trend magnitude in public health municipal financing, Brazil.
Source: Elaborated by the author based on research results.

Considering positive trends only, municipalities were divided in three groups according to the magnitude of the trend. For municipalities' own resources, most of locations show a growth of up to R$25.00[5] per year, worth noting that the proportion of municipalities in such group increases as the recession and post-recession years are added. Consequently, the share of municipalities for which own resources devoted to

[5] R$ stands for Real (Brazilian currency).

healthcare grows by more than R$25.00 per year decreased, going from 41.7% for the 2000-2014 period to 28.1% for 2000-2019.

For intergovernmental transfers made under SUS, a relatively similar pattern is observed. Even though the share of municipalities with annual growth of up to R$25.00 slightly increased with the expansion of the timeframe considered, the bulk of municipalities analyzed – more than 90% of the sample – is already allocated to this group when considering the 2000-2014 interval. This scenario is in accordance with descriptive statistics (Table 1), which show that municipalities' own resources tend to be larger than intergovernmental transfers.

Taking public health municipal financing into account, it is perceived that, differently than observed for both municipalities' own resources and intergovernmental transfers, a greater proportion of locations presents an annual growth between R$25.00 and R$50.00. This proportion ranges from 60.1% for the 2000-2014 period to 55.5% for the 2000-2019 interval. Again, the share of municipalities in the lower group of positive trends (up to R$25.00 per year) increases as more years are added to the time series.

Based on the results found through the Theil-Sen estimator, Figure 3 shows how trends change when recession and post-recession years are added to the time series of each municipality. Specifically, difference in trends were calculated for three cases: recession vs. pre-recession, post-recession vs. recession, and post-recession vs. pre-recession. These scenarios provide evidence on the financial recovery capacity of local health systems when facing adverse events.

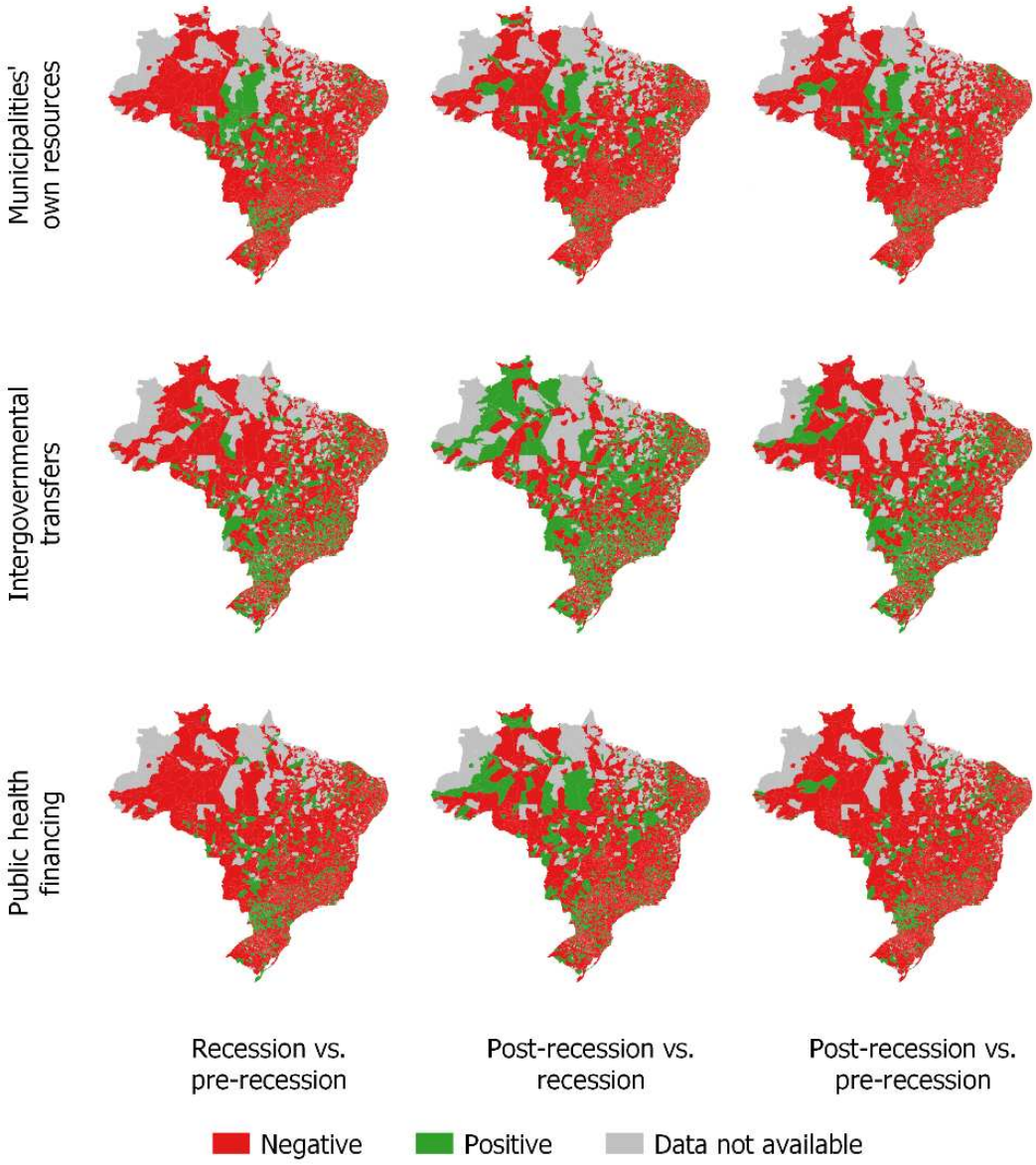

Figure 3. Difference in trends for public health municipal financing, Brazil.
Note: Pre-recession denotes the 2000-2014 period; recession denotes the 2000-2016 period; and post-recession denotes the 2000-2019 period.
Source: Elaborated by the author based on research results.

