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Fiscal Federalism, Fiscal Decentralization, and Economic Growth in Brazil: 1954 - 2018

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Abstract

The aim of this study is to analyze the relationship between economic growth and fiscal federalism in Brazil for the years 1954 to 2018. The simple model of endogenous growth with spending by different levels of government proposed by Xie, Zou and Davoodi (1999) was used to demonstrate how fiscal decentralization affects the long-run growth rate of the economy. Applying the model to the Brazilian Economy, an Autoregressive and Distributed Lag Model (ARDL) and long-term multipliers of the Gross Domestic Product (GDP) per capita growth rate in relation to the expenditures of federated subnational governments were estimated. The results show that the current designs of fiscal federalism and fiscal decentralization do not contribute to balanced and long-term sustainable economic growth.

Palavras chaves: Economic growth; Fiscal Federalism; long run multipliers.

JEL: O47, O43, H77

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ADF - Augmented Dickey-Fuller

ARDL - Autoregressive and Distributed Lag Model

FGV - Getúlio Vargas Foundation

IBGE - Brazilian Institute of Geography and Statistics

IGP-DI - General Price Index - Domestic Availability

IPEA - Institute for Research in Applied Economics

JB - Jarque-Bera

LC - Complementary Law

MELNV - Best Linear Unbiased Estimator

MQG - Generalized Least Squares

MQO - Ordinary Least Squares

PEC - Proposal for Constitutional Amendment

GDP - Gross Domestic Product

RESET - Regression Specification Error Test

SL - Saikkonen and Lütkepohl

TCU - Federal Audit Court

TLC - Central Limit Theorem

VG - Vogelsang and Perron

SUMMARY

1. INTRODUCTION

1.1 CONTEXTUALIZATION OF THE THEME

Fiscal federalism is a general concept representing a vertical public sector financial structure, with allocation of revenues and expenditures among different levels of government and a system of intergovernmental transfers. The traditional theory of fiscal federalism establishes a general normative framework for the assignment of functions of different levels of government and the appropriate fiscal instruments for carrying out these functions, highlighting three objectives of the public sector: economic efficiency, macroeconomic stability, and income redistribution (Oates 1972, 1999; Musgrave 1959). The federal government should be responsible for macroeconomic stabilization and income redistribution, while subnational (regional and local) governments, which are closer to the citizens and have more information about their preferences, should ensure the efficient provision of public goods and services within their jurisdictions. (Musgrave 1959).

Fiscal decentralization is a mechanism of fiscal federalism and can be considered a necessary condition for the latter, because there is no point in a vertical public sector financial structure without some level of decentralization (in which case all resources, authority, and responsibilities would be concentrated at the federal level). In federal states, fiscal decentralization means that revenue and expenditure responsibilities (i.e., the right to collect taxes and independently determine expenditure focus areas) are transferred from the federal level to the regional and local levels.

Finally, the federative pact is the set of constitutional provisions that configure the legal framework, the financial obligations, the collection of resources, and the fields of action of the federated entities.

The relationship between fiscal decentralization and economic growth has been analyzed by researchers and policy makers. This relationship has at least three important reasons (Breuss e Eller 2004). First, economic growth is seen as a goal of fiscal decentralization and efficiency in public sector resource allocation. Second, it is the explicit intention of governments to adopt policies that lead to sustained growth in per capita income. And third, economic growth per capita is easier to measure and interpret than other indicators of economic performance. Thus, researchers and policy makers have analyzed fiscal decentralization as an instrument to promote economic growth under the view that this mechanism leads to better resource allocation and higher productivity. As explained by Oates (1993):

> The basic economic case for fiscal decentralization is increased economic efficiency: the provision of local products that are differentiated according to local tastes and circumstances results in higher levels of social welfare than if it were centrally determined, as well as more uniform levels of products across all jurisdictions.

Therefore, fiscal decentralization provides incentives for local governments to innovate in the production and supply of public goods and services (Martinez-Vazquez e McNab 2003)...in addition to competition between different levels of revenue constraints (Brennan e Buchanan 1980). In turn, Tanzi (1995) e Ter-Minassian (1997) show how, in general, fiscal decentralization can be used to enable the coordination of macroeconomic policies as well as to implement stabilizing economic policies.

On the other hand, Alesina and Spolaore (2003) apud Mendes (2019, p. 64) argue that large countries benefit from economies of scale, offering more and better public services by taxing their population less. In addition, geographic diversity would enable greater availability of inputs and natural resources, complementarity among the country's regions, and a wider range of comparative advantages. But contrary to these arguments, Credit Suisse (2014) apud Mendes (2019, p. 64) shows that, in practice, larger countries have higher tax burdens and offer, on average, public services of lower quality and quantity than smaller countries.

According to Mendes (2019, p. 65), countries with large geographical areas tend to organize themselves into federations, and federative systems exhibit several advantages in terms of management and efficiency in the provision of public goods and services. However, for the purposes of approving economic reforms that are fundamental to economic growth, the existence of overlapping layers of power introduces more actors with veto power, bringing more conflicting interests into the debate. Federal systems can also give rise to much demand for transfers and subsidies for regional development. The designs of these transfers, which arise from political negotiations, may be far from the ideal of efficiency: overlapping and complex tax systems and other mechanisms can lead to concentration of privilege, inefficiency, populism and crystallization of interests, which affect both the productivity of the economy and increase resistance to economic reforms.

Table 1 below highlights the average real GDP growth rate for different periods of the Brazilian economy. The finding that, on average, this rate is quite low in the period after the enactment of the 1988 Federal Constitution, which established the current federative pact, becomes the core of the motivation for the research to be conducted in this study.

Table 1 - Average Real GDP Growth Rate (%)

Periods of the Brazilian Economy	Average Value
JK Target Plan (1956-1960)	8,1
Triennial Plan (1961-1963)	5,3
Government Economic Action Plan - PAEG (1964-1967)	4,2
Economic Miracle (1968-1973)	11,2
2nd National Development Plan - II PND (1974-1978)	6,7
External Debt Crisis (1979-1984)	2,5

Economic Plans of the Sarney Government (1985-1989)	4,4
Collor Plan (1990-1992)	-1,3
Itamar Franco Government (1993-1994)	5,4
Real Plan - FHC Governments I and II (1995-2002)	2,4
Real Plan - Lula I and II Governments (2003-2010)	4,0
Real Plan - Dilma I and II Governments (2011-2016)	0,4
Real Plan - Temer (2017-2018)	1,6

Source: Developed by the Authors.

Note: For the period 1956 to 1961, we considered the information provided in Gremaud et al. (2017, p. 404), Table 14.4. For the other years, we considered the data of the real annual GDP variation rate provided by the Time Series System of the Central Bank of Brazil (series 7326).

1.2 RESEARCH PROBLEM

In a Federation, macroeconomic stability depends on the fiscal situation of the subnational entities. However, in the Brazilian case, the fiscal decentralization introduced after the 1988 Federal Constitution was not accompanied by a strengthening of the fiscal autonomy of the subnational entities. Social rights were progressively expanded without a corresponding expansion of new sources of revenue. Besides, the constitutional text did not establish a clear division of attributions for the Federation entities in relation to social rights. To cope with the progressive expansion of social spending, the federal government, over the past few years, has strengthened its fiscal position by increasing the tax burden with social contributions. The subnational entities, disregarding the possibility of increasing efficiency in the collection of taxes foreseen in the Constitution, have become dependent on intergovernmental transfers.

According to Mendes (2019, p. 65-66): "the country also has large regional imbalances that generate a federalism based on poorly designed redistributive policies that generate economic inefficiency. Another set of structural factors that raises the difficulty of carrying out the reforms that the country needs." And in pointing to the federative form of state organization as a potential source of economic distortions and barriers to reform, Mendes (2019, p. 106) points out:

> This seems to be the case in Brazil, where the federative relations are a clear example of the primacy of inefficient redistribution to the detriment of the provision of public goods in favor of growth. Even though the federative model has many virtues and it is inconceivable to administer a country of continental dimensions in a centralized way, there is a great accumulation of inefficiencies (our emphasis).

This study aims to answer the following questions: do subnational entities' expenditures propitiate higher economic growth, in line with the theory of Oates (1993) that presuppose a better capacity to spend according to the needs of citizens for subnational entities? Does the greater concentration of spending at the federal level not only portray the current asymmetric fiscal federalism[1] in Brazil, but also prevents sustainable long-term economic growth?

