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# The role of policies in transforming regional fiscal structures: an exploratory analysis of spatial data from a policy of fiscal decentralization in Latin America

Juan Camilo Fernández-Marín<sup>1</sup> , Nadja Simone Menezes Nery de Oliveira<sup>2</sup> and Paulo Mourao<sup>3\*</sup>

\*Correspondence:  
[paulom@eeg.uminho.pt](mailto:paulom@eeg.uminho.pt)

<sup>1</sup> Department of Economics,  
Universidad del Valle, Cali,  
Colombia

<sup>2</sup> Department of Economics,  
Regional and Environmental  
Economics Research Group  
– GERA/Universidad del Valle,  
76001 Cali, Colombia

<sup>3</sup> Department of Economics  
& NIPE, University of Minho,  
4700 Braga, Portugal

## Abstract

One of the goals of decentralized policies is to consider the differences between regions and municipalities, which can lead to greater economic growth as well as greater economic development in all areas. However, endogenous limitations should also be overcome. For these purposes, policies have been designed and must therefore be evaluated in terms of the consequences. One of the most ambitious policies in Latin America in recent years has been the implementation of the ‘General Regalías system’ in Colombia. This paper will assess whether this policy has led to significant changes in the fiscal performance of the municipalities in the Valle del Cauca region, in which the most important city is Cali. We found that this policy was not able to change the ‘neighborhood contagion’ observed before implementation. This is an important conclusion of the study, which includes the spatial dependence to explain the fiscal performance of the municipalities. Through an exploratory analysis of spatial data (AEDE), we verified that the referenced system failed to reach its most ambitious objectives, raising the need for another type of public policy instrument.

**Keywords:** Fiscal Performance Index (IDF), General System of Benefits (SGR), Space cluster, Valle del Cauca, Colombia

**JEL Classification:** R51, R12, E62

## 1 Introduction

Municipalities with inefficient fiscal management tend to offer reduced or incomplete public services to citizens, which contributes to social inequality. The activities carried out by the public sector are of great importance for the efficient functioning of the economy and especially for satisfying the basic needs of society.

State intervention in the economic sphere is possible through taxes and efficient allocation, which translates into general benefits. The responsibility for financing social and urban investment almost always falls on the departments and municipalities, although for citizens, this allocation of these obligations is unclear, and the most common discourse is to blame one or another sphere of power for inefficient management.

The efficiency of public resource allocation of has been a fiscal benchmark regarding evaluating the capacities of municipal mayors. In turn, the use of indicators allows the evaluation and comparison of efficiency in public management in different locations, and the financial condition of a given government can be contextualized according to the level of spending on infrastructure, education, health, security, or justice.

Considering the above, this study analyzed the role of changes in fiscal decentralization policies in Colombia; specifically, the General System of Royalties was investigated. One of the two objectives of this policy in Colombia was to contribute to the economic growth of the country and to a further diffusion of two great levels of economic development. We will observe whether the spatial distribution of the Fiscal Performance Index (IDF) was altered by this policy or not. For this purpose, we studied several municipalities in this part of Colombia—Valle de Cauca. Given the regional heterogeneity that characterizes the area, this group of municipalities offers a unique opportunity to test whether national fiscal policies can increase or diminish the heterogeneity of fiscal performances of the observed sub-spaces.

We understand that our work contributes to the existing literature, mainly for Colombian analyses, where there is a significant shortage of works that address the important role that decentralization plays in fiscal performance. In addition, we have also found evidence that different social contexts can provoke unequal reactions in the creation and conduction of fiscal decentralization policies in developing economies, as is the case of Colombia here detailed.

The article is divided into four sections in addition to this introduction. The first ("Motivation, literature revision and theoretical framework" section) is devoted to motivation, literature review and the theoretical research framework. "Empirical methodology" section presents the methodological procedure. "Conclusions, implications, and further challenges" section presents the final considerations of this study.

## 2 Motivation, literature revision and theoretical framework

### 2.1 Motivation and context

The objectives of designing policies with a regional focus include the promotion of greater regional growth, greater social cohesion and obtaining higher levels of economic development for each sub-space and for the set of spaces.