Visual inspection indicates that trends in intergovernmental transfers made under the SUS seem to suffer slightly less from the negative influence of the 2015-2016 economic recession than trends in municipalities' own resources devoted to healthcare. In fact, negative differences for the trends in municipalities' own resources were calculated for more than 80% of locations, whilst the proportion of negative differences does not exceed 60% for intergovernmental transfers.

As previously highlighted, municipalities' own resources tend to account for a larger share of public health financing than intergovernmental transfers. Consequently, the influence of the economic recession on the trend of public health financing ends up following a pattern like that of municipalities' own resources. The 2000-2016 trend is smaller than the 2000-2014 trend in 79% of municipalities. For the difference between the 2000-2019 trend and the 2000-2016 trend, the proportion of locations with a negative difference in 73%.

Going further, the difference in trends is statistically tested using the Wilcoxon signed-rank test, whose results are presented in Table 2. As detailed on the Methodology section, this non-parametric test deals with difference in medians, not difference in means like the *t*-test does. Results evidence that, in general, municipalities' own resources and intergovernmental transfers indeed show difference patterns in terms of how trends behave when recession and post-recession years are considered in time series.

Table 2. Results of the Wilcoxon signed-rank test for difference in trends of public health municipal financing, Brazil

Variable	Difference		
	Recession vs. pre-recession	Post-recession vs. recession	Post-recession vs. pre-recession
Municipalities' own resources	-2.1416***	-2.6735***	-4.7033***
Intergovernmental transfers	-0.4511***	0.3133***	-0.1677***
Public health municipal financing	-2.6950***	-2.3040***	-4.8537***

Notes: Pre-recession denotes the 2000-2014 period; recession denotes the 2000-2016 period; and post-recession denotes the 2000-2019 period. *** statistically significant at the 1% level.
Source: Research results.

The recession period seems to have a way larger influence on municipalities' own resources than on intergovernmental transfers. In fact, the (absolute) median difference between recession and pre-recession trends registered for municipalities'

own resources corresponds to approximately 4.75 times that of intergovernmental transfers. In addition, it is worth noting that when post-recession and recession trends are compared, intergovernmental transfers seem to show some recovery capacity as the median difference is positive.

For the public health municipal financing, results of the Wilcoxon signed-rank test indicate that when the recession years (2015-2016) are added to the pre-recession (2000-2014) time series, the median annual growth calculated using the Theil-Sen estimator falls by roughly R$2.14. Adding the post-recession years (2017-2019) to the recession (2000-2016) time series also seems to make the median trend estimated to fall as a statistically significant difference of approximately -2.30 is identified.

4. Discussion

The results obtained in the present study highlighted the fact that the evolution of public health financing is quite heterogeneous across the Brazilian territory, confirming one of the hypotheses initially raised. This is especially true when municipalities' own resources are the focus of analysis as locations with largest growth tend to be concentrated in the Center-South portion of Brazil. In fact, investigations conducted by Paim et al. (2011), Gragnolati, Lindelow and Couttolenc (2013), and Albuquerque et al. (2017) confirm that Brazil do have a heterogeneous availability of resources within its states and regions.

Heterogeneity in the provision of resources to healthcare financing translates in regional differences in the dependence of public health financing to intergovernmental transfers. Such picture is directly related to the redistributive feature of intergovernmental transfers and the consequent focus on locations with a weaker capacity of resources generation (Mendes, Miranda and Cosio, 2008). As the case study of Andrietta et al. (2020) shows, transfers to local governments may be instrumental in combating recession effects as they enabled a comparatively poorer state (Maranhão) to be more resilient than a richer one (São Paulo).

As previously showed, although intergovernmental transfers tend to account for a smaller share of public health municipal financing, their evolution seems to be more stable over time than that of municipalities' own resources. In fact, if a positive difference in trend medians is seem like an indication of financial resilience, intergovernmental transfers may be a better inducer of recovery capacity than

municipalities' own resources. This evidence is especially relevant in a context where the share of SUS financing by the Federal Government has been steadily decreasing (Gragnolati, Lindelow and Couttolenc, 2013).

5. Final remarks

This study has shown that the 2015-2016 recession may have negatively influenced the evolution of public health financing in most of Brazilian municipalities. Nevertheless, it is worth noting that approximately 20-25% of analyzed municipalities proved to be financially resilient. This is true either for locations whose pace of growth in public health financing did not slow down during recession years and for locations whose pace of growth in public health financing bounced back in post-recession years.

Considering the composition of public health financing, the results found in the present study led to the conclusion that intergovernmental transfers made under SUS seem to be more resilient to the economic shock originated by the 2015-2016 recession than municipalities' own resources devoted to healthcare. In fact, the pace of growth in municipalities' own resources slowed down during recession years in 81% of analyzed locations, whilst the pace of growth in intergovernmental transfers decreased in less than 60% of the municipalities.