1.3 RESEARCH HYPOTHESES

There are two hypotheses that drive this research. First, the current design of fiscal federalism and fiscal decentralization in Brazil causes regional imbalances, poorly designed redistributive policies, and economic inefficiency, contributing to the absence of sustainable economic growth. Second, subnational entities, by better allocating their expenditures to meet the needs of their citizens, contribute to greater economic growth.

1.4 GENERAL AND SPECIFIC OBJECTIVES

This study has the general objective of empirically analyzing the relationship between fiscal decentralization and economic growth for Brazil, based on the endogenous growth model with different levels of government spending developed by Xie, Zou, e Davoodi (1999). In terms of specific objectives, in this study an econometric model Autoregressive and Distributed Deflags (ARDL) is estimated, so that the impacts of fiscal decentralization on economic growth are investigated from the calculation of long-run multipliers of spending in relation to real per capita economic growth, also known as long-run expenditure elasticity of the real per capita GDP growth rate.

1.5 THEME JUSTIFICATION

In an informative note entitled "Expansionary Fiscal Consolidation in Brazil"[2], dated December 31, 2019, the Secretariat of Economic Policy of the Ministry of Economy had already highlighted that the Brazilian economy presented problems that compromised the country's growth prospects and the well-being of the population. Among the measures discussed in this note, for the sustainable resumption of economic growth, is Constitutional Amendment Proposal 188/2019 (PEC of the Federative Pact), containing measures that aim to promote fiscal rebalancing through actions aimed at redesigning the federative pact between the Union, States, Federal District and Municipalities.

1 Symmetric federalism is characterized by homogeneity in the distribution of competencies and revenues among the federated entities. Asymmetric federalism, on the other hand, is characterized by legal and competence disparity, due to regional heterogeneity.

2 Available at: << https://www.gov.br/economia/pt-br/centrais-de-conteudo/publicacoes/notas-informativas/2019/nota_ajuste_expansionista_31_12_2019.pdf >> Accessed September 18, 2021.

Furthermore, this year Complementary Law (LC) 178/2021 was approved, which provides for transparency and fiscal balance actions for subnational entities. The LC establishes goals and commitments that must be met by the entities in order to obtain benefits such as guarantees in credit operations by the Union. According to the Finance Bulletin of the Subnational Entities[3] of 2021, the National Treasury points out that the entities have diversified realities, so the Fiscal Restructuring and Adjustment Programs of the Subnational Entities were restructured in the LC 178/2021 with the objective of adapting the programs proposed by the Union to a wider range of fiscal situations of the entities.

Thus, fiscal federalism is a topic that has been discussed and reevaluated in the scope of public administration, and it is important that this discussion also be deepened at the academic level.

In addition, the strong economic recession imposed by the pandemic brings the need to evaluate the most effective ways to provide economic growth. In this sense, revisiting the theories and studying their empirical implications allows us to better evaluate the possibilities of economic policies that provide vigorous, sustainable, balanced, and inclusive growth.

The results found point out that fiscal decentralization is not an instrument capable of propitiating economic growth in Brazil. The long-term expenditure multipliers decrease as fiscal decentralization increases. This result shows that local governments tend to spend less efficiently, that is, the possibility of considering local characteristics and needs in order to improve social welfare is not valid.

1.6 DELIMITATIONS OF THE STUDY SCOPE

This study is limited to evaluating the impact of consolidated expenditures by subnational entities on economic growth through an ARDL model and the calculation of long-term multipliers of expenditures in relation to economic growth. Although the model included the consolidated tax burdens of the subnational entities, aspects related to transfers from the Union to the subnational entities were not considered due to unavailability of data for part of the period analyzed.

1.7 ORGANIZATION OF THE STUDY

This study is divided into six sections, the first being this introduction. The second section presents the literature review, containing theoretical and empirical studies. The third section presents the data and how it was treated. The fourth section presents the methodology used. In the fifth section the results of the empirical analysis are reported. The sixth section contains the final considerations, followed by the appendices and bibliographical references.

3 Available at: << https://www.tesourotransparente.gov.br/publicacoes/boletim-de-financas-dos-entes-subnacionais/2020/114>> Accessed September 18, 2021.

2. THEORETICAL FRAMEWORK

2.1 THEORETICAL CONTRIBUTIONS

Several researchers have modified economic growth models - Solow's Model, Barro's Endogenous Growth Model, and Diamond's Overlapping Generations Model - to incorporate a potential relationship between fiscal decentralization and economic growth (Brueckner 2006; Davoodi e Zou 1998; Thiessen 2003).

The most common analytical framework relating spending decentralization and economic growth is a model developed by Davoodi e Zou (1998)which is a modified version of the model by Barro (1990). In this model, a Cobb-Douglas production function has two inputs (private capital and public capital) divided into three levels of government (federal, state, and local). Public spending is financed through taxes levied on the output. By maximizing the utility function of a representative agent with respect to a dynamic budget constraint, the following solution is obtained: the growth rate of output depends on the shares of different levels of government in total public spending. From this model, it is possible to calculate the growth-maximizing shares of public spending. Using data from 46 countries for the period 1970 to 1989, the results obtained indicated the existence of a negative relationship between fiscal decentralization and economic growth in developing countries, as well as the nonexistence of this relationship for developed countries. As far as this study is concerned, one must consider that cultural and structural differences among the various countries are substantial, and without proper adjustments it is difficult to determine the real effect of fiscal decentralization, a fact recognized by the authors. Another aspect that they emphasize is that the measure of decentralization needs to reflect the autonomy of subnational governments in deciding how they will carry out their expenditures, and if there is no autonomy in this sense, subnational governments behave as mere agents of the central government.

The augmented Solow model presented by Mankiw, Romer, e Weil (1992) also provides the basis for econometric analyses of the relationship between fiscal decentralization and economic growth (Thiessen 2003). In addition to the standard determinants of economic growth that are derived from Solow's model-such as initial value of output; physical and human capital accumulation; and labor force growth-in the empirical specification, Thiessen (2003) uses additional decentralization measures and other conditioning factors as independent variables.

Brueckner (2006) uses Diamond's model to show the advantages of fiscal decentralization, theoretically. The Diamond-Brueckner Model consists of two overlapping generations at time t: the young and the old (each agent lives for two periods, being young in the first period, and the old in the second period). The young individuals can invest part of their time in education increasing their future income and can work the rest of the time. In addition, this young generation can save a portion of

their income and invest it in physical capital. In turn, old individuals devote all their time to work. A consumption basket for each generation consists of two goods: public and private. The old generation, whose disposable income is high, given its higher level of human capital and its greater dedication of hours to work, can consume more, and therefore has a high demand for public goods and services. Brueckner (2006) then compares two systems: a decentralized system (federalism) and a centralized system (unitary). Under federalism, it is assumed that a perfect Tiebout-sorting mechanism allows individuals to sort themselves into two homogeneous demand jurisdictions with different levels of public good provision (higher for old than for young). Under a unitary system, a common level of public good is provided for all individuals. According to the proposition presented by Brueckner (2006), the time spent on education and levels of physical capital is greater in the federalist equilibrium than in any unitary equilibrium. Economic growth, determined by the growth rate of human capital is therefore greater under federalism. Although excessively abstract and difficult to implement empirically, this model provides insights into how federalism, in the form of the decentralized provision of public goods and services, can positively influence economic growth.

In summary, previous research about the theoretical relationship between fiscal decentralization and economic growth, Baskaran, Feld, e Schnellenbach (2014) identify four potential positive channels of this relationship: (i) heterogeneity preferences; (ii) market preservation; (iii) structural change; and (iv) policy innovation. First, of a positive relationship between fiscal decentralization and economic growth. Second, market preservation means that fiscal decentralization increases horizontal fiscal competition, which constrains the negative incentives of subnational governments, improves market development conditions, and ultimately accelerates economic growth. Third, structural change is related to the potential positive effects of decentralization during structural crises (for example, when there is a permanent negative demand shock in a specific industry sector). Structural change is easy to implement under decentralization because in a centralized system, risk-averse public authorities may have a high interest in providing excessive financial aid to inefficient industrial sectors, which prevents structural reforms (Besley e Coate 2003). Fourth, policy innovation means that fiscal decentralization creates conditions for using regions as laboratories for economic experiments (Oates 1999). If a policy innovation is successful in one region of the country, it can be disseminated among other regions, creating opportunities for economic growth.

