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Fondo de Participación Municipal y Equiparación de Ingresos: Posibilidades de Compartir Métodos Basados en Indicadores Socioeconómicos

Municipal Participation Fund and Revenue Equalization: Possibilities of Allocation Methods based on Socio-Economic Indicators

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Abstract

Purpose of the research: The Municipal Participation Fund (MPF) has an essential redistributive potential of revenues in Brazilian fiscal federalism. In this sense, this study proposes the application of a method of allocating MPF resources based on indices that correspond to the explanatory factors of municipal collection capacity and then analyzes the effects of this method on the equalization of revenues between municipalities.
Theoretical framework: It is assumed that a fiscal equalization regime should adopt some measure of the revenue potential of each jurisdiction as a reference, so that the degree of economic development, associated with the municipality's capacity to generate revenue, can function as an equalizing criterion.
Methodology: The study employs a quantitative approach, utilizing mean analysis and estimates derived from linear regression with panel data, stacked in annual time series, and based on 5,570 Brazilian municipalities as observation units. The proposed allocation method was described and simulated, and its effects were analyzed.
Results: The hypothesis that the allocation of MPF resources based on GDP *per capita* and average revenue of the municipalities tends to benefit those with lower collection capacity, thus producing equalizing effects on municipal revenues.
Originality: The study presents a specific and original approach to the explanatory model of municipal collection capacity, proposing criteria for redistributing MPF resources to ensure an equitable allocation between distributed resources and municipal fiscal capacities.
Theoretical and practical contributions: The results contribute to understanding the structures of fiscal federalism, formulations about redistributive mechanisms, and the reduction of regional inequalities, as well as to the development of revenue distribution systems more appropriate to the complexities and heterogeneities characteristic of the Brazilian federation.
Keywords: Fiscal federalism. Municipal Participation Fund. Revenue equalization. Socioeconomic factors. Collection capacity.

Resumo

Objetivo da pesquisa: o Fundo de Participação dos Municípios – FPM – tem um importante potencial redistributivo de receitas no federalismo fiscal brasileiro. Nesse sentido, este estudo propõe a aplicação de um método de partilha do FPM baseado em índices que correspondam aos fatores explicativos da capacidade de arrecadação municipal e, em seguida, analisa os efeitos desse método quanto à equalização de receitas entre municípios.
Enquadramento teórico: parte-se do pressuposto de que um regime de equalização fiscal deve adotar como referência alguma medida de potencial de arrecadação própria de cada jurisdição, de maneira que o grau de desenvolvimento econômico, estando associado à capacidade de geração de receitas nos municípios, poderá funcionar como critério equalizador.
Metodologia: o estudo tem abordagem quantitativa, com aplicação de análises de médias e estimações baseadas em regressão linear com dados em painel, empilhados em séries temporais anuais, tendo como unidades de observação os 5.570 municípios brasileiros. Foi feita a descrição e aplicação simulada do método de partilha proposto e analisados os seus efeitos.
Resultados: confirmou-se a hipótese de que a repartição do FPM baseada em índices de PIB *per capita* e renda média dos municípios tende a beneficiar aqueles com menor capacidade própria de arrecadação, produzido, assim, efeitos equalizadores nas receitas municipais.
Originalidade: o estudo oferece abordagem específica e original quanto ao modelo explicativo da capacidade própria de arrecadação municipal e quanto à proposição de critérios específicos de redistribuição do FPM, no sentido de possibilitar uma associação equitativa entre os recursos distribuídos e as capacidades fiscais dos municípios.
Contribuições teóricas e práticas: os resultados contribuem para a compreensão das estruturas do federalismo fiscal, para formulações acerca de mecanismos redistributivos e de redução de desigualdades regionais; e para o desenvolvimento de sistemas de repartição de receitas mais adequados às complexidades e heterogeneidades características da federação brasileira.

Palavras-chave: Federalismo fiscal. Fundo de Participação dos Municípios. Equalização de receitas. Fatores socioeconômicos. Capacidade de arrecadação.

Resumen

Objetivo de la investigación: el Fondo de Participación Municipal – FPM – tiene un importante potencial para la redistribución de ingresos en el federalismo fiscal brasileño. En este sentido, este estudio propone la aplicación de un método de reparto del FPM basado en índices que corresponden a los factores explicativos de la capacidad de ingresos municipales, para luego analizar los efectos de este método respecto de la igualación de ingresos entre municipios.
Marco teórico: se basa en el supuesto de que un régimen de equiparación fiscal debe adoptar como referencia alguna medida del potencial de ingresos específico de cada jurisdicción, para que el grado de desarrollo económico, al estar asociado a la capacidad de generación de ingresos de los municipios, pueda funcionar como criterio igualador.
Metodología: el estudio tiene un enfoque cuantitativo, aplicando análisis de promedios y estimaciones de regresión lineal con datos de panel, apilados en series temporales anuales, teniendo como unidades de observación los 5.570 municipios brasileños. Se describió el método de intercambio propuesto y se simuló su aplicación y luego se analizaron sus efectos.
Resultados: se confirmó la hipótesis de que la distribución del FPM basada en índices de PIB per cápita e ingreso promedio de los municipios tiende a beneficiar a aquellos con menor capacidad recaudatoria, produciendo así efectos igualadores sobre los ingresos municipales.
Originalidad: el estudio ofrece un enfoque específico y original respecto del modelo explicativo de la capacidad recaudatoria municipal y la propuesta de criterios específicos para la redistribución del FPM, con el fin de posibilitar una asociación equitativa entre los recursos distribuidos y las capacidades fiscales de los municipios.
Contribuciones teóricas y prácticas: los resultados contribuyen a la comprensión de las estructuras del federalismo fiscal, a formulaciones sobre mecanismos redistributivos y la reducción de las desigualdades regionales; y para el desarrollo de sistemas de reparto de ingresos más adecuados a las complejidades y heterogeneidades características de la federación brasileña.

Palabras clave: Federalismo fiscal. Fondo de Participación Municipal. Igualación de ingresos. Factores socioeconómicos. Capacidad de recaudación.

Introduction

Intergovernmental transfers have significant relevance in the current scenario of transformation of the management and government model, as they aim to balance fiscal capacities between subnational units, especially in the face of high economic disparities between municipalities (Prado, 2020; Arretche, 2010; Souza & Grin, 2021). In this sense, the Municipal Participation Fund (MPF) acts as one of the pillars of the transfer system for equalization in the distribution of resources. However, it has become a static and distorted allocation regime for income tax (IR) and tax on industrialized products (IPI) revenue (Prado, 2020). A viable option for recovering the national character of the MPF would be to adopt some measure of collection potential as a reference, thus seeking to indirectly operate a fiscal equalization regime (Rezende, 2018).