Since the trends of intergovernmental transfers and municipalities' own resources showed different responses to the 2015-2016 recession, the approach employed by the public sector to combat the effects of a given economic shock is of fundamental importance to the financial resilience of local public health systems in Brazil. Austerity measures, for instance, may reduce the availability of resources devoted to healthcare by the Federal Government, impairing the flow of intergovernmental transfers to states and municipalities.

In response to the 2015-2016 recession, the National Congress of Brazil passed the Constitutional Amendment 95. Such modification became the cornerstone of Brazil's recent fiscal policy, having implemented a cap to government spending that limits the year-to-year growth to inflation adjustments only (Brasil, 2016). Since intergovernmental transfers seemed more resilient than municipalities' own resources, the absence of austerity measures could therefore improve the financial resilience of local health systems.

Considering that austerity measures may hurt public health financing primarily via intergovernmental transfers, it is worth stressing the relevance of constitutional mechanisms in guaranteeing the proper public health financing. The Constitutional Amendment 29 require states and municipalities to devote at least 12% and 15% of their budgets to public health, respectively (Brasil, 2000). In this sense, enforcement mechanisms may have collaborated to mitigate the effect of the 2015-2016 recession on public health financing.

Enforcement mechanisms are important not only for setting a floor for public health financing by federated entities, but for guaranteeing that resources – especially those from intergovernmental transfers – have the proper destination. In other words, the analyzed context requires the avoidance of resources fungibility. As the bulk of intergovernmental transfers made under SUS is directed to specific goals, it is possible to conclude that a higher level of dependence from intergovernmental transfer may improve financial resilience.

Lastly, it is necessary to highlight the limitations of the present study. Here, only the financial dimension of health systems resilience was analyzed. Thus, future studies may advance the literature by investigating other dimensions of resilience having the Brazilian system as the focus of analysis. Additionally, it is worth highlighting that this study does not provide an examination of the “cause-effect” type. Therefore, it would be very important to investigate what causes local health systems to respond differently to external shocks.

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ARTICLE 3

How public health financing respond to economic fluctuation?
Evidence from Brazilian municipalities

Abstract: The relationship between government spending and economic fluctuation is known in the specialized literature as the cyclicality of government spending. When government spending is directly (inversely) proportional to economic fluctuation, it is referred to as pro-cyclical (counter-cyclical). Although the cyclicality literature covers all kinds of government spending, great attention has been paid specifically to social spending. Among the subcomponents of social spending, health is worth highlighting, especially in a context of rising care towards achieving universal coverage in healthcare. In Brazil, a developing country with a relatively unstable economy, a relevant portion of the public budget is allocated to financing public health services. This being said, the present study analyzed how public health financing respond to economic fluctuation in Brazil. In order to investigate the relationship of interest, the investigation relied on longitudinal data at the municipality level, covering the period between 2002 and 2019. To causally identify the impact of economic fluctuations on public health financing, the relationship was empirically estimated using a shift-share instrumental variable approach. The results obtained indicate that, at the municipality level, public health financing have a pro-cyclical behavior with regard to economic fluctuations. The present study identified a pro-cyclical behavior for the subdivisions of public health financing as well, with intergovernmental transfers seem to be more volatile than municipal resources.

Keywords: Public Health Financing. Economic Fluctuation. Cyclicality. Brazil.

Resumo: A relação entre gastos do governo e flutuação econômica é conhecida na literatura especializada como ciclicidade dos gastos do governo. Quando os gastos do governo são diretamente (inversamente) proporcionais à flutuação econômica, eles são chamados de pró-cíclicos (contra-cíclicos). Embora a literatura de ciclicidade abranja todos os tipos de gastos governamentais, grande atenção tem sido dada especificamente aos gastos sociais. Dentre os subcomponentes do gasto social, destaca-se a saúde, especialmente em um contexto de preocupação crescente com

a universalização da saúde. No Brasil, país em desenvolvimento com economia relativamente instável, parcela relevante do orçamento público é destinada ao financiamento dos serviços públicos de saúde. Dito isso, o presente estudo analisou como o financiamento público da saúde responde às flutuações econômicas no Brasil. Para investigar a relação de interesse, o estudo utilizou dados longitudinais em nível de município, abrangendo o período entre 2002 e 2019. Para identificar o impacto causal das flutuações econômicas no financiamento da saúde pública, a relação foi estimada empiricamente usando uma abordagem de variável instrumental shift-share. Os resultados obtidos indicam que, em nível de município, o financiamento público da saúde tem um comportamento pró-cíclico em relação às flutuações econômicas. O presente estudo identificou também um comportamento pró-cíclico para as subdivisões do financiamento público da saúde, sendo que as transferências intergovernamentais parecem ser mais voláteis do que os recursos municipais.

Palavras-chave: Financiamento Público da Saúde. Flutuação Econômica. Ciclicidade. Brasil.

1. Introduction

Economic fluctuation shapes the demand for public services. During economic downturns, vulnerable households switch from private to public services. Conversely, periods of economic growth lead households to expand their access to private services. Regarding the supply of public services, however, no clear consensus of its relationship with economic fluctuation is observed. Depending on the financing approach governments adopt and the legal background, the provision of public services may be directly or indirectly proportional to economic fluctuation.

The relationship between government spending and economic fluctuation is known in the specialized literature as the cyclicality of government spending. When government spending is directly proportional to economic fluctuation, for instance, it is referred to as procyclical. When government spending is indirectly proportional to economic fluctuation, in turn, it is referred to as countercyclical. In other words, if government spending is procyclical (countercyclical) it will decrease (increase) during economic downturns (Cashin, 2016).