2.2 EMPIRICAL CONTRIBUTIONS

Thus, the theoretical relationship between fiscal decentralization and economic growth is established and justified. But is there solid empirical evidence of this relationship?

Researchers and policymakers have shown a growing interest in fiscal decentralization as an effective strategy to promote economic growth, based on the following arguments: (1) fiscal decentra-

lization contributes to increased economic efficiency as local governments are able to provide better public goods and services due to proximity and informational advantages; (2) competition and population mobility among local governments for the provision of public goods and services ensures the right match of preferences between communities and local governments (Tiebout 1956).

Oates (1993) argues that there is strong reason to believe that policies designed to provide infrastructure and human capital that are sensitive to local and regional conditions tend to be more effective in encouraging economic development than centrally determined policies that ignore geographic differences. This is based on the assumption that local governments will be proactive in identifying the needs and pursuing the well-being of their population. It is argued that fiscal decentralization has the useful potential to influence economic development. However, the translation of this potential into growth depends on some crucial conditions regarding the way in which institutions respond to the level of local welfare and their own structure. There is a considerable contrast between the level of fiscal centralization in developed and developing countries. By the fiscal indices used in the study, developing nations had a much higher level of centralization than industrialized countries. However, while differences in fiscal centralization between industrialized and developing countries are a well-established property of the tax structure, their significance and implications are not very clear. For this reason, a better understanding of these relationships is important and justifies interest in the potential that fiscal decentralization has to foster economic growth.

Although there is an accepted theoretical prediction that fiscal decentralization contributes positively to economic growth, some studies conducted have reached a contrary result. For example, Zhang e Zou (1998) conducted a study with data from China regarding how the allocation of fiscal resources between the central government and local governments affected economic growth. Using data from 1980 to 1992 from 28 provinces, the results obtained indicated that there was a negative relationship between fiscal decentralization and economic growth in Chinese provinces. It was argued that the results could be explained by the current stage of economic development observed in the country at the time, when the central government made substantial investments in projects of national priority such as highways, railroads, energy, and telecommunications. These investments may have a more significant impact on provincial growth when made by the central government, than their local counterparts.

In turn, Xie, Zou, e Davoodi (1999) conducted a study with data on the US economy from 1948 to 1994. Decentralization was measured as the share of spending by each level of government in consolidated spending. Their results showed that the existing level of fiscal decentralization is consistent with growth maximization, and that at the stage of development and fiscal decentralization observed in the study period, implementing more decentralization would be harmful to growth.

However, Akai e Sakata (2002) found empirical evidence that fiscal decentralization contributes positively to economic growth. They used a database with fiscal and socioeconomic data for the 50 states of the United States for the period 1992 to 1996, arguing that it was a more appropriate database

because it did not incorporate periods of large economic growth and there were no substantial historical differences among the states analyzed. The estimated econometric model considers four indicators of fiscal decentralization, evaluated individually: income, spending, autonomy, and an average between income and spending. In addition, independent variables on income distribution, education, patents, population among others, are used to test the effect of fiscal decentralization[4].

Yushkov (2015) prepared an empirical analysis for regions of Russia in the period from 2005 to 2012, and the results obtained showed that excessive decentralization of spending within a region, which is not accompanied by the respective level of revenue decentralization, is negatively and significantly related to regional economic growth. On the other hand, regional dependence on intergovernmental fiscal transfers from the federal government is positively related to economic growth.

In the Brazilian case Afonseca e Gadelha (2020) analyzed the relationship between the level of fiscal decentralization and the economic growth of macro-regions in Brazil, taking as reference the study of Akai e Sakata (2002). From the estimation of an econometric model in static panel data with fixed effects covering the period from 1995 to 2016, the results obtained indicated that fiscal decentralization positively impacted the economic growth of Brazilian macro-regions, but through different transmission channels. Specifically, in the South and Southeast macro-regions, revenue autonomy promoted economic growth, while in the other macro-regions, the relevant aspect was revenue decentralization.

In summary, the results of various studies on the relationship between fiscal decentralization and economic growth from a cross-country and cross-regional perspective are quite contradictory. Some researchers have found a positive relationship (Akai e Sakata 2002; Buser 2011; Iimi 2005; Thiessen 2003; Afonseca e Gadelha 2020)while other researchers have shown that fiscal decentralization and economic growth are negatively correlated (Baskaran e Feld 2013; Davoodi e Zou 1998; Rodríguez-Pose e Ezcurra 2011) or not correlated (Asatryan e Feld 2015; Thornton 2007). In contemporary studies, researchers refer to the multidimensional nature of fiscal decentralization, and their results show that decentralization of government spending has a negative effect on economic growth, while decentralization of revenue is positively related to long-term growth prospects (in the case where spending is more decentralized than revenue). In other words, the convergence hypothesis is confirmed: achieving a balance between revenues and expenditures at the regional and local levels is positively related to economic growth (Cantarero e Gonzalez 2009; Gemmell, Kneller, e Sanz 2013; Rodríguez-Pose e Krøijer 2009) and creates positive incentives for subnational governments to preserve market institutions (Jin, Qian, e Weingast 2005).

4 With respect to previous works that obtained results contrary to the theoretical hypothesis, Akai and Sakata (2002) make some caveats. First, Zhang and Zou (1998) used data from a period of high economic growth in China and the United States. Akai and Sakata (2002) argue that in such periods the highest level of government is required to promote public investment that generates large externalities in the early stages of economic development, which explains the negative relationship found for the data used. Second, Davoodi and Zou (1998) use data from several countries without taking into account that institutional and cultural differences are substantial, which makes it difficult to determine the true effect of fiscal decentralization.

2.3 ENDOGENOUS GROWTH MODEL WITH DIFFERENT LEVELS OF GOVERNMENT SPENDING PROPOSED BY XIE, ZOU AND DAVOODI (1999)

Xie, Zou, e Davoodi (1999) expanded and applied Barro's (1990) mathematical model to the US economy, segregating public expenditures among the three levels of government (federal, state, and local). Thus, the study considers that public spending (g) is divided among the three levels of government: federal (f), state (s), and municipal (l), that is:

$$f + s + l = g \tag{1}$$

The production function is CES, that is, the elasticity of substitution is constant, and it is a special case of the Cobb-Douglas production function when $\emptyset = 0$ as follows:

$$y = \left[\alpha k^{\emptyset} + \beta f^{\emptyset} + \gamma s^{\emptyset} + \omega l^{\emptyset}\right]^{\frac{1}{\emptyset}}, \quad -\infty < \emptyset < 1 \tag{2}$$

Where: k is private capital; $0 < \alpha, \beta, \gamma, \omega < 1$ e $\alpha + \beta + \gamma + \omega = 1$.

It is noteworthy that neither human capital nor labor are considered in this model.

Consolidated government spending is financed by taxes, which correspond to a rate (τ) of income, as follows:

$$g = \tau y \tag{3}$$

To find the long-term growth rate of the economy, we first analyze the choice of the private sector, where a representative individual is the one who maximizes his or her utility curve, which is defined according to the equation below:

$$max \int_0^{\infty} \left[\frac{c^{1-\sigma} - 1}{1-\sigma}\right] e^{\rho t}\, dt \tag{4}$$

Where: c is consumption; σ is the inverse of the intertemporal elasticity of substitution, and ρ is the rate of time preference.

The individual faces a dynamic budget constraint, which is defined by the following equation:

$$\dot{k} = \frac{dk}{dt} = (1-\tau)\left[\alpha k^{\emptyset} + \beta f^{\emptyset} + \gamma s^{\emptyset} + \omega l^{\emptyset}\right]^{\frac{1}{\emptyset}} - c \tag{5}$$

being k_0 given.

The individual's choices are made based on the tax rate (τ) and the expenditures of the three levels of government (f, s, and l) disclosed. With this, he chooses his consumption basket $\{k(t): t \geq 0\}$, and to characterize the individuals' optimal resource allocation, we write below the corresponding

Hamiltonian (relationship between the utility function and the budget constraint) as follows:

$$H = \left[\frac{c^{1-\sigma}-1}{1-\sigma}\right] + \lambda\left\{(1-\tau)\left[\alpha k^{\emptyset} + \beta f^{\emptyset} + \gamma s^{\emptyset} + \omega l^{\emptyset}\right]^{\frac{1}{\emptyset}} - c\right\} \quad (6)$$

The first-order condition is given as:

$$c^{-\sigma} = \lambda \quad (7)$$

$$\lambda` = \rho\lambda - \lambda\alpha(1-\tau)\left[\alpha k^{\emptyset} + \beta f^{\emptyset} + \gamma s^{\emptyset} + \omega l^{\emptyset}\right]^{\frac{(1-\emptyset)}{\emptyset}} k^{\emptyset-1} \quad (8)$$

The transversality condition is $k\lambda e^{-\rho t}$ when t tends to infinity.