In this perspective, macroeconomic indicators such as GDP *per capita* and revenue can be applied as a revenue redistribution criteria, as they have already been used in some countries, such as India, Switzerland, Canada, and South Africa (Prado, 2020; Rezende, 2018; Rao, 2007; Wilson, 2007; Mendes, 2023). Socioeconomic factors were used as a reference for collection capacity and, therefore, parameters of equalization in the distribution of resources. Thus, this study seeks to analyze the problem of reconfiguring the MPF as a resource redistribution fund. We proposed the following research question: What are the possible effects of applying a distribution method for the MPF resources, whose allocation criteria are based on demographic and socioeconomic indicators?

Thus, this study aimed to propose a method of allocating MPF resources based on indices corresponding to the explanatory factors of the municipal collection capacity, and to analyze the effects of this distribution on the equalization of revenues between municipalities. The hypothesis tested is that the adoption of criteria based on macroeconomic indicators in MPF resource allocation systems produces an equalizing effect on municipal revenues, benefiting municipalities with lower collection capacity.

The results may provide relevant evidence on the possibilities of adequate criteria and parameters for the distribution of MPF resources to reduce fiscal disparities between subnational units and a reorientation of the MPF as a national resource fund with a redistributive and equalizing purpose. However, it should be considered that the allocation model proposed for analysis does not pretend to offer the most adequate specific form, but only corresponds to one of many possibilities.

The study employs a quantitative approach, utilizing secondary data collection, documentary and bibliographic research techniques, and a statistical procedural method. It uses linear regression models with structured panel data, stacked in annual time series, considering 5570 Brazilian municipalities as observation units.

In addition to this introduction, the article is structured in four sections: theoretical background, methodological procedures, results and discussions, and conclusions. The theoretical background addresses the following issues: intergovernmental transfers and their redistributive dimensions; historical contributions and the current criteria for allocating MPF resources; and the relationship between fiscal capacities and macroeconomic indicators. The methodological procedures describe the study's variables and quantitative methods.

The results and discussions section presents the results of the panel linear regression models for estimating the explanatory factors of the municipalities' fiscal capacity; then, there is the description and simulated application of the method for allocating MPF resources proposed in the study; after that, an analysis of the effects of the proposed method through panel regression estimates and comparative analysis of averages is presented. Finally, the conclusions of the study are presented to confirm the hypothesis tested, considering its limitations and the relevance of its contributions to the theoretical, organizational, and social scopes.

Theoretical Background

Intergovernmental transfers and their redistributive dimensions

The model of fiscal federalism adopted in Brazil is centered on a system of intergovernmental transfers as a way of financing national public policies and balancing spending capacities among subnational units, whose levels of collection and economic production are highly unequal (Prado, 2020; Rezende, 2018; Souza, 2016). The ability to generate revenue from their local activities largely reflects the economic inequality between jurisdictions (Arretche, 2010; Souza, 2016). In the meantime, the redistributive dimension of the transfers becomes relevant for the federative balance and to guarantee basic services in the municipalities, allowing the poorest jurisdictions a volume of resources greater than their collection capacity (Afonso, 2016; Prado, 2020).

Prado (2020) proposes the classification of transfers into four modalities: devolutionary, compensatory, redistributive, and conditional. In the case of municipalities, the return transfers are composed of the quota-share of the tax on circulation of goods and transport and communications services (ICMS), the tax on property of motor

vehicles (IPVA), the tax on rural territorial property (ITR), and the tax on financial operations (IOF). Therefore, they correspond to a part of the tax revenue collected by the states and the Union, which is "returned" to the local governments where the collection was made. On the other hand, compensatory transfers are those resulting from compensations for estimated revenue losses, such as export exemptions - (IPI)-Municipalities and ICMS LC No. 87/96–, and for the exploitation of natural resources, primarily *royalties* and holdings in the exploration for oil and other minerals.

In turn, conditional transfers refer to resources transferred to subnational entities whose use is linked to specific public policies, such as education and public health. The primary ones are the Fund for the Maintenance and Development of Basic Education (Fundeb), the Unified Health System (SUS), the National Fund for the Development of Education (FNDE), and the National Fund for Social Assistance (FNAS). Finally, the redistributive transfers correspond to the Municipal Participation Fund (MPF), whose primary purpose is to grant a larger share of resources to the municipalities that, in theory, need it most, that is, those that have fewer resources to maintain their services and administrative structure.

The MPF, the quota-share of the ICMS, and the Fundeb transfers are the three primary transfers destined for the municipalities. According to data from the National Treasury Secretariat (STN, 2023a, 2023b), in 2022, an amount of BRL (sum of the three transfers) was distributed, with the MPF distributing BRL 146.33 billion to the municipalities, the ICMS quota-share distributing BRL 135.18 billion, and Fundeb transferring BRL 157.53 billion. Each of the transfer modalities presents different characteristics regarding the effects on the equalization of revenues between municipalities. Devolutionary transfers tend to favor the most economically developed municipalities, thus presenting a low equalizing effect of fiscal capacity. Both these and compensatory transfers only marginally affect the disparities in collection between municipalities (Souza & Grin, 2021; Arretche, 2010; Baião, Cunha, & Sousa, 2017; Prado, 2020). On the other hand, conditional transfers, especially Fundeb and SUS, have a significant revenue redistribution effect, contributing the most to fiscal equalization between municipalities, with a substantial impact on the finances of local governments (Prado 2020; Baião, Cunha, & Sousa, 2017; Souza & Grin, 2021).

In turn, the MPF constitutes the primary source of resources for small municipalities and has a significant effect on reducing revenue disparities (Souza & Grin, 2021; Arretche, 2010). However, the current model produces some imbalances, as in the issue of the pre-apportionment system between states, which results in lower distribution due to the sole population criterion, failing to consider criteria of a socioeconomic nature (Rezende, 2018; Prado, 2020; Baião, Cunha, & Sousa, 2017). As argued by Rezende (2018), an adequate discussion about the MPF is necessary, in the sense of a recovery of its national character and the adoption of distribution criteria aimed at contributing to the equalization of revenues between municipalities.