Although the cyclicality literature covers all kinds of government spending, great attention has been paid specifically to social spending, as periods of economic downturn may exacerbate poverty, hunger and malnutrition. On the one hand, there is evidence that countercyclical social spending is more effective in smoothing income shocks then government spending as a whole (Furceri, 2009). On the other hand, social spending seems to suffer the worst cut when economic downturns are accompanied by austerity measures (Doytch, Hu and Mendoza, 2010).

Among the subcomponents of social spending, health is worth highlighting, especially in a context of rising care towards achieving universal coverage in healthcare (WHO, 2010). In fact, many are the studies dedicated to examine the cyclicality of public health spending (e.g., Afonso and Jalles, 2013; Granado, Gupta and Hajdenberg, 2013; Keegan et al., 2013; Velenyi and Smitz, 2014; Liang and Tussing, 2019). Usually, studies on this thematic rely on cross-country data, dividing nations in groups according to their degree of development.

However, as stressed by Braun and Gresia (2003), even in countries with similar levels of development, public health financing may present different responses to economic fluctuation. In light of this, the present study aims at investigating how public health financing respond to economic fluctuation in Brazil. Due to some features of its public health system, especially those regarding the financing and provision of health services, Brazil provides a unique case study on the analysis of the relationship between public health financing and economic fluctuation.

The Brazilian public health system, known as *Sistema Único de Saúde* (SUS), has its origins in the 1988 Constitution, which defines its basic principles, guidelines, and form of financing. Based on its principles, the SUS must guarantee integral, universal and free-of-charge access to health services for the whole population of Brazil. To this end, the functioning of the system follows a set of guidelines: decentralized management, social control, regionalized service provision, and hierarchy of health services.

While the responsibility for managing and financing the public health system is shared among all levels of government, the bulk of health services are provided to the population by the municipal government[6]. In this sense, the state and federal

[6] Although most of public health services are provided by municipal governments, the Federal Constitution is crystal clear in determining the joint responsibility of the levels of government in terms of public health. In fact,

governments provide technical and financial cooperation. Resources from the state and federal governments are transferred to municipalities via fund-to-fund transfers, i.e., each level of government has its own health fund and resources flows top-down (Simão and Orellano, 2015).

Therefore, one can say that Brazilian municipalities have two types of financial resources available for the financing of public health services, which vary according to their origin. First, there are the municipal health resources, i.e., the resources directly invested by municipalities, which are obtained via tax collection and constitutional transfers. Second, there are the intergovernmental health transfers, i.e., the resources transferred by the federal and state governments to municipalities through the aforementioned fund-to-fund transfers.

In this context, it is worth stressing that the resources destined to finance public health services in Brazil are, in general, legally earmarked. The Constitutional Amendment No. 29, ratified by the Complementary Law No. 141, of January 13, 2012, set an investment floor in public health financing for states and municipalities of 12% and 15% of their net current revenue, respectively. These legal marks, however, did not set a similar investment floor for the Federal Government in terms of public health financing.

Until 2015, federal resources destined to public health were at least corrected with respect to the annual change in nominal GDP[7]. With the passage of the Constitutional Amendment No. 86, federal resources started to be effectively earmarked as a floor of 15% of the net current revenue was set. Nonetheless, such floor was later revoked by the Constitutional Amendment No. 95, which defined that the minimum investment made by the Federal Government in public health should correspond to the previous year investment corrected for inflation.

Furthermore, it is also worth noting that, in addition to the fact that sub-national rulers are free to expand public health financing beyond the legally defined floor, governments may have access to resources from parliamentary amendments (Baptista et al., 2012). These political instruments make it possible for congressmen to participate in the elaboration of the government annual budget. Specifically,

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under the terms of Article 23, item II, the federal, state and municipal governments must concurrently take care of health and public assistance.

[7] If a negative change was registered for nominal GDP, nominal health financing was not be diminished.

congressmen use parliamentary amendments to designate resources to their states and at least half of the amended amounts must be allocated to public health.

Nonetheless, since a major share of resources destined to public health financing are constitutionally earmarked, two hypotheses are raised and tested in this article. First, a procyclical behavior is expected as legal mechanisms condition public health financing to follow the direction of economic fluctuation. Second, the impact of economic fluctuation is expected to be larger on municipal resources than on intergovernmental transfers as local governments seem to be more fiscally vulnerable than other government levels.

Although the bulk of studies on the cyclicality of social spending in general – and health spending in specific – are essentially economic in nature, this thematic is of great importance for the area of public administration as well. In fact, evidence on the cyclicality of health spending may depict how governments respond to economic fluctuations and how such responses may influence services provision, thus offering relevant information on the design of the mechanisms of financial resilience necessary for the maintenance of public services financing.

Specifically, the contributions of this study are threefold. First, differently than usually observed in similar studies, the cyclicality of public health financing is investigated using information at the municipality level. Second, it adds to the literature on the topic by providing causal evidence of the impact of economic fluctuation on public health financing through the use of a shift-share instrument. Third, the results obtained here may aid Brazilian policymakers with regard to the financial management of public health resources during economic downturns.