The equations (5), (7) e (8), together with the initial condition and the transversality condition determine the individual's optimal response and from them we find the consumption growth rate, which is given by:

$$\frac{c`}{c} = \frac{r(x)-\rho}{\sigma} \quad (9)$$

Where x denotes the vector (k, f, s, l, τ); r(x) is interpreted as the real rate of interest and is defined by the following equation:

$$r(x) = \alpha(1-\tau)\left[\alpha k^{\emptyset} + \beta f^{\emptyset} + \gamma s^{\emptyset} + \omega l^{\emptyset}\right]^{\frac{(1-\emptyset)}{\emptyset}} k^{\emptyset-1} \quad (10)$$

The expenditures of the three levels of government are defined as φ_f, φ_s e φ_l and the sum of the three is equal to 100% of public spending ($\varphi_f + \varphi_s + \varphi_l = 1$), that is:

$$\varphi_f = \frac{f}{g}, \varphi_s = \frac{s}{g}, \varphi_l = \frac{l}{g} \quad (11)$$

Substituting the equations (10) e (11) into equation (9), we obtain the economy's long-term growth rate (G) as a function of shared spending among the three levels of government, the tax rate, and other exogenous factors, as follows:

$$G = \frac{\propto(1-\tau)}{\sigma}\left[\frac{\alpha\tau^{-\emptyset}}{\tau^{-\emptyset}-\beta{\varphi_f}^{\emptyset}-\gamma{\varphi_s}^{\emptyset}-\omega{\varphi_l}^{\emptyset}}\right]^{\frac{1-\emptyset}{\emptyset}} - \frac{\rho}{\sigma} \quad (12)$$

This shows that the variation in spending among the three levels of government can impact economic growth.

To examine how the long-run growth rate responds to various levels of spending and taxes, it is assumed that the government's objective is to maximize growth in equation (12), which is identical to maximizing the growth of individual consumption, which coincides with the growth rate of output and capital in equation (9), subject to the government's budget constraint. With this, the problem can be formulated as one of maximizing equation (12), as follows:

$$f + s + l \leq \tau\left[\alpha k^{\emptyset} + \beta f^{\emptyset} + \gamma s^{\emptyset} + \omega l^{\emptyset}\right]^{\frac{1}{\emptyset}} \tag{13}$$

The maximum growth rate is given by the following equation:

$$\frac{\tau^{1-\emptyset}}{\emptyset\tau+(1-\emptyset)} = \prod^{1-\emptyset}, \text{ onde: } \prod = \beta^{\frac{1}{(1-\emptyset)}} + \gamma^{\frac{1}{(1-\emptyset)}} + \omega^{\frac{1}{(1-\emptyset)}}. \tag{14}$$

The growth-maximizing shares of federal, state, and local government spending are given by:

$$\varphi_f^* = \frac{\beta^{1/(1-\emptyset)}}{\prod} \tag{15}$$

$$\varphi_s^* = \frac{\gamma^{1/(1-\emptyset)}}{\prod} \tag{16}$$

$$\varphi_l^* = \frac{\omega^{1/(1-\emptyset)}}{\prod} \tag{17}$$

In equations (15), (16) e (17) are defined as the individual productivities of each level of government, i.e, $\beta^{1/(1-\emptyset)}$ is the productivity of the federal government $\gamma^{1/(1-\emptyset)}$ is the productivity of the state government, and $\omega^{1/(1-\emptyset)}$ is the productivity of the local government.

Similarly, the aggregate of the productivity of the three levels of government can be defined a: $\prod = \beta^{\frac{1}{(1-\emptyset)}} + \gamma^{\frac{1}{(1-\emptyset)}} + \omega^{\frac{1}{(1-\emptyset)}}$.

From the equations (15), (16) e (17) it is clear that the growth-maximizing shares of spending are equal to individual productivity ratios relative to aggregate productivity. If the current spending share does not correspond to growth maximization, then some reallocation will be required for economic growth improvement.

This can be clearly identified by the Cobb-Douglas production function, considering $\emptyset = 0$ then the maximum growth rate in equation (14) will be as follows:

$$\tau^* = \beta + \gamma + \omega \tag{18}$$

This maximum rate is exactly the same as that obtained by Barro (1990) in equation (2) after making the notation consistent. With that, $\prod = \beta + \gamma + \omega$ and the growth-maximizing rates are given by:

$$\varphi_f^* = \frac{\beta}{\beta+\gamma+\omega} \quad (19)$$

$$\varphi_s^* = \frac{\gamma}{\beta+\gamma+\omega} \quad (20)$$

$$\varphi_l^* = \frac{\omega}{\beta+\gamma+\omega} \quad (21)$$

The model focuses on growth maximization with the allocation of public expenditures of the three levels of government and the tax burden. Naturally, the question can be raised that the government can maximize the welfare of society. In general, growth maximization and welfare maximization lead to different tax rates and different shares of spending for the three levels of government. However, if the production function is Cobb-Douglas, these two types of maximization produce the same solutions.

2.4 CONTRIBUTION OF THIS STUDY TO THE LITERATURE

This study contributes to the literature on the topic by empirically demonstrating that the current design of fiscal federalism and fiscal decentralization does not contribute to long-term sustainable economic growth in Brazil.

3. DATA DESCRIPTION AND TREATMENT

The study used annual data covering the period from 1954 to 2018. The database is composed of several historical series, which were constructed as detailed below:

1. Real Gross Domestic Product (GDP) per capita growth rate (Y_t). The current GDP was deflated by the General Price Index - Internal Availability (IGP-DI)[5] and divided by the population[6]. The GDP values from 1954 to 1990 are from the historical series of the Brazilian Institute of Geography and Statistics (IBGE)[7] and from 1990 onwards from data of the

5 Source: Getúlio Vargas Foundation (FGV). Available at: http://www.ipeadata.gov.br/Default.aspx.

6 Source: IBGE. Available at: http://www.ipeadata.gov.br/Default.aspx.

7 Source: IBGE. Available at: https://seculoxx.ibge.gov.br/economicas/financas-publicas.

Institute of Applied Economic Research (IPEA)[8].

2. Expenditures by the federal government (df_t), state (de_t) and municipalities (dm_t), as a proportion of total expenditure. In accounting terms, the expenditure committed by each entity of the Federation is considered. The values were transformed in terms relative to the total expenditures of the three spheres. The values from 1954 to 1999 come from the IBGE historical series[9] and from 2000 onwards from data from the Public Sector Balance Sheet[10].
3. Federal (ctf), state (cte) and municipal (ctm) tax burden as a proportion of the total tax burden. The values from 1954 to 1999 are from the IBGE historical series[11] and from 2000 onwards from data from the federal government's rendering of accounts to the Federal Audit Court (TCU)[12].
4. Capital (k) as a proportion of GDP. The values of gross fixed capital formation were obtained from IBGE's historical series[13], and the data were transformed in terms of percentage of current GDP.
5. Household consumption (gf) as a proportion of GDP. It was obtained by subtracting the total consumption and government consumption series, both produced by IBGE[14], the result was divided by the current GDP.

All data were log-transformed so that the results could be analyzed in the form of elasticities.

4. METHODOLOGY

4.1 TESTING AND UNIT ROOT

When dealing with time series data, researchers should be aware of possible structural breaks. A structural break occurs when the behavior of a series abruptly changes at a given point in time. Such breaks usually result from exogenous shocks, for example, commodity price shocks, conflicts, policy changes, and exchange rate and/or monetary regime changes.