Historical contributions and the current criteria for allocating MPF resources

The MPF was established by Constitutional Amendment No. 18 of 1965 and is regulated by the National Tax Code – Law No. 5,172 of 1966. Initially, it was composed of 10% of the net revenue on income taxes (IR) and industrialized products (IPI), already with an allocation criterion based on population size. In 1967, through Complementary Act No. 35, the categorization of municipalities into "capitals" and "countryside" was created, with 10% of the MPF resources being allocated to the capitals. In 1981, another category was created with Decree-Law No. 1,881, the "reserve", including municipalities with a population greater than 142,633 inhabitants. The distribution of the MPF resources was then 10% for the capitals, 3.6% for the reserve, and 86.4% for the countryside (STN, 2023c).

As Rezende (2018) argues, in its initial configuration, the MPF had a national character and consisted, albeit indirectly, of a transfer regime with the purpose of fiscal equalization, functioning as a compensation for the concentration of fiscal capacity in those municipalities that had a more developed economic base. Thus, the distribution formula adopted for countryside municipalities sought to benefit those with low population, which corresponded to the vast majority of economically weaker municipalities.

Since the 1980s, there has been a gradual increase in the percentages of the IR and IPI allocated to the MPF, reaching 22.5% in 1993. Subsequently, other increases were added, so that the total transfer rate reached 25.5% by 2025. It should also be noted that a 20% deduction for FUNDEB is also applied to the MPF transfer percentages (STN, 2023c).

The distribution criteria of the MPF are different for the three categories: capital, countryside, and reserve (STN, 2023c). Two factors are used for the capitals: population and revenue *per capita*. The population factor (*fat_pop)* is obtained by the ratio of the population of the specific capital to the sum of the populations of all capitals. A resulting factor, defined as values indicated in Article 3 of Decree-Law No. 1,881 of 1981, is extracted from this

value. The revenue factor *per capita* (*fat_rpc*) is obtained by dividing the revenue *per capita* of the state of the capital in question, the value of which will then be divided by 100. This is then applied in a specific table, provided for in Article 90 of Law No. 5,172/66, thus obtaining the indicated factor. The coefficient of each capital will result from the product of the population factor times the revenue factor *per capita*.

Then, the coefficient calculated for each capital will be divided by the sum of the coefficients of all capitals (*somat_coef_cap*). The result of this division will correspond to the individual percentage of participation of each in the amount distributed among the capitals. The general equation for calculating the value of the quota-share distributed to each of the capitals can be defined as follows: *quota-share capital = MPF amount x 0.1 X fat_pop x fat_rpc / somat coef_cap.*

For the countryside municipalities, the so-called pre-apportionment between the states takes place, that is, the amount destined to the countryside – 86.4% of the fund – is initially distributed among the states based on predefined coefficients according to the table of percentages of participation of the states in the MPF (*coef_pr_est*), contained in the Resolution of the Federal Court of Accounts (TCU) No. 242/90. These coefficients have remained fixed since 1990 and consider the number of municipalities in each state based on the number of municipalities existing in 1990 (Prado, 2020; Rezende, 2018).

After the pre-apportionment, the resources are then distributed among the municipalities of each state by applying coefficients defined for each population group (*coef_pop*), according to the table of coefficients by population group, provided for in Decree-Law No. 1,881/81. Thus, each state distributes resources among its municipalities based on the individual percentage of each, calculated by dividing its population coefficient by the sum of the coefficients of all countryside municipalities in the respective state (*somat_coef_pop_est*). The general equation for calculating the value of the quota-share distributed to each countryside municipality can be defined as follows: *quota-share countryside = MPF amount x 0,864 X coef_pr_est x coef_pop / somat_coef_pop_est.*

For the reserve municipalities, the calculation is analogous to that of the capitals, differing only in that another calculation base is used, which is 3.6% of the amount of the fund, while that of the capitals is 10%, that is, the same equation applies, replacing the 10% (0.1) for 3.6% (0.036). It should be noted that the reserve municipalities also participate, cumulatively, in the distribution among the municipalities of the countryside category.

Prado (2020) argues that the MPF distribution system contradicts a basic premise of any equalization system, which would be the variability in the time of distribution coefficients in the face of the variation in the general conditions of municipal governments, given their development dynamics and fiscal capacities. Thus, the MPF became a mere mechanism for static allocation of IR and IPI revenues, especially with the prior fixation of interstate apportionment.

Thus, it is evident that the mechanism of pre-apportionment creates significant distortions. As an example of this, in 2022, according to STN data (2023B), municipalities with less than 10 thousand inhabitants in the state of Amapá received a share of BRL 6.14 million, and those in Roraima, BRL 4.82 million. Those in the state of São Paulo, in this same population group, received BRL 11.85 million, and those in Paraná, BRL 13.17 million. There seems to be no coherence in these values, especially when considering that the states of São Paulo and Paraná had, in 2021, a revenue *per capita* of BRL 971.82 and BRL 817.79, respectively, while Amapá and Roraima, in the same year, had a revenue *per capita* of BRL 451.27 and BRL 549.54, respectively (Instituto Brasileiro de Geografia e Estatística – IBGE, 2023).

As stated by Rezende (2018), it is necessary to recover the national character of the MPF, adopting allocation criteria consistent with a revenue equalization regime for the municipalities. Such questions seem to highlight the need to discuss new methods of distribution of MPF resources more appropriate to the dynamics of economic development of Brazilian municipalities.

Relationship between fiscal capacities and macroeconomic indicators

According to the theme, a fiscal equalization regime should aim at equalizing the budget of each jurisdiction according to the size of its spending needs. Thus, it seeks to equalize revenues considering the size of the populations, which implies a residual issue, as there are possibilities of disincentive to the exploitation of local tax bases, since, by ceasing to collect, the jurisdiction could be compensated through the allocation of a greater volume of transfers. The option, in this case, would be to adopt some measure that can represent the potential of municipal collection for the beneficiaries of the transfers (Rezende, 2018; Prado, 2020).

Thus, to avoid discouraging the collection effort, it would be appropriate to use some reference of potential revenue instead of the effective revenue for equalization, which allows estimates of the collection *per capita* based on the economic capacity of each jurisdiction. Therefore, among the applicable criteria, there is the possibility of using macroeconomic indicators such as revenue *per capita* and GDP *per capita* (Prado, 2020).

However, the current rules for MPF resource allocation disregard critical economic criteria. Thus, when assuming that smaller municipalities need the most resources, the distribution method applied to the MPF fails to consider the fact that many medium and small municipalities may have high fiscal capacity, associated with a high GDP *per capita* (Baião, Cunha, & Souza, 2017). It is also important to note that the deconcentration of economic activity in recent decades has generated a significant diversity in municipal GDP dimensions, increasing the proportion of small and medium-sized municipalities with high economic activity (Prado, 2020).