2. Methodology

2.1. Empirical strategy

In order to investigate the relationship of interest, this article relies on longitudinal data at the municipality level, which covers the period between 2002 and 2019. Specifically, the impact of economic fluctuations on public health financing is empirically modeled by regressing the annual percentage change in public health financing (PHF) against the annual percentage change in the Gross Domestic Product (GDP) and a set of control variables, as follows:

$$\Delta PHF_{it} = \beta_0 + \beta_1 \Delta GDP_{it} + \mathbf{X}'_{it}\beta_2 + \epsilon_{it}, \quad (1)$$

where ΔPHF_{it} is the annual percentage change in public health financing from $t-1$ to t for municipality i, ΔGDP_{it} is the annual percentage change in GDP from $t-1$ to t for municipality i, $\mathbf{X}'_{it}$ is a vector containing a set of control variables, and ϵ_{it} is the error term.

In order to avoid issues regarding the existing heterogeneity on the size of population across Brazilian municipalities and, consequently, the magnitude of PHF and GDP, these variables are expressed in per capita terms. The parameter of interest is β_1, which informs by how many percentage points PHF per capita changes, on average, in response to a change of one percentage point in GDP per capita.

Considering year-to-year changes in GDP growth introduce some difficulties in the interpretation of the relationship of interest. Following Avdic, New and Kamhofer (2021), a scale-independent measure of economic activity that enables the comparison of municipalities over time is constructed. Considering that GDP growth can be expressed as the weighted growth of economic sectors, adjusted GDP growth is calculated as follows

$$\Delta GDP^A_{it} = \sum_{k=1}^{K} s_{ikt} g_{ikt}, \quad (2)$$

where s_{ikt} is the share of the gross value added (GVA) of economic sector k on the GDP of municipality i for the year t and g_{ikt} is the growth rate of the GVA of economic sector k in the municipality i.

In the construction of the adjusted GDP, growth rate is calculated in relation to the base year rather than to the previous period in order to simplify the analysis. Due to data availability, the base year considered here is 2002. Moreover, GDP is indexed by setting the 2002 value equal to one and multiplying the values of all years by 100, thus obtaining the percentage change in municipal GDP with respect to 2002 levels.

While the use of the adjusted measure of economic fluctuation facilitates the interpretation of the coefficient of interest, there is still concern about the existence of simultaneity bias arising from correlated asymmetric shocks to both PHF and GDP. For instance, there may exist reverse causation, in which local-specific shocks to PHF

influences GDP growth heterogeneously across municipalities via improvements in healthcare and, consequently, health conditions.

In order to address such concern, a shift-share instrumental variable (SSIV) is applied. Originally proposed by Bartik (1991), this approach is based on a shift-share analysis, considering that economic growth can be decomposed into regional (shift) and sectoral (share) factors. The SSIV estimates the effect of economic fluctuation on the outcome of interest by using weighted averages of common shocks, which vary according to the level of exposure (weights).

In the present study, SSIV is implemented by instrumenting the (endogenous) local GDP growth with the national sectoral-specific GDP change weighted by sector shares from the base year ($t = 2002$). Following Autor and Duggan (2003), the national growth rate excludes own-area GDP values in order to avoid influences of larger municipalities. Moreover, due to the way public healthcare is structured, regional[8] GDP values are excluded instead of local values.

Formally, the shift-share instrument is specified as

$$\Delta GDP_{it}^{Z} = \sum_{k=1}^{K} s_{ik,t=2002} g_{kt}, \quad (3)$$

where $s_{ik,t=2002}$ is the share of the GVA of economic sector k on the GDP of municipality i for 2002 and g_{kt} is the national growth rate of the GVA of economic sector k between $t-1$ and t.

The shift-share instrument is applied in the analysis of the effect of economic fluctuations on public health financing by means of a two-stage least square (2SLS) estimator. The first stage corresponds to a regression of ΔGDP_{it}^{A} on ΔGDP_{it}^{Z} and a set of control variables. The second stage, in turn, corresponds to the regression of ΔPHF_{it} on the predicted values of ΔGDP_{it}^{A} obtained in the first stage, $\Delta \widehat{GDP_{it}^{A}}$, and the same set of control variables.

2.2. Data

[8] Region, in this case, refers to the so-called health regions set by the Ministry of Health for management purposes. In general, municipalities within the same health region share health services and thus public health financing of a given municipality may be correlated to those of other municipalities from the same health region.

The data used in this article were gathered from different sources. Information on GDP and its components was collected from the website of the Brazilian Institute of Geography and Statistics (IBGE, *Instituto Brasileiro de Geografia e Estatística*), whilst information on public health financing was collected from the website of the Information System on Public Health Budgets (SIOPS, *Sistema de Informações sobre Orçamentos Públicos em Saúde*).

Data are presented in longitudinal terms, covering 5,569 Brazilian municipalities[9] for the period between 2002 and 2019. Time bounds were set due to data availability. Although data on GDP and its components are available for years prior to 2002, they are not compatible as they are presented on a different basis. The upper bound, in turn, was imposed in order to avoid the influence of the COVID-19 pandemic on the results.

Public health financing refers to the sum of municipal health resources and intergovernmental health transfers. In order to construct the shift-share instrument, GDP data was collected separately for each component: taxes, agriculture, industry, services and public sector. All variables are expressed in per capita terms and were deflated using the Extended National Consumer Price Index (IPCA), being exhibited in 2019 values.

Additionally, three control variables were considered: the share of staff expenditure on public health financing, private health insurance coverage, and an indicator for economic recession (2015-2016). The first control variable is expected to be positively correlated with public health financing. For the other two variables, on the other hand, a negative correlation with the dependent variable is expected.