However, the heterogeneous structure of the areas poses several challenges for the achievement of these objectives. Several studies have observed that areas in close proximity—which also tend to have similar socioeconomic realities—often react even more unevenly to policies that are designed for general application. Works such as Thisse (2000) or Sorensen (1994) have shown that in several cases, regional policies have led to greater economic imbalance after the policy implementation. Other studies, such as that of Mourão (2019), have demonstrated that municipalities share many similar values with neighboring municipalities, justifying disaggregated regional policies which consider the specificities of each cluster of municipalities.

In Latin America, studies such as those by Klasen et al. (2009) or Barroeta et al. (2017) show that there is evidence of 'spatial autocorrelation', showing that not only are municipalities in 'natural clusters' formed by contiguity/geographical proximity, but there are also 'exogenous pressures' coming from neighboring municipalities (either demographic

flows or monetary or economic flows) that influence the levels of economic growth or economic development of each area.

In the case of Colombia, one of the regions with the greatest economic and social divisions is the Valle del Cauca, which has a great diversity of patterns of socioeconomic development, both among urban municipalities and among rural municipalities (Castillo 2008; Torres and Ruco 2008; Lozano et al. 2005).

However, the southern municipalities of Valle del Cauca have had the highest scores in the Fiscal Performance Index in all of Colombia. Reasons that have been identified previously for this trend are the outstanding generation of financial resources by the municipalities of the region, their low dependence on intergovernmental transfers and the low percentage of total expenditures dedicated to investment.

The outlined facts can be consulted in the work of Fernández-Marín (2017), where it is also clear that the municipalities located in the northwest of the Valle del Cauca have completely opposite behavior to those in the south of the department. In this order of ideas, the latter are part of a spatial cluster where good generation and execution of public finances predominates, while the former seem to be being affected by their proximity to municipalities in other departments that are not doing very well with those responsibilities.

To clarify the reasons for this situation, Galvis et al. (2016) developed a poverty analysis in the Colombian Pacific region, where the Valle del Cauca is located, as are the departments of Nariño, Cauca and Chocó, and concluded the existence of an environment with low social mobility, institutional weakness and notable deficiencies in infrastructure conditions in the departments of Chocó and Cauca (especially in the south of the latter department). For this reason, the municipalities in the northwest of Valle del Cauca behave differently from those in the south in terms of fiscal performance since they are near the poor fiscal situation of departments such as Chocó.

According to all foregoing considerations, the municipalities of Valle del Cauca compose a good sample of Colombian municipalities for assessing the quality of changes implemented by Colombian federal policies. Therefore, the next sections will review the relevant literature, detail the methodology observed for testing the significance of changes inserted by federal policies and detail the econometric and empirical processes.

## 2.2 Review of the literature on fiscal decentralization policies in Colombia

According to Sánchez and Zenteno (2010), the current fiscal decentralization process in Colombia started with the promulgation of the 1991 constitution, which created a robust impulse for a process that had been implemented since 1983 (Valencia-Tello and Karam de Chueri 2014). The most notable changes within the fiscal decentralization process have occurred in the intergovernmental transfer system, which increased the participation of the municipalities. This system had worked from 1993 to 2001, which was when the current General Participation System (GSP) began; later, in 2012, the General System of Royalties (SGR) was definitely established.

Article 360 of the Political Constitution of Colombia of 1991 defines royalties as "the economic compensation that arises from the exploitation of a non-renewable natural resource and whose ownership is the Colombian State." That is to say, constitutionally they have been recognized as an economic consideration in favor of the State, which

comes from the exploitation of non-renewable natural resources (RNN), and which is in charge of the people who are granted the right to exploit the natural and mineral resources existing in the subsoil (Pública 2022).

Due to the fiscal decentralization process that Colombia adopted since 1983 (Valencia-Tello and Karam de Chueri 2014), which seeks greater autonomy of territorial entities through a more equitable, transparent and effective distribution of the country's financial resources, the implementation of the General Royalties System (SGR) has become a relevant issue (Bonet and Ayala 2015).