Variations in revenue *per capita* and GDP *per capita* for subnational units are associated with the degree of collection capacity (Conte & Arend, 2017; De Araújo et al, 2016; Costa et al, 2018; Rao, 2007). Federations, such as Canada and Germany, adopt *per capita* spending capacity equalization systems based on potential revenue (Costa, 2020; Rezende, 2018). Countries such as India, Switzerland, and South Africa use regional GDP as an indicator of fiscal capacity and a criterion for equalizing revenues through intergovernmental transfers (Rao, 2007; Wilson, 2007).

In the Brazilian context, regarding the contribution of the MPF to the equalization of municipal revenues, Costa (2020) observed that population size, adopted as a distribution criterion, is not a significant indicator to determine the revenue generation capacity of a municipality. He also noted that the pre-apportionment between states alters the population logic, thus creating a disproportionality between the revenue-generating capacity and the resources received from the fund. As a positive aspect, the author points out that the inclusion of the revenue factor mitigates the distortions in the distribution of resources between the capitals and reserve municipalities.

Santos (2023) also maintains that the MPF does not equalize the fiscal capacities of municipalities, mainly due to the sole population criterion adopted for the "countryside" category, in addition to the pre-apportionment, which also contributes to disproportionality. He also notes that the addition of MPF transfers to the primary revenues of municipalities reduces the degree of concentration of these revenues from 0.236 to 0.195 – measured by the Gini index –, thus characterizing a low reduction when compared to those of OECD countries, in which the Gini index falls by an average of two-thirds after equalization. Ribeiro (2023), in turn, observed that MPF resource distribution rules disregard equity criteria and can cause adverse effects for the balance between jurisdictions.

Therefore, the theoretical and empirical contributions discussed so far show a need to reconfigure the MPF, aiming to make it an equalizer fund for municipal revenues. The methods for investigating the hypothesis proposed in this study will be described in the following section.

Methodological Procedures

The data set is structured in a panel format, comprising 111,400 observations, organized as stacked time series. It includes 5,570 cross-sectional units and features an annual time dimension with 20 time units, spanning the years 2003 to 2022. The observation units - cross-sectional - are the 5,570 Brazilian municipalities (IBGE, 2023). The study variables are described in Chart 1, below.

Chart 1 - Chart describing the variables

VARIABLE	DESCRIPTION	SOURCE
rp_pc	Municipality revenue *per capita*	Siconfi - STN
roael_pc	Revenue from local economic activity *per capita*	Siconfi - STN
pib_pc	Gross Domestic Product *per capita*	IBGE
fpm_pop_pc	MPF quota-share *per capita – population factor*	Research data
fpm_pib_rmm_pc	MPF quota-share *per capita - GDP and average revenue factor*	Research data
Rmm	Average monthly revenue	Dataviva
Pop	Population	IBGE
N (dummy)	Northern Region	IBGE
NE (dummy)	Northeast Region	IBGE
S (dummy)	Southern Region	IBGE
MW (dummy)	Midwest Region	IBGE

Source: Prepared by the authors.

Two dependent variables (y) were defined to represent the collection capacity of the municipalities. The first is the municipality revenue *per capita*, which covers the sum of tax, property, agricultural, industrial, services, contributions - deducted contributions to the municipalities' social security system – and other current revenues, according to the criteria for defining net current revenue (RCL) provided for in the Law on Fiscal Responsibility – LC No. 101/2000.

The second is revenue from local economic activity *per capita,* which corresponds to the sum of the municipalities' revenues and transfer revenues that have their origin directly linked to the economic activity of the municipalities. These are the return transfers, resulting from the quotas-share of the ICMS, IPVA, and ITR collected in each municipality, and transfers of compensation for estimated collection losses due to export exemptions – IPI-Municipalities and ICMS LC No. 87/96.

The explanatory variables for estimating the predictive effects of the collection capacity were: GDP *per capita*, according to estimates of the gross domestic product of the municipalities, based on the methodologies of the IBGE accounts; average monthly revenue, referring to formal jobs in the municipalities, according to data based on information from RAIS and made available on the Dataviva platform, developed by the Center for Development and Regional Planning of the Universidade Federal de Minas Geraiss; and population, according to data from the census and population estimates of the IBGE.

The predictor variables *fpm_pop_pc and fpm_pib_rmm_pc* were used in the analysis of the effects of the MPF resource allocation method tested in the study, and correspond to the value of the quota-share of the MPF resources distributed to municipalities in the countryside, based on the current rules of the MPF, that is, by the population coefficient; and the value of the quota-share of the MPF calculated in the proposed model, applying the GDP *per capita* and average revenue, also for the "countryside" category. *Dummy* variables were also included to indicate the location of the municipalities in the geographic macroregions North, Northeast, South, and Midwest. The Southeast region was defined as the control group.

Regarding the dependent variables, *rp_pc and roael_pc*, it should be noted that not all local governments provide consistent information to the Secretariat of the National Treasury (STN, 2023a). Thus, there are municipalities without data, and some of the data reported contains inconsistent values. Therefore, for this analysis, cases that presented current revenue inferior to the deductions or the sum of current transfers were excluded. Thus, the data used in the analysis have 108,773 observations, which corresponds to 97.64% of the total observations.

The analysis procedure consisted of three stages. In the first, through panel regression, the explanatory effects of the variables *pib_pc, rmm,* and *pop* were estimated on the dependent variables *rp_pc and roael_pc*. The regression included the *dummy* variables *N, NE*, *S*, and *MW*. In the second stage, the proposed method for distributing MPF resources was applied, with each municipality's participation percentages submitted to coefficients based on GDP *per capita* and average revenue indicators. In the third stage, the effects of the proposed MPF resource allocation method were estimated by comparing the effects of distribution by GDP per capita and average revenue coefficients, as proposed in the study, with the effects of distribution by population coefficient, according to the current rules of the MPF.

The regression model with panel data presents cross-sectional units followed over time, thus having a temporal and spatial dimension. According to Gujarati & Porter (2011), this model provides advantages such as the possibility of capturing specific individual variations in data sets with high heterogeneity, a lower collinearity between variables, and the minimization of biases. The equation of the general regression model for a dependent variable y_{it} is defined by: $y_{it}=\alpha_i+x'_{it}\beta+\varepsilon_{it}$, where *i* represents the observed units, *t* are the time periods, x'_{it} are the regressors, α_i are the specific individual effects, and ε_{it} is the idiosyncratic error (Cameron & Trivedi, 2009).