In econometric analysis, one of the main assumptions is that descriptive statistics (parameters), such as the mean and standard deviation, are relatively stable over time. However, structural

8 Source: IPEA. Available at: http://www.ipeadata.gov.br/Default.aspx.

9 Source: IBGE. Available at: https://seculoxx.ibge.gov.br/economicas/financas-publicas.

10 Source: IBGE. Available at: https://seculoxx.ibge.gov.br/economicas/financas-publicas.

11 Source: IBGE. Available at: https://seculoxx.ibge.gov.br/economicas/financas-publicas.

12 Source: IBGE. Available at: https://portal.tcu.gov.br/contas/contas-do-governo-da-republica/.

13 Source: IBGE. Available at: http://www.ipeadata.gov.br/Default.aspx.

14 Source: IBGE. Available at: http://www.ipeadata.gov.br/Default.aspx.

breaks often distort these statistics. As a result, the parameters may no longer accurately characterize the properties of the series and econometric methods may generate biased and inconsistent estimates and, as a result, poor forecasts and estimations.

Furthermore, Maddala e Kim (1999) explain that structural changes affect the results of unit root, cointegration and causality tests. In view of this, two unit root tests that consider the presence of structural break will be considered in the stationarity analysis. The first test is proposed by Saikkonen e Lütkepohl (2002)hereafter referred to as the SL test. This test considers that change can occur over a period of time and using a level change function ($f(\theta)'\gamma$) it is possible to obtain a gradual transition function, which is added to the deterministic term. The general model is expressed in the following equation:

$$y_{t,} = \mu_{0,} + \mu_1 t + f(\theta)'\gamma + v_t \tag{22}$$

Where y_t is the data series μ_0 is the intercept μ_1 is the deterministic trend coefficient; θ and γ are unknown parameters, v_t are residuals generated by an autoregressive process, which must contain unit root. There are three possible change functions $f(\theta)'\gamma$: change dummy, exponential change and rational change. In this study we used rational change, which represents a change in the lag function of the operator, applied to a change dummy. In the last test, the deterministic terms are estimated by Generalized Least Squares (GLS), then they are subtracted from the original series, generating a new series. Then the Augmented Dickey-Fuller (ADF) test is applied to the adjusted series. Critical values are tabulated by Lanne, Lütkepohl, e Saikkonen (2002).

The second test implemented is proposed by Vogelsang e Perron (1998)VP, hereafter referred to as VP, which also allows for endogenous breaks by an innovation outlier, VP like SL assumes that breaks occur gradually. Two models are used to check the stationarity hypothesis: break at the intercept, break at the intercept and break at the trend, both at level and first difference. The general model is expressed in the form of the following equation:

$$y_t = \mu_0 + \mu_1 y_{t-1} + \mu_2 t + \beta_1 D_l + \beta_2 D_p + \beta_3 D_t + \sum_{i=1}^{j} p_t \Delta y_{t-i} + \varepsilon_t \ , \tag{23}$$

where y_t is the data series, μ_0 the intercept μ_2 the deterministic trend coefficient; β_1, β_2 e β_3 are the break parameters to be estimated; D_l, D_p e D_t are dummies for the intercept break, level break, and trend break, respectively; p_t e μ_(1) are unknown parameters, Δ is the first difference operator, j is the best lag selected by the Akaike information criterion; and ε_t are independent and identically distributed innovations (i.i.d).

4.2 GROWTH EQUATION

The first specification that was used to understand the interaction between the variables is a multivariate estimation conducted by the autoregressive and distributed lags (ARDL) model.

The linear relationship between federal government expenditures and the real growth rate of GDP per capita follows Xie, Zou, e Davoodi (1999)using different variables from those used by them in the vector X_t^j vector, as follows:

$$Y_t = \alpha_{t,} + \beta_1 X_t^j + \beta_2 df_t + \beta_3 de_t + \beta_4 dm_t + \varepsilon_t \ , t = 1, \dots, T \quad (24)$$

where Y_t is the real GDP per capita growth rate; df_t represents the federal government's expenditures, de_t represents the state government expenditures, and dm_t represents municipal government expenditures, and ε_t is the error term. α, β_1, β_2, β_3 e β_4 are unknown parameters to be estimated. The vector X_t^j includes variables that may impact the relationship between government spending and expenditures, which are described in Section 3.

In ARDL models all variables, dependent and independent, are related contemporaneously and in their lagged values. The advantages of this technique is that different lags between variables are accepted, which allows the dynamics of the system to be captured without omitting important lags.

4.3 LONG-TERM MULTIPLIERS

Consider Y_t the real growth rate of GDP per capita, X_t^j the vector of regressors related to expenditures (federal, state, and municipal) as a proportion of total expenditure, and the independent and identically distributed error term $\varepsilon_t \sim N(0,\sigma^2)$. A distributed lagged autoregressive model is given by:

$$Y_t = C + \underbrace{\alpha_1 Y_{t-1} + \cdots + \alpha_k Y_{t-k}}_{PIB} + \underbrace{\beta_0 X_t^j + \beta_1 X_{t-1}^j + \cdots + \beta_n X_{t-n}^j}_{Despesa} + \varepsilon_t \quad (25)$$

Thus, the current real GDP per capita growth rate is related to the real GDP per capita growth rates of previous periods, to current expenditures, and to lagged expenditures. One of the features of equation (25) is that it makes it possible to find the dynamic effects of a change in government spending on current and future values of the real GDP per capita growth rate. The immediate effect, called the impact multiplier, of a unit change in government expenditure is given by the coefficient β_0.

The equation (25) can be rewritten as follows:

$$A(L)Y_t = B(L)X_t + \varepsilon_t \quad (26)$$

where:

$$A(L) = \left(1 - \alpha_1 L - \alpha_2 L^2 - \cdots - \alpha_k L^k\right) \quad (27)$$

$$B(L) = (\beta_0 + \beta_1 L + \beta_2 L^2 + \cdots + \beta_n L^n) \quad (28)$$

If the unit of variation in government spending is sustained, an expression for the long-run multiplier can be obtained. Assuming that the variables are stationary and are in the form of logarithms, one can define static equilibrium as the situation where Y e X are at their long-run expected values:

$$Y^* = \left(\frac{\overbrace{\beta_0+\beta_1+\beta_2+\cdots+\beta_n}^{Despesa}}{\underbrace{1-\alpha_1-\alpha_2-\cdots-\alpha_k}_{PIB}} \right) X^* = \frac{B(1)}{A(1)} X^* \quad (29)$$

The term B(1)/A(1) is known as the long-run expenditure elasticity of the real growth rate of GDP per capita, also known as the long-run multiplier of the real growth rate of GDP per capita relative to expenditures. This term has a direct relationship with growth-maximizing rates as described in equations (19) to (21), because these rates are calculated in a steady-state situation for the modeling economy.

Thus, in principle, the contributions of each subnational entity of the Federation to long-term real economic (de)growth can be calculated individually. In other words, in a country that has presented sustainable real economic growth in the long run, the multiplier will indicate which portion of government spending contributes to this growth. But in countries that historically have not presented sustainable long-term economic growth, as is the case of Brazil, the values of the expenditure elasticity will highlight which sphere of government has been responsible for preventing this growth from occurring.