The General Royalties System (SGR) was created by Legislative Act 05 of 2011, and for its effective entry into operation, transitory Decree Law 4923 of 2011 was issued, which established the distribution, objectives, purposes, administration, execution, control, efficient use and allocation of income from the exploitation of non-renewable natural resources (RNN), leaving clear details on the conditions of participation of their beneficiaries (Departamento Nacional de Planeación [DNP] (2022); EITI Colombia 2016; Función Pública (2022).

Subsequently, Law 1530 was approved, containing the regulation of the Budgetary System of the SGR. This system must have a resource plan presented by the Ministry of Finance and Public Credit, where each of the projects that seek financing must be registered in the Bank of Investment Programs and Projects of the SGR and those of the respective territorial entities (municipalities and departments). On the other hand, it also specified the content of the biannual budget of income and expenses of the SGR (Alcaldía de Bogotá 2022a).

Unlike other public investment mechanisms, SGR resources can only finance investment projects, that is, they are not allocations or quotas destined for territorial entities and therefore cannot be invested in operating expenses. This has been expected to stimulate the investment of mining-energy income going to the poorest population as a priority, and also contributing to social equity (EITI Colombia 2016). In addition, funds were created that support projects within different pillars of society, such as science, technology, innovation, territorial development, pension savings, etc. (EITI Colombia 2016).

Finally, the first biennial budget was established in 2012 (Law 1606 of 2012), which covers the years 2013 to 2014, and made available to the different investment projects the sum of seventeen billion and seven hundred twenty-six thousand and two hundred forty-one million pesos (\$17,726,241,381,642) (Mayor's Office of Bogotá 2022b). Regarding Valle del Cauca, this area received \$133,533,000 in the year 2012 for royalties (first year of the SGR), and \$361,808,000 in the period 2013–2014 for the same concept, amounts that were assigned to the Regional Science Fund, to the Regional Development Fund and to the Direct Assignments Fund (Gobernación del Valle del Cauca 2015).

With the process of fiscal decentralization in Colombia after the promulgation of the 1991 constitution, more than half of the nation's current income was gradually transferred to subnational governments, and although initially no clear rules were established regarding fiscal sustainability, a financial crisis that broke out in the 1990s (caused by the same lack of rules), led to a series of fiscal responsibility measures, among which Law 617 of 2000 stood out (to control spending), Law 488 of 1998 and 788 of 2003 (to promote the generation of own resources), Law 715 of 2001 (establishing the rules for

intergovernmental transfers), and finally, Law 358 of 1997 (which places restrictions in the territorial credit).

On the other hand, Law 1176 of 2007 characterized the GSP transfers as conditional transfers (still holding). This law determined that the municipalities could only use the amounts transferred via the GSP for sectors other than health, education, domiciliary public services, water access and basic sanitation.

The most notorious changes within the fiscal decentralization process have occurred in the system of intergovernmental transfers, passing from the fiscal situation and the participation of the municipalities, a system that operated from 1993 to 2001, to the current general system of participations (SGP), which is still in force to date, and finally, the coexistence of the latter with the general royalty system (SGR) created in 2012.

It is important to mention that the 1991 Constitution established that the resources of the participation of the municipal entities would correspond to 14% of the current income of the nation (ICN) in 1993, and that this percentage would increase one point each year until reaching 22% for 2000. Regarding the distribution of financial resources in the municipalities, 60% was distributed according to the number of inhabitants with unsatisfied basic needs (UBN) and the relative level of poverty of the population, and the other 40% was based on fiscal efficiency, progress in terms of quality of life and the population size.

Subsequently, with the appearance of the SGP, each year an amount equivalent to 4% was earmarked for the National Pension Fund of Territorial Entities (Fonpet) and other expenses. Of the remaining 96%, 58.5% went to education, 24.5% to health, and 17% to general purposes. This until 2007, since Law 1176 established that of that 17% of the SGP originally assigned to the last item, 5.4% would be assigned to drinking water and basic sanitation, and 11.6% would continue to be considered as general expenses.

This last law gave SGP transfers the characteristic of being conditional transfers, which still remains to date. This law determined that the municipalities could only use the amounts transferred via the SGP to sectors other than health, education, household public services for drinking water and basic sanitation.