Panel regression offers some possibilities for analysis due to the interaction of individual variables with the time series. The most common are the fixed effects models, which consider the angular coefficients with constants and the intercept variable between individuals; and the random effects model, in which the intercept assumes a common average value between individuals and the angular coefficients vary over time and between individuals. The two models were estimated, and the Hausmann test was applied to define the most adequate model (Guajarat & Porter, 2011). To better adjust the regression models, the variables were transformed into a neperian logarithm, which provides a reduction in asymmetry and heteroscedasticity, allowing a direct estimation of elasticities (Sartoris, 2013; Gujarati & Porter, 2011).

Regarding the limitations of this study, it should be noted that the proposition of the MPF resource allocation model based on GDP and revenue index does not necessarily claim to offer a more adequate method, among the many possibilities. It seeks only to analyze whether a method based on these criteria can produce the intended effects, that is, an association between the distributed resources and the fiscal capacities of the municipalities.

Furthermore, the estimated association between the studied variables has limitations in its explanatory power, as other factors not observed can also influence the collection capacity indices of the municipalities.

Results And Discussions

Explanatory factors of revenue generation capacity in municipalities

Linear regression models with panel data were estimated using the fixed effects and random effects methods to analyze the explanatory effects of the collection capacity of the municipalities. The dependent variables are the municipality's revenue and the revenue from local economic activity – *rp_pc* and *roael_pc*. The predictor variables are: GDP *per capita*, average monthly revenue, and population – *pib_pc, rmm*, and *pop*. These five variables were converted to neperian logarithm; thus, the acronyms indicated are, respectively, *log_rp_pc, log_roael_pc, log_pib_pc, log_rmm*, and *log_pop*. Four *dummy* variables were included in the models, corresponding to the North, Northeast, South, and Midwest regions - N, NE, S, and MW. The results are presented in Table 1. The panel is structured in 18 annual periods, from 2003 to 2020, with 5,570 observation units.

Table 1 - Estimation of linear regression in fixed effects and random effects panels - Explanatory factors of the municipality's collection capacity

VARIABLES	Dependent variable: municipality's revenue		Dependent variable: revenues from local economic activity	
	Estimator fixed effects	Estimator random effects	Estimator fixed effects	Estimator random effects
log_pib_pc	0.672*	0.675*	0.573*	0.606*
log_rmm	0.632*	0.628*	0.492*	0.471*
log_pop	0.066*	0.085*	-0.142*	-0.093*
N		-0.265*		-0.198*
NE		-0.203*		-0.268*
S		0.003		-0.008
MW		-0.032*		-0.029*
Constant		-2.750*		-0.744*
Observations	97,622	97,622	54,554	54,554
R^2	0.356	0.410	0.498	0.555
Adjusted R^2	0.317	0.410	0.468	0.554
F Statistics	16931.79* df = 3	69498.9*	30422.53* df = 3	123890.3*
Note: *p<0.01				

Source: Prepared by the authors.

For the two dependent variables, the random effects models presented a higher adjusted R^2 (0.410 and 0.554) compared to fixed effects models (0.317 and 0.468). Statistical significance was obtained at the level of 99% reliability – p-value < 0.01 - in all regressors, except *dummy* S. The predictors *log_pib_pc* and *log_rmm* obtained positive and relatively high estimators, while the variable *log_pop* had lower estimators, being positive for the first dependent variable and negative for the second. The *dummies* N, NE, and MW presented negative estimators.

The Breusch-Pagan and Breusch-Godfrey/Wooldridge tests were performed to verify the hypotheses of heteroskedasticity and serial correlation of idiosyncratic errors, respectively. Both tests indicated *p*-value < 0.05 in all models tested; thus, the null hypotheses of homoscedasticity and serial uncorrelation of errors were rejected. Therefore, the tests confirmed the presence of heteroskedasticity and serial correlation. Therefore, to improve the consistency of the estimates, the covariance matrix described by Arellano (1987) was applied for estimations with robust standard error in the presence of heteroskedasticity and serial correlation, in which the predictive variables maintained statistical significance.

In the comparison of model consistency, the Hausman test for the dependent variable *log_rp_pr* resulted in a *p*-value = 0.499. Thus, because the *p*-value was greater than 0.05, the null hypothesis that both models are consistent was not rejected, indicating the random effects model as the most appropriate. Otherwise, for the

dependent variable *log_roael_pc*, the Hausman test indicated the *p*-value < 0.05, rejecting the null hypothesis. Thus, in this case, the fixed effects model was the most appropriate.

Thus, for the dependent variable *log_rp_pc*, the random effects model obtained an adjusted R^2 of 0.410, and the estimators for the predictors *log_pib_pc, log_rmm, and log_pop* were 0.675, 0.628, and 0.085, respectively. Thus, according to the direct estimation of the elasticities for the logarithmic variables (Sartoris, 2013; Gujarati & Porter, 2011), the regression explained about 41% of the variations in the municipality's revenue *per capita*; a 1% change in GDP *per capita* and 1% in average revenue corresponded to an average variation of 0.67% and 0.63% of the *per capita* municipality's revenue, respectively.

For the dependent variable *log_roael_pc*, the fixed effects model obtained an adjusted R^2 of 0.468, and the estimators for the predictors *log_pib_pc, log_rmm, and log_pop* were 0.573, 0.492, and -0.142, respectively. Thus, the model explained about 46.8% of *per capita* revenue variations from local economic activity; a 1% change in the variables *log_pib_pc, log_rmm, and log_pop* corresponded to an average variation of 0.57%, 0.49%, and 0.14% of the variable *log_roael_pc*, respectively.

The results of the regression estimates indicated that the GDP per capita and average revenue indices are factors that exert predictive effects on the municipality's revenues and revenues from local economic activity. Such evidence corroborated the argument by Prado (2020) that the collection incident on the economic base of each municipality reflects the distribution of financial wealth among these federal entities. The results are consistent with the evidence pointed out in the studies of Conte and Arend (2017) and Costa et al. (2018), who observed a strong relationship between municipal GDP and tax revenues, as well as Araújo et al. (2016), who observed a high explanatory coefficient of GDP and average revenue on the municipality's revenue.

Since higher fiscal capacities are associated with higher GDP per capita and average revenue indices, it can be considered that a method of MPF distribution that is based on these indicators would tend to produce an inverse association between fiscal capacity and MPF distribution. The application of these parameters would therefore tend to benefit municipalities with lower levels of these indicators. A method of allocating in this sense could minimize distortions and inadequacies in the current criteria of the MPF (Baião, Cunha e Souza, 2017; Santos, 2023; Ribeiro, 2023; Costa, 2023).