3. Results

The estimates of the relationship between economic fluctuation and public health financing, considering the years from 2002 to 2019, are presented in Table 1. Each column refers to a given specification of the relationship of interest. The first line shows the estimates obtained via OLS, whilst the second reports the second-stage

[9] Officially, Brazil has 5,570 municipalities, with Brasília (national capital) being classified as one of them. For financing purposes, however, Brasília – and the Federal District as a whole – has a different classification and, therefore, follows a distinct financing rule. In this sense, Brasília was not considered in the analysis.

results from the 2SLS estimator. The first-stage results from the 2SLS estimator are presented in the Appendix.

Table 1. Estimated effect of economic fluctuation on public health financing

Model	Specification		
	I	II	III
OLS (adjusted GDP growth)	0.022***	0.023***	0.021***
2SLS (instrumented GDP growth)	0.959***	0.945***	0.996***
Controls	N	N	Y
Fixed effects	N	Y	Y
Observations	88,524	88,524	88,524

Note: *** denotes statistical significance at the 1% level.

Source: Research results.

Regardless of the estimator used and the specification, estimates of the relationship of interest are all positive and statistically significant, indicating that, in Brazil, public health financing presents a cyclical behavior. In other words, the results presented in Table 1 show that, at least at the municipality level, public health financing tends to grow when the local economy grows or to retract when the local economy retracts.

As for the preferred specification of the relationship of interest (2SLS estimator with fixed effects and controls), it is observed that an increase of 1 p.p. in the annual growth of GDP per capita leads to an increase of roughly 1 p.p. in the annual growth of PHF per capita. The comparable estimate (OLS estimator with fixed effects and controls) has a smaller magnitude, indicating that such model may be biased towards zero.

Assuming that the different financing sources may respond differently to economic fluctuations, the econometric model was also estimated using both the municipal health resources and intergovernmental health transfers as dependent variables. The results presented in Table 2 indicate that the impact of economic fluctuations on municipal health resources is very similar to that obtained for public health financing.

In a similar fashion to what was observed for the main model, i.e., public health financing as the dependent variable, the results obtained for the relationship between municipal health resources and economic fluctuation also proved to be robust as the coefficients estimated via both OLS and 2SLS (second-stage) were all positive and

statistically significant at the 1% level, although the magnitude of estimates varied according to the estimator used.

Table 2. Estimated effect of economic fluctuation on municipal health resources in Brazil, 2002-2019

Model	Specification		
	I	II	III
OLS (adjusted GDP growth)	0.026***	0.027***	0.024***
2SLS (instrumented GDP growth)	0.968***	0.953***	0.995***
Controls	N	N	Y
Fixed effects	N	Y	Y
Observations	88,524	88,524	88,524

Note: *** denotes statistical significance at the 1% level.

Source: Research results.

According to the results shown in Table 3, intergovernmental health transfers seem to suffer a larger impact from economic fluctuation than both municipal health resources and public health financing. In fact, the estimates obtained via 2SLS indicate that an increase of 1 p.p. in the annual growth rate of local GDP leads to an increase of approximately 1.6 p.p. in intergovernmental health transfers.

Table 3. Estimated effect of economic fluctuation on intergovernmental health transfers in Brazil, 2002-2019

Model	Specification		
	I	II	III
OLS (adjusted GDP growth)	0.013***	0.022***	0.018***
2SLS (instrumented GDP growth)	1.578***	1.566***	1.688***
Controls	N	N	Y
Fixed effects	N	Y	Y
Observations	88,524	88,524	88,524

Note: *** denotes statistical significance at the 1% level.

Source: Research results.

Summing up, the results presented in Tables 1-3 provide evidence that, at least at the municipality level, public health financing and its components have a procyclical behavior regarding the fluctuation of GDP per capita. It is worth stressing, however, that the magnitude of the positive impact of economic fluctuation seems to be larger for intergovernmental health transfers than municipal health resources.

Going further, this study also explores possible heterogeneity in the impact of economic fluctuation on public health financing in terms of the geographical distribution of municipalities as well as their population size. Table 4 shows the estimated effect of economic fluctuation on public health financing and its components separately for each of the five regions of Brazil, whilst Table 5 does the same according to three categories of population size.

The results exhibited in Table 4 indicate that the effect of economic fluctuation on public health financing and its components indeed vary according to the geographical distribution of municipalities. Even though all coefficients estimated are positive, corroborating the procyclical behavior identified earlier, they vary in terms of magnitude. It is also noteworthy that a similar pattern is identified as before as intergovernmental transfers still suffers the largest impact.

Table 4. Estimated effect of economic fluctuation on public health financing, municipal health resources and intergovernmental health transfers in Brazil, by geographic region, 2002-2019

Dependent variable	Region				
	North	Northeast	Southeast	South	Center-West
Public health financing	0.716***	0.915***	1.016***	1.358***	3.574
Municipal health resources	0.823***	0.857***	0.972***	1.308***	5.189
Intergovernmental health transfers	1.028***	1.341***	2.509***	1.910***	4.582
Controls	Y	Y	Y	Y	Y
Fixed effects	Y	Y	Y	Y	Y
Observations	5,346	26,316	28,584	20,484	7,794

Note: *** denotes statistical significance at the 1% level.

Source: Research results.

Table 5 shows the estimates of the effect of economic recession on public health financing and its components by population size. In general, intergovernmental transfers suffer a larger impact than municipal resources as previously noted. For large municipalities, however, the inverse relation is observed. It is important to highlight that the impact of economic fluctuations seems to increase as the population of the municipality increases.