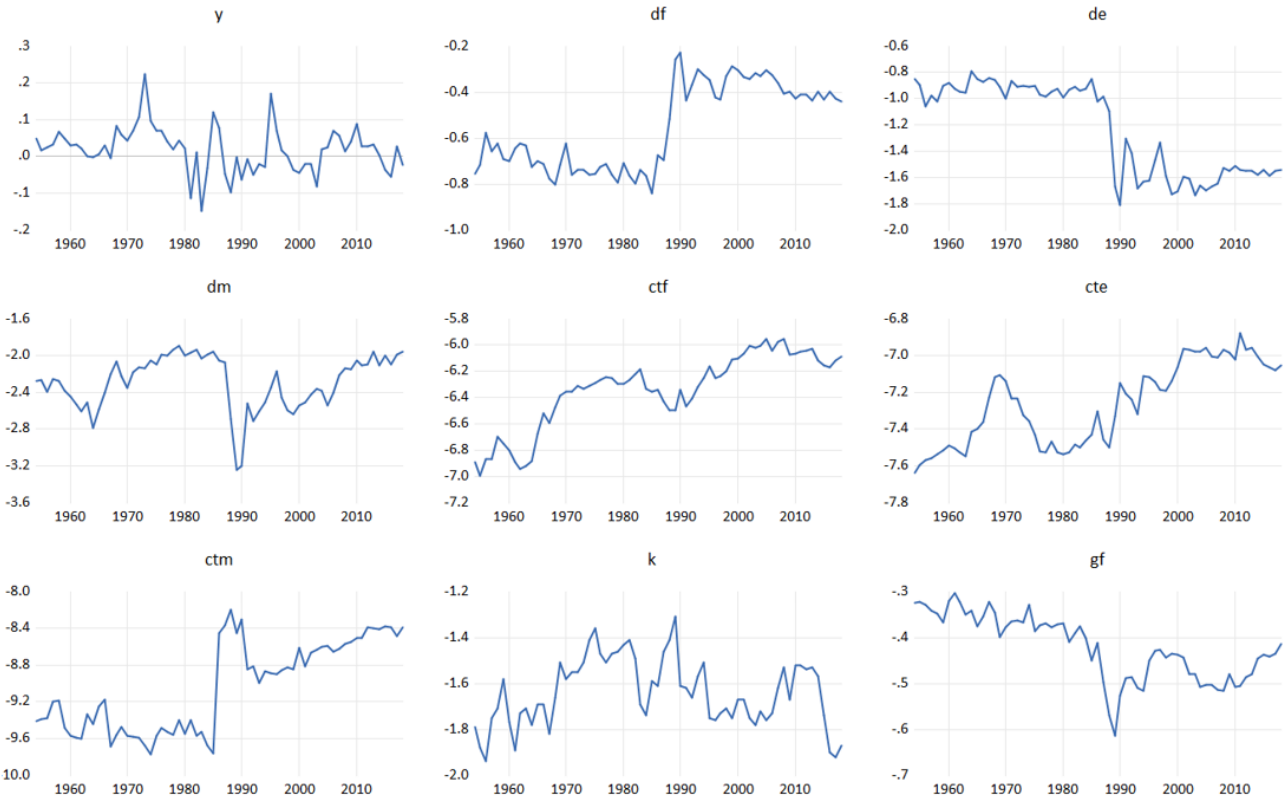
Equation (25) must meet certain assumptions. First, the variables in the econometric model must be stationary. Second, the expected mean value of the error term must be zero. Third, if the error term is not serially correlated, the coefficients of the model estimated by ordinary least squares (OLS) will be consistent in the statistical sense. Finally, it is important that the assumptions of normality and homoscedasticity of the error term are valid. All these assumptions have been duly met and will be analyzed in the next section and in the appendices of this study.

5. ANALYSIS OF RESULTS

5.1 UNIT ROOT TEST RESULTS

The graphic analysis of the treated series showed that we should find structural breaks in the series. These results were expected, due to the long period of time considered in the study and the several economic changes in the country, mainly regarding the relations between the federated entities. The breaks in the series and can be observed graphically in Picture 1.

Picture 1 – Treated Series



Therefore, the analysis was performed using the unit root test with structural breaks, as presented in Table 2. Both, the SL and VP tests reached the same conclusions, in which the series real GDP per capita growth rate, federal and state expenditures and household expenditures were stationary in level. However, municipal expenditures, total tax burden, and capital and were stationary in first difference.

Most of the selected breaks occurred in 1986 and 1989. Considering that the promulgation of the Federal Constitution dates back to 1988 and established the foundations of our current federative relationship, we included dummies referring to these periods in the model.

Another important break selected in the tests occurred between the periods 1990 and 1995, in which the federative fiscal relation also suffered changes, due to the establishment of fiscal consolidation rules, in which states and municipalities lost powers and there was a greater concentration of decisions and revenues with the federal government. Vaz (2008) explains that the implementation of the Plano Real, states and municipalities lost their capacity to intervene in the economic process, due to the loss of banks and state-owned companies, as well as experiencing a decrease in sources for tax financing, due to the decrease in their participation in funds, and financial, due to limitations in indebtedness.

Table 2 - Unit Root Test with Structural Break

Variable	Test Equation	*SL - Rational Shift*			*VP- Innovational Outlier*		
		Data	t- statistic	Lags	Data	t- statistic	lags
y	Constant	1973	-6.139762***	0	1995	-3.0663* *	2
	Constant and trend	1973	-6.014588***	0	1995	-3.1808* *	2
	D(Constant)	1960	-10.73290***	0	1995	-3.1046* *	2
	D(Constant and trend)	1966	-10.55435***	0	1995	-4.4227* *	2
df	Constant	1988	-1.8238	2	1937	-6.736795***	3
	Constant and trend	1988	-3.6260***	2	1987	-7.461594***	2
	D(Constant)	1988	-4.0593* **	2	1989	-9.131038***	1
	D(Constant and trend)	1988	-4.2569* **	2	1985	-8.27812 4***	1
de	Constant	1989	-2.5811*	2	1988	-8.419236***	2
	Constant and trend	1989	-3.0688* *	2	1987	-5.801830***	2
	D(Constant)	1989	-28650*	2	1989	-11.95261***	1
	D(Constant and trend)	1989	-4.0296* **	2	1996	-10.11758	1
dm	Constant	1988	-0.2984	2	1992	-3.675161	1
	Constant and trend	1988	-1.5465	2	1987	-7.160647***	1
	D(Constant)	1988	-24547	2	1991	-8.13 3414***	0
	D(Constant and trend)	1988	-3.5099* *	2	1991	-8.257405***	0
ctf	Intercept	1964	-3.763103	0	1965	-1.3529	2
	Trend and Intercept	1964	-3.814095	0	1965	-22210	2
	D(Intercept)	1965	-8.449232***	0	1965	-5.6060* **	2
	D(Trend and Intercept)	1963	-8.717057***	0	1965	-5.6058* **	2
cte	Intercept	1998	-3.728481	0	199-	-21425	2
	Trend and Intercept	1998	-3.612929	8	199-	-23797	2
	D(Intercept)	1990	-8.100420***	0	1994	-4.1604***	2
	D(Trend and Intercept)	1990	-7.918444***	0	199-	-4.6876* **	2
ctm	Intercept	1985	-8.086013***	2	1986	-2.2044	2
	Trend and Intercept	1985	-8.330160***	10	1986	-1.7928	2
	D(Intercept)	1967	-9.310931***	9	1986	-5.5801***	2
	D(Trend and Intercept)	1988	-9.617980***	0	1986	-5.3440***	2
k	Constant	2014	-3.448563	0	1990	-2.0101	2
	Constant and trend	1968	-4.428859	1	1990	-23531	2
	D(Constant)	1969	-8.367088***	0	1990	-3.6307* **	2
	D(Constant and trend)	1969	-8.240240***	0	1990	-4.0685* **	2
gf	Constant	1986	-5.206094***	9	1937	-0.6914	2
	Constant and trend	1986	-6.984244***	9	1937	-1.4354	2
	D(Constant)	1969	-7.869635***	0	1937	-5.2104***	2
	D(Constant and trend)	1967	-7.726115***	0	1937	-5.7488* **	2

Fonte: Elaboração dos Autores.

Nota: *, ** e *** representam significância aos níveis de 10%, 5% e 1%; D() representa testes em primeira diferença. Os valores críticos dos testes SL são: (i) modelo com constante: -3,48 (1%); -2,88 (5%); e -2,58 (10%); (ii) modelo com constante e tendência: -3,55 (1%); -3,03 (5%); -2,76 (10%). Os valores críticos dos testes VP são: (i) modelo com constante: -5,34 (1%); -4,86 (5%); e -4,60 (10%); (ii) modelo com constante e tendência: -5,72 (1%); -5,18 (5%); -4,89 (10%).

5.2 ESTIMATION RESULTS OF THE ECONOMETRIC MODEL

The ARDL model was applied accepting up to 5 lag lags. From the result the lags that did not present statistically significant results were excluded, leaving the model better adjusted. All dummies presented in the structural break tests were tested and only the dummy for the year 1995 (d1995) presented statistically significant results.

The model was defined by using the variables according to the results of the unit root tests, so the variables real GDP per capita growth rate, expenditure (federal, state and municipal) as a proportion of total expenditure, and household spending, were used in level; while the variables that became stationary only after differentiation - tax burden (federal, state and municipal) as a proportion of GDP, and capital - were used in first difference. The ARDL model used is reported in Appendix A.

As shown in Appendix B, the estimated model presented significant results in the residuals test, showing that the residuals have normal distribution, are homoscedastic and not auto correlated. The stability test also showed significant results, showing that the linear model is well specified in terms of functional form.

The coefficients found for the capital variable as a proportion of GDP also presented results consistent with economic theory, showing that higher investment spending leads to higher growth.