The current MPF criteria are not adequate to effectively reduce disparities in fiscal capacities among Brazilian municipalities (Santos, 2023) and disregard the fact that medium and small municipalities may also have relatively higher fiscal capacities (Baião, Cunha e Souza, 2017). In the current method, the population size criterion acts as a biased factor, as it is not a significant variable to determine the revenue generation capacity of municipalities. Thus, more developed regions have received more benefits from the fund, while poorer areas are not privileged in the allocation (Costa, 2020; Ribeiro, 2023). Therefore, one should consider the incorporation of revenue and GDP *per capita* indicators as mechanisms to improve the distribution of MPF resources.

Description and application of the proposed method for allocating the MPF resources

This topic proposes a method for allocating MPF resources, using the municipality's GDP *per capita* and average monthly revenue indicators as additional criteria to the MPF's current rules. The time frame for the method's simulation included ten annual periods, from 2013 to 2022, given that there was no change in the total number of municipalities in this interval; thus, the data of the MPF quota-share contains the same number of observations for each year. The GDP and revenue indicators were outdated by two years, considering that the current MPF resource distribution system also uses outdated revenue *per capita* data from the states, in this case, of three years. Likewise, the estimated population was outdated by one year, as occurs in the current form of distribution.

The first part of the method simulation consists of applying current allocation rules. Initially, the total amounts of the MPF resources distributed in each year were divided into three parts, referring to the three categories of municipalities: capital, reserve, and countryside. For the capitals, the same amounts received by each municipality were maintained, according to STN data (2023B), whose sum corresponds to 10% of the total fund. For the "reserve" category, which covers municipalities with a population above 142,633 inhabitants, except capital cities, 3.6% of the total MPF was distributed, and the values applicable to each municipality were calculated according to the current method of distribution, based on population and revenue coefficients *per capita*.

Then, the amount allocated to the “countryside” category, which is 86.4% of the total fund, was divided into two equal parts. The first half was distributed according to the current criteria of the MPF, that is, based on the percentages of pre-apportionment between states and the population coefficients of the municipalities, according to the rules provided for in Complementary Laws No. 62 of 1989 and No. 91 of 1997, in Article 1 of Decree-Law No. 1881/81, in Articles 90 and 91 of Law No. 5,172/66, and in TCU Resolution No. 242/90.

The other half of the 86.4% of the fund was distributed based on the municipalities' GDP *per capita* and average revenue. This amount, corresponding to 43.2% of the MPF, was then distributed as follows: three fifths was divided by the GDP *per capita* criterion, which is equivalent to 25.92% of the total MPF (30% of the countryside category), and the other two-fifths, by the average revenue criterion, equivalent to 17.28% of the total MPF (20% of the countryside category).

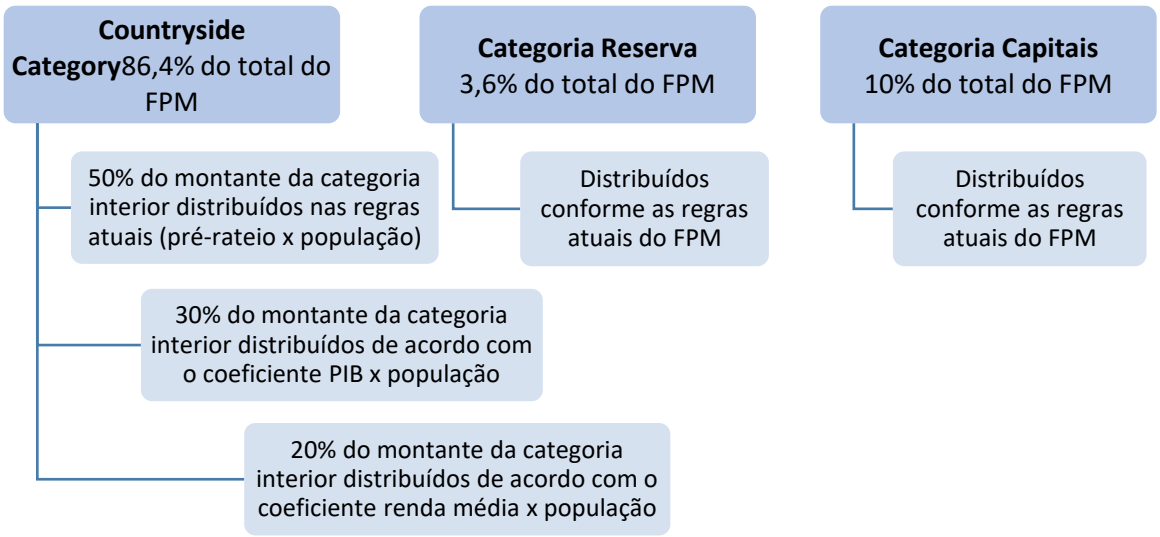
The GDP *per capita* factor *(ft_pibpc)* for each municipality was defined by dividing the GDP *per capita* from the set of all municipalities of the countryside category *(som_pibpc_int)* by the GDP *per capita* of each municipality *(pibpc_mun)*, limiting this index to a minimum of 0.6 and a maximum of 6, to avoid factors that differ significantly from the average. Subsequently, the product of the GDP *per capita* factor was multiplied by the population coefficient *(coef_pop)*, resulting in a GDP X population coefficient *(coef_pibpop)*. This coefficient, divided by the sum of the coefficients of all municipalities in the countryside category *(som_coef_pibpop_int)*, corresponds to the percentage of participation of each municipality (*perc_part_pibpc*) in the amount allocated based on the GDP *per capita* criterion. The equations applied to define the percentage distributed to each municipality by the GDP *per capita* criterion are thus expressed in three stages: 1: *pibpc_mun / som_pibpc_int = ft_pibpc -> 2: ft_pibpc x coef_pop = coef_pibpop -> 3: coef_pibpop / som_coef_pibpop_int = perc_part_pibpc*.

Similarly, the average revenue factor *(ft_rm)* was obtained by dividing the average monthly revenue of all municipalities in the countryside category *(som_rm_int)* by the average monthly revenue of each municipality *(rm_mun)*, limiting this index to a minimum of 0.4 and a maximum of 2.5. Then, the average revenue factor was multiplied by the population coefficient, resulting in the average revenue x population coefficient *(coef_rmpop)*. The division of this coefficient by the sum of the coefficients of all municipalities in the countryside category (*som_coef_rmpop_int)* resulted in the percentage of participation of each municipality (*perc_part_rm*) in the amount allocated by the average revenue criterion. The equations applied to define the percentage distributed to each municipality by the average revenue criterion are thus expressed in three stages: 1: *rm_mun / som_rm_int = ft_rm -> 2: ft_rm x coef_pop = coef_rmpop -> 3: coef_rmpop / som_coef_rmpop_int = perc_part_rm*.