Table 5. Estimated effect of economic fluctuation on public health financing, municipal health resources and intergovernmental health transfers by population size

Dependent variable	Population		
	Small	Medium	Large
Public health financing	0.929***	1.167***	1.753***
Municipal health resources	0.883***	1.175***	2.288***
Intergovernmental health transfers	1.710***	1.566***	1.980***
Controls	Y	Y	Y
Fixed effects	Y	Y	Y
Observations	61,172	16,578	4,774

Note: Small denotes municipalities with population of up to 25,000 inhabitants; Medium denotes municipalities with population from 25,000 up to 100,000 inhabitants; Large denotes municipalities with population of more than 100,000 inhabitants; *** denotes statistical significance at the 1% level.
Source: Research results.

4. Discussion

The results obtained in the present study indicate that, at the municipality level, public health financing have a procyclical behavior with regard to economic fluctuations. Even though no similar investigation has been conducted at the subnational level and thus no direct comparison of results is possible, the findings of the present study are in line with prior evidence, at the national level, that confirms the procyclical behavior of public health spending in developing countries (e.g., Ilzetzki and Vegh, 2008; Granado, Gupta and Hajdenberg, 2013).

In fact, by using data at the national level, Gadelha and Divino (2013) provide evidence on the procyclicality of the Brazilian fiscal policy. The authors, however, did not segregate the analysis by spending function and no evidence regarding health spending in specific is presented. Although focusing on political cycles instead of business cycles, it is worth stressing the study conducted by Sakurai (2009), which indicates that municipal health spending is indeed influenced by the political cycle.

As highlighted by Massuda et al. (2020), Brazil is the sole country in the world to provide free, comprehensive services for anyone within its territory. Nevertheless, many other countries worldwide also provide universal healthcare for its citizens (e.g., Canada, Portugal, Sweden and United Kingdom). Examining the results provided by Velenyi and Smitz (2014), it is perceived that, differently than Brazil, all the

aforementioned countries present, at least for the 2003-2010 period, a counter-cyclical behavior regarding government health expenditure.

The present study identified a procyclical behavior for the subdivisions of public health financing as well. Such results may be directly related to the constitutional and legal mechanisms that govern public health spending in Brazil. The Constitutional Amendment No. 29/2000, for instance, set a floor for the health spending of municipalities and states, which is defined as a percentage of total revenue. Thus, such floor may induce a procyclical behavior if government focuses only on complying with it, leading health spending to fluctuate with total revenue.

The scenario cited above may be connected to the notion of pro-cyclical trap, as defined by Frankel, Vegh and Vuletin (2013). One of the causes of the pro-cyclical trap is the rent-seeking behavior of influence groups. Counter-cyclical behavior may be achieved by saving resources during economic growth and increasing government spending during economic downturn (Velenyi and Smitz; 2014). However, pressure from influence groups prevent the accumulation of resources as these groups tend to capture additional revenue and so procyclicality remains.

Comparing the results for the subdivisions of public health financing, it is observed that intergovernmental transfers seem to be more volatile than municipal resources. There are two possible explanations for this. First, the effect of economic fluctuations possibly differs among government levels. In fact, tax revenues are distributed asymmetrically among government levels, being concentrated in the federal government, whilst the nature of taxes also vary among the levels of government, leading to heterogenous variation in tax revenue (Giovanella et al., 2012).

Second, the decentralization of public health services in Brazil may prevent municipalities from presenting a similar behavior than other levels of government in terms of spending adjustment. According to the public administration literature, decentralization is closely related to increases in the level of public accountability as the fate of local politicians are in the hand of the local electorate (Smoke, 2015). Therefore, local governments may be tempted in not following, when possible, adjustments undergone by other levels of government.

Still about how intergovernmental transfers and municipal resources differ in terms of the response to economic fluctuation, the findings of Cruz, Barros and Souza (2022) somehow complement the evidence provided here. The authors found that the fiscal dependence of Brazilian municipalities regarding the financing of public health

services, given by the increase in intergovernmental transfers, increased after the economic recession. This is especially true for smaller municipalities – both in terms of population and per capita household income.

The analysis conducted in this study also presented evidence that the impact of economic fluctuations on public health financing varies according to geographic location. In fact, although a procyclical behavior was identified for all regions, the magnitude of public health financing responses to economic fluctuations seems to vary among them. Less developed regions (North and Northeast) are comparatively less procyclical them the more developed ones (Southeast and South), which may be related to the existence of redistributive mechanisms (Prado, 2006).

As noted for geographic distribution, the impact of economic fluctuations also appears to vary with population size. The results indicate that the most populous municipalities show a more pro-cyclical behavior than the smallest municipalities. This difference is more pronounced for municipal health resources than for intergovernmental health transfers, which may be related to the fact that smaller municipalities are in a process of increasing both fiscal and health financing dependence on intergovernmental transfers (Cruz, Barros and Souza, 2022).

5. Final remarks

Investigating Brazilian municipalities, this study has shown that public health financing is directly proportional to economic fluctuations. Therefore, the initial hypothesis that public health financing is procyclical in Brazil has been proved true. Additionally, the coefficient estimated for municipal health resources was smaller than that obtained for intergovernmental health transfers. Consequently, the other hypothesis initially raised was rejected, since municipal resources were expected to be more procyclical than intergovernmental transfers.