The coefficients estimated in the econometric model were used to calculate the long-term expenditure multipliers by federal entities. The calculation followed equation (29). The results are presented in Table 3 below:

Table 3 - Long-Term Expenditure Multipliers by Federal Entity

Expenditures	Long-Term Multiplier
Federal Expenditure	2,17
State Expenditure	1,42
Municipal Expenditure	0,25

Source: Developed by the Authors.

The results found show that the long-term expenditure multiplier decreases as there is greater decentralization. Thus, fiscal federalism is not an instrument that has the capacity to generate economic growth in Brazil.

The decreasing values of the long-term multipliers reported in Table 3 clearly reflect the current designs of fiscal federalism and fiscal decentralization, which generate imbalances and tensions between the Federation's entities and negatively impact long-term economic growth. And, as highlighted by Monteiro Neto (2014, p. 292-293), although the 1988 Federal Constitution established fiscal

decentralization, it is important to remember that a process of reversal of the constituents' initial objectives occurred. With the implementation of the Real Plan, starting in 1994, the effort to carry out the sanitation of public accounts and macroeconomic stabilization required the recentralization of fiscal funds in the sphere of the Union: the retention of 20% of all federal revenue in the form of the Social Emergency Fund (FSE), and then in the Fiscal Stabilization Fund (FEE); the creation of contributions, such as the permanent contribution on financial movement (CPMF) that was extinguished in 2007, the social contribution on net income (CSLL) and CIDE fuels, which need not be shared with subnational governments; and the fiscal discipline instituted by the Fiscal Responsibility Law. Finally, in the early 2000s, the federal government increasingly operated with a pattern of intergovernmental relations that aimed at decentralizing the execution of public policies - especially in the areas of education, health, and cash transfers to poor families - but left little room for subnational governments to design and implement their own policies. In other words, the state governments executed the federal government's public policy, but did not elaborate and design their own public policies.

Therefore, these results indicate that the subnational entities do not have a greater capacity to provide economic growth, despite the possibility of considering the local characteristics and needs in order to improve social welfare.

This conclusion is in line with the results of Davoodi e Zou (1998)who found a negative relationship between decentralization and economic growth for developing countries, Brazil being part of the list of countries selected in this study.

Our result is also in line with the evidence obtained by Zhang e Zou (1998) who concluded that decentralization and economic growth in China have a negative relationship, possibly caused by the higher investment capacity of the central government. Xie, Zou, e Davoodi (1999) They also concluded that more decentralization in the United States would be harmful, given that the level of decentralization consistent with growth maximization had already been achieved.

6. FINAL CONSIDERATIONS AND POLICY IMPLICATIONS

The general objective of the present study was to analyze the relationship between fiscal federalism, fiscal decentralization, and economic growth for the Brazilian case. The results found here corroborate the evidence already obtained in the literature regarding the existence of an asymmetric fiscal federalism, which has contributed to the absence of sustainable economic growth[15]. The lower results of the long-term expenditure multipliers point to the conclusion that the subnational entities have less capacity to generate economic growth. However, the lower decentralization of expenditures to these subnational entities represents less implementation of their own public policies. Thus, in terms of policy implications, we recommend efforts toward a symmetrical fiscal federalism in which the contributions of the federal entities to sustainable economic growth can occur in a balanced and efficient manner.

If, on the one hand, the democratic transition anchored by the 1988 Federal Constitution represented the transition from a closed and centralized political-economic model to a decentralized democracy, on the other hand, the fiscal decentralization resulting from this process stimulated increased public spending and misallocation, exerting adverse and hostile effects on economic growth. First, subnational governments (states, Federal District and municipalities) are financed by mandatory federal transfers (constitutional and legal), inducing low fiscal responsibility. Second, the rules of intergovernmental transfers induced the creation of small municipalities with high administrative costs and no minimum scale to operate efficiently. And to finance the increase in current spending and the public deficit, the tax burden was increased and investments in infrastructure were reduced. The high tax burden reduces the profitability and performance of companies, as well as raising their costs, negatively affecting their productivity, as many companies downsized or moved into the informal market of the economy.

The study did not evaluate the autonomy of the entities in terms of tax collection capacity or the possibility of indebtedness. It is a fact that the tax burden is concentrated on the federal government, which, by making transfers to the entities, allows them to increase their expenditures; however, part of these transfers represent tied revenue for the entities, so that there is not much margin for spending autonomy. The economic theory favorable to fiscal decentralization as a form of economic growth assumes that the entities have a better capacity to decide where to spend according to the needs of their citizens, however, the binding of revenues reduces this autonomy. Thus, this factor may have contributed to the result found in this study. Thus, it is suggested that this study be further developed by analyzing the impact of tied and untied revenues on economic growth.

15 Stylized facts have shown that historically other factors also contribute to low economic growth in Brazil, such as: misallocation of resources, low productivity of the factors of production, and excessive non-productive public spending.

Suggestions for future research are highlighted based on the results of this study. For example, it is considered important to conduct a study that evaluates in detail the items of expenditure of each entity that effectively impact positively on economic growth, considering that not all spending by entities should generate economic growth, in terms of non-Keynesian effects of fiscal policy.

In addition, the implementation of policies that improve the current design of the federative pact is suggested. The sole paragraph of Article 23 of the Federal Constitution provides for the establishment of complementary laws that establish rules for cooperation among the entities. In this way, through its regulation it is possible to define measures aimed at balancing development and welfare at the national level, as well as reducing the dependence of subnational governments on mandatory and voluntary transfers. On this last aspect, a broad tax reform is suggested to enable greater financial autonomy for subnational entities.

Finally, the path to vigorous, balanced and sustainable long-term economic growth, whose results are the generation of income and jobs for society, needs to be based not only on the redesign of fiscal federalism, but also on the implementation of structural reforms that enable greater investment, as well as pro-market microeconomic reforms that contribute to increasing the productivity of the economy. And these reforms need to reach all the entities of the Brazilian Federation in order to have a fair federative pact.

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APPENDIX A - ECONOMETRIC MODEL

Table 4 – Resultado da Estimação

Variable	Coefficient	Standard Error	t-statistic	Probability
Y(-1)	-0.287976	0.104797	-2.747945	0.0117
Y(-2)	-0.228917	0.098308	-2.328579	0.0295
Y(-3)	-0.338267	0.091986	-3.677376	0.0013
Y(-5)	-0.267171	0.120681	-2.213858	0.0375
DF(-2)	1.204895	0.250934	4.801644	0.0001
DF(-3)	1.706796	0.281286	6.067829	0.0000
DF(-4)	0.976675	0.238143	4.101209	0.0005
DF(-5)	0.720870	0.256742	2.807754	0.0103
DE(-1)	0.373743	0.065987	5.663915	0.0000
DE(-2)	0.511409	0.130300	3.924856	0.0007
DE(-3)	0.552827	0.148407	3.725064	0.0012
DE(-4)	0.792250	0.120653	6.566360	0.0000
DE(-5)	0.777962	0.143707	5.413526	0.0000
DM	0.163063	0.032560	5.008026	0.0001
DM(-3)	0.372195	0.062513	5.953841	0.0000
DM(-4)	0.116108	0.058927	1.970361	0.0615
DM(-5)	-0.124973	0.047643	-2.623120	0.0155
D(CTF)	-0.402311	0.076147	-5.283366	0.0000
D(CTF(-2))	0.327552	0.089982	3.640187	0.0014
D(CTF(-3))	0.293520	0.088107	3.331421	0.0030
D(CTF(-5))	0.373462	0.085340	4.376164	0.0002
D(CTE(-1))	-0.377195	0.080074	-4.710591	0.0001
D(CTE(-2))	-0.963547	0.099642	-9.670115	0.0000
D(CTE(-3))	-0.525154	0.083559	-6.284827	0.0000
D(CTE(-5))	-0.211655	0.093149	-2.272214	0.0332
D(CTM(-1))	0.059455	0.027301	2.177725	0.0404
D(CTM(-2))	-0.125238	0.031360	-3.993565	0.0006
D(CTM(-3))	-0.176334	0.034683	-5.084188	0.0000
D(CTM(-5))	0.078663	0.030379	2.589392	0.0167
D(KB)	0.395560	0.060755	6.510734	0.0000
D(KB(-1))	0.154319	0.055860	2.762614	0.0114
D(KB(-3))	0.138804	0.059482	2.333532	0.0292
D(KB(-5))	0.157704	0.051960	3.035083	0.0061
GF	-0.546631	0.286400	-1.908627	0.0694
GF(-1)	-1.193639	0.273532	-4.363800	0.0002

D1995	0.245005	0.045665	5.365275	0.0000
C	6.650821	0.868880	7.654473	0.0000

R^2	0.946283	Average SD	0.017611
R^2 Adjusted	0.858383	Standard Error SD	0.063752
Standard Error	0.023991	AIC	-4.354518
SQR	0.012663	SIC	-3.051656
Log Likelihood	165.4583	HQ	-3.845933
F-statistic	10.76543	DW	2.224358
Prob(F-statistic)	0.000000		

Source: Prepared by the authors using Eviews.