Finally, the MPF resources distributed to the countryside category, in each year, by the method proposed in this study, resulted in three parts: the first, equivalent to 50% of the countryside amount, was allocated by the population criterion, that is, the current method; the second, by the GDP *per capita* criterion, corresponding to 30% of the countryside amount; and the third, by the average revenue criterion, corresponding to 20% of the countryside amount. Figure 1 presents a summary of the allocation in the proposed form.

Figure 1 - Summary chart of MPF resources allocated according to the method applied in the study

Source: Prepared by the authors.



The proposed formulations for allocating the MPF resources seek to implement conditions to make this distribution more dynamic and equitable. In this sense, changes in the socioeconomic situation of the

municipalities over time could direct, at least in part, changes in the distribution patterns of the fund. Thus, we aim to establish a reference for revenue potential, an indirect form of fiscal equalization regime, while also providing the possibility to inject more dynamism into the MPF, consistent with Prado (2020) and Rezende (2018).

Analysis of the effects of the proposed allocation method

Considering the period from 2013 to 2022, the simulation applied resulted in an increase in MPF value *per capita* to 48.12% and a decrease to 51.88% in Brazilian municipalities. The average variation for those who obtained an increase was 23%, and for those who received a reduction, it was -14.67%. A panel regression estimate was determined to verify whether the changes in the distribution would tend to increase the MPF resource values received by municipalities with lower collection capacity and reduce the values for those with higher capacity. The observations for this regression covered ten annual periods, from 2013 to 2022. The capitals were not included in this analysis, as the value of the MPF resources received by the municipalities of this category did not change in the simulation of the proposed method.

For this estimated regression, the explanatory variables were *fpm_pop_pc*, which represents the value *per capita* received by each municipality in the countryside category based on population criteria, and *fpm_pibrmm_pc*, which corresponds to the value *per capita* received by each of these municipalities based on the sum of the GDP *per capita* and average revenue criteria. After logarithmic conversion, these two predictor variables were identified with the acronyms: *log_fpm_pop_pc* and *log_fpm_pibrmm_pc*. The region *dummies* N, NE, S, and MW were also included in the regression.

Thus, the objective of the regression was to estimate the explanatory effects of these two variables on the dependent variables *log_rp_pc* and *log_roael_pc*, that is, we sought to verify the effects of the two forms of distribution of the MPF resources for the countryside municipalities - by population criteria and by GDP and revenue criteria – in relation to the municipalities' collection capacity.

Table 2 - Estimation of linear regression in fixed effects and random effects panels to analyze the effects of the proposed method for allocating MPF resources

VARIABLES	Dependent variable: municipality's revenue		Dependent variable: revenues arising from local economic activity	
	Estimator fixed effects	Estimator random effects	Estimator fixed effects	Estimator random effects
log_fpm_pop_pc	1.621*	1.364*	1.331*	1.420*
log_fpm_pibrmm_pc	-0.305*	-1.064*	-0.425*	-1.019*
N		-0.110*		-0.042*
NE		-0.213*		-0.244*
S		0.030*		0.016*
MW		0.038*		0.052*
Constant		1.825*		1.980*
Observations	54,434	54,434	54,455	54,455
R2	0.171	0.205	0.174	0.353
Adjusted R2	0.077	0.205	0.081	0.353
F Statistics	5052.31* df = 2	14294.4*	5154.66* df = 2	29496.67*
Note: *p<0.01				

Source: Prepared by the authors.

The regressors of the models estimated for the two “y” variables showed statistical significance, and the adjusted R^2 was higher in the random effects model, with values of 0.305 and 0.353, and lower in the fixed effects model, with values of 0.077 and 0.081. The Hausman test indicated that the fixed effects model presented greater consistency than the random effects model. The Breusch-Pagan test for heteroscedasticity and the Breusch-Godfrey/Wooldridge test for serial correlation indicated a $p < 0.05$ in the tested models. Thus, the null hypotheses for homoscedasticity and serial uncorrelation of errors were rejected, confirming the presence of heteroskedasticity and serial correlation. Coefficient tests with robust error in the presence of heteroscedasticity

and serial correlation were performed using the Arellano method, in which all predictor variables maintained statistical significance in a 99% reliability interval (p-value < 0.01).

Although the regression resulted in a low adjusted R^2 in the fixed effects model, indicated as the most appropriate in the consistency tests, it should be noted that the variable *log_fpm_pibrmm_pc* obtained negative estimators. In contrast, the variable *log_fpm_pop_pc* obtained positive estimators in both models tested. This indicates that, in the first case, the increase in the value of the MPF *per capita*, according to the GDP and revenue criterion, corresponded to a lower collection capacity of the municipalities; in the second case, a higher value in the MPF *per capita* according to the population criterion, corresponded to a greater collection capacity of the municipalities. Therefore, this relationship indicates that the distribution of MPF by the GDP and revenue criterion showed a tendency to favor municipalities with lower levels of municipality's revenue and revenue from local economic activity.

In addition to the regression method, means were compared between the municipalities of the countryside category. Based on the differences between the variables *fpm_pibrmm_pc* and *fpm_pop_pc*, we determined which municipalities obtained a gain and which presented a reduction in the value of the MPF received. Then, we verified which of these municipalities have collection capacity above or below the national average, using the variables *rp_pc* and *roael_pc* as measures of collection capacity.

Thus, it was observed that among the municipalities presenting an increase in MPF, 92.47% were below the *rp_pc* average, and 93.88% below the *roael_pc* average, considered the average among the total Brazilian municipalities. Among those presenting a reduction in MPF, 63.10% and 71.48% showed *rp_pc* and *roael_pc* above average, respectively. In the comparison by population groups, according to the distribution in 18 groups used in the MPF distribution, more than 90% of the municipalities presenting a gain in the MPF were below the *rp_pc* and *roael_pc* averages in 14 of the 18 groups. Table 3 presents the comparison by population size group of the municipalities presenting gains and decreases in the tested model.