Existing legal mechanisms guarantee that a minimum share of government revenues is destined to health spending. Such mechanisms alone, however, may induce (or at least reinforce) a procyclical behavior in public health financing as governments may simply comply with the legally required share. Therefore, the path to a counter-cyclical behavior must pass through the funding of medium- and long-term projects, as well as the addition of mechanisms that increase the availability of resources to be used discretionally during countercyclical periods.

Given the legal framework of Brazil, the creation of additional enforcement mechanisms leading municipalities to save resources during economic growth to be used during economic downturns would not be possible. In fact, as highlighted by Bassi (2019), the Federal Constitution states that special funds must be included in the Annual Budget Law (LOA) and cannot be funded by earmarked resources. These features may prevent a special fund from being successful as a countercyclical tool.

Additionally, it is noteworthy that the discrepancy between the levels of government with regard to fiscal capacity and the consequent fiscal dependence of state and municipal governments on the federal government is also a matter of concern in terms of public health financing. During economic downturns, the public financing of local health services may be affected by both the fiscal stress faced by municipal governments and the pro-cyclical behavior of intergovernmental transfers, which may be worse for smaller municipalities.

In conclusion, the structure of public health financing in Brazil imply that municipalities will only graduate from the procyclical trap if the upper levels of government, with emphasis on the federal government, provide the appropriate fiscal structure to do so. Given the importance of intergovernmental transfers for the financing of public health services at the local level, the observance of a counter-cyclical behavior by the federal government could lead to a ripple effect and the consequent graduation from the procyclical trap by local governments.

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FINAL REMARKS

Since the enactment of the Constitution of the Federative Republic of Brazil, in 1988, health started to be defined as a universal right and a responsibility of the Brazilian public sector. Following these premises, there was the creation of a unified health system, the so-called *Sistema Único de Saúde* (SUS), which provides a plethora of free-of-charge health services to anyone in the territory of Brazil. The system, however, has long been suffering from many problems, like insufficient funding and the irregular flow of resources.

The financial issues that have been historically plaguing the Brazilian public health system, like the ones cited above, may be exacerbated during episodes of economic crisis like the recession that affected the country between 2015 and 2016. In fact, economic downturns can put extra pressure on the public health system through the expansion of demand and the lack of financing. With this in mid, the present study aimed at investigating the relationship of economic fluctuation and public health financing in Brazil.

To this end, three distinct but complimentary articles were developed. Following the PRISMA guidelines, the first article systematically reviewed the literature on public health and the 2015-2016 economic recession in Brazil. The second article, in turn, conducted a trend analysis to evaluate the financial resilience of the SUS to the 2015-2016 economic recession. Finally, the third and last article employed an instrumental variables (IV) approach to identify how public health financing respond to economic fluctuation in Brazil.

The systematic review indicated a possible gap in the analyzed literature due to the lack of applied studies focusing on the influence of the 2015-2016 economic recession on the financing of public health services in Brazil. Most of the applied studies focus on epidemiology issues, indicating that the economic crisis negatively affected the population health. This fact reinforces the need of filling the existing literature gap as the financing of public health services may act as a mechanism for the impact of the recession on health status.

With respect to the analysis of the financial resilience of SUS, the results obtained indicate that the 2015-2016 crisis may indeed have negatively influenced the evolution of public health financing in most of Brazilian municipalities. In fact, according to the criterion established in the analysis, only a quarter of municipalities proved to be

financially resilient. Furthermore, the trend analysis also indicated that intergovernmental health transfers seem to be more resilient to economic shocks than municipal health resources.

The investigation conducted in the third article of this study provided evidence that public health financing is directly proportional to economic fluctuation in Brazilian municipalities. In other words, the findings suggest that public health financing is pro-cyclical in Brazil. Additionally, the econometric analysis indicated that intergovernmental health transfers are more responsive to fluctuations in the gross domestic product (GDP) than municipal health transfers, with both presenting a pro-cyclical behavior.

Based on the results obtained, some conclusions can be made. First and foremost, the findings of the two empirical articles reinforces the relevance of intergovernmental health transfers for the financing of public health services in Brazil. Such financing source, although more volatile to economic fluctuation, proved to have a higher resilience than municipal health resources. Therefore, the strengthening of intergovernmental transfer mechanisms seems to be instrumental for increasing the resilience of the Brazilian public health system.

The health system can possibly benefit from the adoption of the resilience concept beyond the financial dimension. In fact, a comprehensive analysis of resilience must include all of the health systems' building blocks: service delivery; health workforce; health information systems; access to essential medicines; financing; and leadership/governance. The design and implementation of continuous actions focused on the resilience of public health systems can enhance the ability to face external shocks (e.g., disease outbreaks and pandemics).

In this sense, it is worth stressing the importance of investing in cutting-edge scientific researches on the subject. Investigations should cover several areas of knowledge in order to provide a multidisciplinary approach to the strengthening of the Brazilian public health system in terms of its exposure to external shocks. The performance of policymakers with respect to the public health system can greatly benefit from the generation of knowledge about resilience from the perspective of public administration.

It should also be noted how the economic approach adopted by the government in the face of economic crises seems to be directly related to the financial resilience of publicly funded health systems. In Brazil, despite the existence of constitutional

mechanisms of checks and balances, the observance of a pro-cyclical behavior of public health spending can be considered as an obstacle to the construction of a financially resilient health system. Therefore, protecting public health funds is the first step in making the health system more resilient.