Note: Method: Ordinary Least Squares; DV: Dependent Variable: Y; Sample from 1960-2018 period, includes 59 observations after adjustments SQR: Sum of Squared Residuals. Prob: Probability; AIC: Akaike Information Criterion; SIC: Schwarz Information Criterion; HQ: Hannan-Quinn Information Criterion; DW: Durbin-Watson statistic.

APPENDIX B - RESIDUAL DIAGNOSTIC AND STABILITY ANALYSIS

B.1 Analysis of the Normality of Residuals

The error term represents the combined influence of many independent variables that are not explicitly introduced in econometric modeling. The Central Limit Theorem (CCT) allows one to show that if there are a large number of independent and identically distributed random variables, then, with few exceptions, the distribution of their sums tends to the normal distribution as the number of these variables increases indefinitely.

Without the normality assumption, under the other 10 assumptions, the Gauss-Markov theorem showed that the MQO estimators are the best linear unbiased estimators (MELNV or BLUE). With the additional assumption of normality, MQO estimators are not only best unbiased estimators, but also follow known probability distributions. The ordinary least squares estimators of the intercept and the angular coefficient are themselves normally distributed, and the MQO estimator of the variance of εi relates to the chi-square distribution.

The Jarque-Bera (JB) statistic is based on the differences between the skewness and kurtosis coefficients of the sample distribution of the series and the theoretical normal distribution and is used to test the null hypothesis that the sample was drawn from a normal distribution. In this test, you first calculate the skewness and kurtosis of the MQO residuals and use the following statistical test:

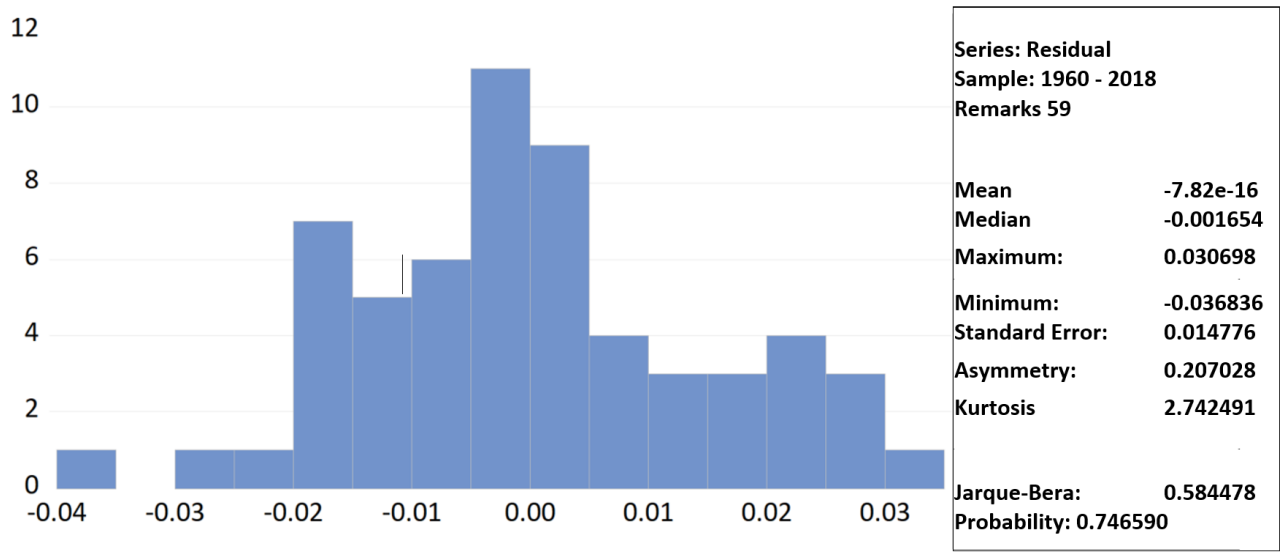
$$JB = n\left[\frac{S^2}{6} + \frac{(K-3)^2}{24}\right]$$

Where n = sample size, S = skewness coefficient and K = kurtosis coefficient. For a normally distributed variable, S = 0 and K = 3. Therefore, the JB test for normality is a test of the joint hypothesis that S and K are equal to 0 and 3, respectively. In this case, the value of the JB statistic is expected to be equal to zero.

Under the null hypothesis that the residuals are normally distributed, it is shown that, asymptotically (i.e., in large samples), the Jarque-Bera (JB) statistic follows the chi-square distribution with 2 degrees of freedom. If the p-value calculated for the JB statistic in an application is sufficiently low, which happens when the value of the statistic is very different from zero, one can reject the null hypothesis that the distribution of the residuals is normal. But if the p-value is reasonably high, which happens when the value of the statistic is close to zero, one does not reject the hypothesis of normality.

The results reported in Picture 2 below indicate the normality of the residuals of the estimated econometric model.

Picture 2 – Test for Normality of Residuals



B.2 Analysis of the Homoscedasticity of Residuals

In the presence of heteroscedasticity, the conventional variances and covariances of the least squares estimators exhibit bias. Consequently, the hypothesis tests based on them (t and F tests, confidence intervals) are no longer valid.

The results of White's Test reported in Table 5, below show that the residuals of the estimated econometric model are homoscedastic.

Table 5 – White's Heteroscedasticity Test

F-statistic	0.486167	Prob. F(36,22)	0.9734
Remarks * R2	26.14093	Prob. Chi-square(36)	0.8865
Sum of squares explained	3.166670	Prob. Chi-square (36)	1.0000

Source: Prepared by the authors using Eviews.

Note: Null Hypothesis - Homoscedasticity; Prob: Probability

B.3 Autocorrelation Analysis of Residuals

In the presence of autocorrelation, the MQO estimators, although linear, unbiased (i.e., unbiased), consistent and with asymptotic normal distribution (i.e., in large samples), no longer exhibit minimum variance among all linear unbiased estimators, in other words, they cease to be efficient.

In short, MQO estimators are not efficient relative to other linear, unbiased estimators, that is, these estimators are not MELNT. As a result, the t-tests, F-tests, and X^2 are not valid.

The results of the Breusch-Godfrey LM Test indicate no serial correlation, as shown in Table 6 below.

Table 6 – LM Breusch-Godfrey Test for Serial Correlation

F-statistic	0.456764	Prob. F(2,20)	0.6398
Remarks * R^2	2.577191	Prob. Chi-square(2)	0.2757

Source: Prepared by the authors using Eviews.

Note: Null Hypothesis: No serial correlation up to 2 lags; Prob: Probability.

B.4 Model Specification Analysis

The Ramsey test for specification errors in regression, also called RESET (“ Regression Specification Error Test “) is a general test of model specification errors. Under the null hypothesis that the original estimated model is correctly specified, adding squared and higher powers of the regressors should not add anything to the model.

The results reported in Table 7 below indicate that the estimated econometric model is correctly specified.

Tabela 7 – Ramsey RESET test

	Value	df	Probability
t-test	0.786179	21	0.4405
F-statistic	0.618077	(1, 21)	0.4405
Likelihood Ratio	1.711438	1	0.1908

Source: Prepared by the authors using Eviews.

Note: Specification: Y Y(-1) Y(-2) Y(-3) Y(-5) DF(-2) DF(-3) DF(-4) DF(-5) DE(-1) DE(-2) DE(-3) DE(4) DE(5) DM DM(-3) DM(-4) DM(-5) D(CTF) D(CTF(-2)) D(CTF(-3)) D(CTF(-5)) D(CTE(-1)) D(CTE(-2)) D(CTE(3)) D(CTE(-5)) D(CTM(-1)) D(CTM(-2)) D(CTM(-3)) D(CTM(-5)) D(KB) D(KB(-1)) D(KB(-3)) D(KB(-5)) GFGF(-1) D1995C; Omitted Variables: squares of the fitted values.