That is when the figure of the general royalty system (SGR) appears in 2012. According to Bonet and Urrego (2014), the financial resources generated from royalties were distributed only among the municipalities that generated them, while now they can go to any other municipality via unconditional transfers, this with the objective to make a more equitable distribution of what could be called "oil jam".

Making a comparison between the SGP and the SGR, in a later work, Bonnet and Ayala (2015) reach the conclusion that the SGP, by following a series of criteria to decide on intergovernmental finance transfers, ultimately encourages political stability and reduces disparities. Alternatively, the SGR, by seeking to extend the distribution of royalties to municipalities that do not even participate in the exploitation of non-renewable natural resources (RNN), tends to promote fiscal inequality between municipal territorial entities.

Furthermore, according to Bonet and Urrego (2014), before the implementation of the SGR, the financial resources generated by the own revenues were distributed only among the municipalities that actually generated them. In contrast, they can now go to any other municipality via transfers of an unconditional nature, with the objective

of creating a more equitable distribution of what could be referred to as spreading the wealth.

Regarding Valle del Cauca, which is the area of analysis for this article, Bonet et al. (2018b), explain that since the mid-twentieth century there has been the presence of social movements in the department of Chocó and in the municipality of Buenaventura, which have been a form of claim for the economic and social lags experienced within these territories.

It is also said that as a result of these social movements two opposing points of view have emerged. On the one hand, the inhabitants suggest that there is a public neglect of these areas, and on the other, that a good amount of resources does indeed come from the central government. According to the results of this work, we observed that the national government and local governments have actually spent more resources, but that the investment needs related to the requests of the inhabitants exceed in most cases the available funds, for which it is necessary to work on local public management, increasing its transparency and the quality of the expenditure that is carried out.

In terms of economic development, both Chocó and Buenaventura have not shown notable changes in recent years. On the one hand, poverty in Chocó has been reduced, but for the period 2004–2017 this department had the highest monetary poverty rate among the 23 departments in the country and Bogotá.

Finally, there is the obstacle that for Buenaventura there are no updated data on poverty, since the latest direct indicators are the Unsatisfied Basic Needs Index (UBN) and the Multidimensional Poverty Index (MPI), calculated only with 2005 information. However, when looking at indicators such as net coverage and gross school coverage, it can be seen that the figures continue to be lower on average than those of the rest of Valle del Cauca.

Regarding the experience of fiscal decentralization in Colombia, the process of fiscal decentralization in Colombia began in 1983, and although at the end of the last century there were problems such as high levels of dependence on transfers from the central government by a good number of municipalities (Valencia-Tello and Karam de Chueri 2014; Aponte 2017; Sánchez and Zenteno 2010), since the year 2000 it has been possible to find a trend towards increasing tax revenues of local governments at a general level. This trend together with recent reforms such as the SGR have reduced regional disparities, slowly contributing to the closing of gaps in terms of territorial development between poor and non-poor municipalities (Bonet and Ayala 2015; Bonet and Urrego 2014).

It is worth noting that during the period 2000–2013, the mining departments of Colombia that have stood out for making large contributions to their departmental gross domestic product are La Guajira, Meta, Cesar, Huila, Chocó and Córdoba (Pacheco-Flórez and Saldarriaga-Isaza 2019). In addition, among the oil and mining departments (at the same time), we have Meta and Casanare, which were the only ones that during the period 2002–2010 contributed more than 4 billion pesos in royalties, allocating them to themselves Departamento Nacional de Planeación [DNP], (2021).

After the reform of the SGR, since non-producing departments could access these financial resources, during the 2012–2020 period, 6 more departments were able to access the range of receiving more than 4 billion in royalties together with Meta and



Casanare, being these La Guajira, Cesar, Bolívar, Córdoba, Antioquia and Valle del Cauca Departamento Nacional de Planeación [DNP], (2021).