Table 3 - Comparison by population groups among the municipalities presenting gains and reductions in MPF and that were below/above the average *per capita* revenue.

percentage of municipalities presenting a gain in MPF and that were below the *rp_pc* average				percentage of municipalities presenting a reduction in MPF and that were above the *rp_pc* average			
Group 1	92.7%	Group 10	94.4%	Group 1	54.3%	Group 10	76.4%
Group 2	95.0%	Group 11	92.5%	Group 2	47.2%	Group 11	76.1%
Group 3	95.5%	Group 12	87.0%	Group 3	54.2%	Group 12	83.4%
Group 4	96.3%	Group 13	87.0%	Group 4	63.2%	Group 13	81.4%
Group 5	94.3%	Group 14	88.5%	Group 5	65.9%	Group 14	80.2%
Group 6	95.4%	Group 15	93.6%	Group 6	71.9%	Group 15	87.2%
Group 7	96.4%	Group 16	94.4%	Group 7	71.4%	Group 16	83.8%
Group 8	95.9%	Group 17	95.0%	Group 8	75.9%	Group 17	87.1%
Group 9	93.0%	Group 18	83.1%	Group 9	77.2%	Group 18	90.3%

Source: Prepared by the authors.

Concerning the comparison between regions, by the model tested, considering the entire period from 2013 to 2022, in the Northeast and North regions with the lowest averages of *per capita* revenue and GDP, 86% and 85.3% of the municipalities, respectively, obtained an increase in the value *per capita* of the MPF resources received. On the other hand, in the South, Southeast, and Midwest regions, which have better GDP and revenue indices, the percentage of municipalities with a reduction in the amount received was 96.4%, 64.8%, and 74.5%, respectively.

In the comparison between states, Maranhão, Piauí, Paraíba, and Ceará presented the lowest *per capita* revenue and GDP indices. The percentage of municipalities presenting an increase in the amount received was 93.8%, 95.1%, 93.9%, and 88.1%, respectively. In contrast, in the states of Rio Grande do Sul, Santa Catarina, São Paulo, and Rio de Janeiro, those with the highest average *per capita* revenue and GDP indices, the percentage of municipalities presenting a reduction in the amount received was 96.5%, 93.3%, 88.9%, and 75.6%, respectively. Table 4 shows the comparison by macroregion, and Table 5 shows the comparison by state.

Table 4 - Comparison by macroregion between the municipalities presenting gains and reductions in MPF resources and that were below/above the average *per capita* revenue and GDP.

Region	% of municipalities presenting a gain in MPF resources	% of municipalities presenting a reduction in MPF resources	% *rpc* in relation to the national *rpc*	% *pib_pc* in relation to the national *pib_pc*
N	85.3%	14.7%	66.2%	71.0%
NE	86.0%	14.0%	56.2%	49.4%
SE	35.2%	64.8%	130.8%	117.4%
S	3.6%	96.4%	133.4%	145.8%
MW	25.5%	74.5%	104.7%	142.8%

Source: Prepared by the authors.

Table 5 - Comparison by macroregion between the municipalities presenting gains and decreases in MPF resources and the proportion in relation to national averages of *per capita* revenue and GDP.

State	% of municipalities presenting a gain in MPF resources	% of municipalities presenting a reduction in MPF resources	% *rpc* in relation to the national *rpc*	% *pib_pc* in relation to the national *pib_pc*
MA	93.8%	6.2%	44.1%	41.3%
PI	95.1%	4.9%	46.3%	42.0%
PB	93.9%	6.1%	52.9%	44.0%
CE	88.1%	11.9%	56.1%	44.6%
RS	3.5%	96.5%	132.7%	153.9%
SC	6.7%	93.3%	141.7%	148.9%
SP	11.1%	88.9%	169.2%	144.9%
RJ	24.4%	75.6%	152.2%	179.1%

Source: Prepared by the authors.

In this sense, the results observed indicate that the application of a method of allocating the MPF resources based on GDP *per capita* and average revenue of the municipalities could contribute to the equalization of revenues and reduction of resource disparities between municipalities and regions. The results observed indicate an equalizing effect of the proposed method, tending to benefit, in general terms, the municipalities with lower collection capacity, thus enabling the use of GDP *per capita* and average revenue indices as indirect forms of revenue equalization (Rezende, 2018; Prado, 2020).

The evidence from this study corroborates the analyses of Costa (2020), Ribeiro (2023), Santos (2023), and Baião, Cunha & Souza (2017) in the sense that the current rules of allocating MPF resources generate distortions in the distribution of resources and tend to benefit regions with larger amounts of small municipalities, even those that have greater fiscal capacities and better development indices. Meanwhile, the poorest regions are no longer privileged in allocation, highlighting the need for factors such as revenue and GDP to be incorporated as parameters for MPF resource distribution.

In summary, the results highlight the inadequacy of the current criteria and suggest potential changes to the rules of MPF resource distribution using revenue and GDP *per capita* as indicators to define resource allocation coefficients, aiming to achieve revenue equalization between municipalities and regions.

Conclusions

This study aimed to propose a method of allocating MPF resources based on indices corresponding to the explanatory factors of the municipal collection capacity, and to analyze the effects of this distribution on the equalization of revenues between municipalities. Regression models were estimated for the dependent variables of a municipality's revenue and revenue from local economic activity.

The predictor variables GDP *per capita* and average revenue presented statistical significance and high estimators, indicating the adequacy of these indices with parameters for the equalization and distribution of MPF resources. After the description and simulated application of the allocation method proposed in the study, its effects were analyzed, indicating that the method of MPF resource distribution based on GDP *per capita* and average revenue indices of the municipalities tended to benefit those with lower fiscal capacity.

Based on the evidence, this study confirms the initial hypothesis that an MPF distribution regime that uses criteria based on GDP *per capita* and average revenue indicators tends to produce an equalizing effect, benefiting municipalities with lower collection capacity, thus contributing to the reduction of tax disparities between municipal entities.

The results of the study may contribute to theoretical and empirical formulations that involve mechanisms of equalization and redistribution of revenues through intergovernmental transfers in the context of Brazilian fiscal federalism, especially in its regional dimensions and socioeconomic disparities. For organizations and public institutions, understanding the relationships between socioeconomic factors and the fiscal capacities of subnational entities may contribute to the development of revenue allocation systems more appropriate to the complexities and heterogeneities that characterize the Brazilian federation. The problems presented in this study are relevant to society in that they contribute to the understanding of the structures of fiscal federalism, primarily through transfer systems, and their implications for the reduction of regional inequalities and the construction of appropriate conditions for federal balance.

In this sense, we suggest future studies that involve explanatory models using other methodological possibilities for analyzing the associations between socioeconomic factors and fiscal capacities of federal entities, as well as formulations of alternatives of methods and criteria for revenue distribution, or analyses that use different regional cuts or population size.

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