Regarding the area of analysis and in the same years of our empirical analysis, in 2010 (before the reform of the SGR), the departments of Cauca, Chocó, Nariño and Valle del Cauca had scores in the Fiscal Performance Index (IDF) of 71.58, 53.7, 72.4 and 71.72, respectively. For the year 2014 (the third year after the entry into force), these scores are 73.44, 56.95, 63.57 and 78.18, respectively, for the same departments. Nariño was the only department that decreased its score, and Chocó continues to be the one with the lowest score Departamento Nacional de Planeación [DNP], (2011) and (2015).

When discussing fiscal decentralization policies, three major directions emerge from the current debates: policy effectiveness, path dependence, and neighboring effects. Following the works of Shrimali et al. (2016), an effective policy is the one able to significantly change the socioeconomic indicators observed for each sub-space (region or municipality) before the policy's establishment. Therefore, if a significant number of sub-spaces change the low levels of development (observed before the policy establishment) to higher levels due to a certain policy, we can state that policy was effective. Obviously, not all sub-spaces are able to improve their previous values and therefore authors consider that a reasonable number should be posited between one-half and two-thirds of changing spaces.

However, authors like Bruttel and Friehe (2014) or Araujo and Rezende (2003) reinforce the idea that for most spaces there is a "path dependence", a concept originally discussed by authors like Bellaïche (2009). Path dependence means that each sub-space has its own conditions on the development process and therefore even empowered policies will not introduce significant changes into the starting inequality observed at the sub-spaces. At last, this means that poorer spaces before a policy will continue among the poorest sub-spaces after a given policy. Additionally, urban municipalities (which are denser areas) have more incentives to attract high-income individuals, to obtain higher local income.

Better performance of these municipalities implies a better use of their resources to provide high-quality goods and services, which allows them to attract more high-income people. In other words, to maintain this virtuous circle may generate more interesting incentives to urban than rural municipalities. In contrast, with a less educated population, the most impoverished rural municipalities will have fewer monetary resources and fewer opportunities to attract high-income individuals. Finally, the theory of the neighboring effects (Mourao et al. 2020; Mourao 2019) suggests that neighboring spaces exert a significant influence on the dimensions observed for a given sub-space, which can be thought as a derivation of the institutional isomorphism (DiMaggio and Powell 1983). Therefore, for the development of a space, it is needed that the surrounding sub-spaces also develop; otherwise, development gains of a given space will not last.

## 2.3 Theoretical framework

### 2.3.1 Origins of the SGR in 2012

In comparing the SGP and the SGR, Bonet and Ayala (2015) concluded that the SGP, by following a series of criteria to decide on intergovernmental financial transfers, aimed to reduce fiscal disparities. In the case of the SGR, by seeking to extend the distribution

of resources, several authors concluded that it lastly tended to promote fiscal inequality between municipal territorial entities. On July 18, 2011, legislative act number 5 constituted the General System of Royalties and amended articles 360 and 361 of the political constitution. With the efforts of different entities and actors during the second half of the year, mobilization occurred in all regions of Colombia; the goal of the General System of Royalties (originally, Sistema General de Regalias) was to build and share reform that would guarantee the principles of social and regional equity. These grants/royalties are now a reality for all the departments in the country, and they were distribution with the prioritization of poverty, population, and unemployment criteria. The reform has been an example of regional efforts and planning for the formulation of megaprojects, which have impact that transcend the borders of municipalities and states. The system has led Colombian politicians to set the goal of generating well-being through routes such as economic growth, employment, and competitiveness (Bonet et al. 2014).

However, authors such as Huriot and Lise (2009) have claimed that decentralized policies are not always successful without reducing the inequalities between and within different areas. Additionally, Stiglitz (2012) enumerated several examples of policies that have not ended in a reduction in the inequality between areas with differing socioeconomic status.

Other studies, such as those of Giraud (1996), Milanovic (2012) or Polèse and Rubiera (2012), detailed or differentiated the performances of fiscal decentralization policies in countries in South America or Latin America. For Colombia in particular, studies such as that of Giraud (1996) have shown the indefinite effects of uninformed policies, given the highly differentiated profile of spatial segregation that originated from the historical development.

The studies of Milanovic (2012) or Polese and Rubiera (2012) also referred to the difficulty of a clear conception of the focus of decentralization policies. Sometimes, these policies are focused on an overly heterogeneous set of spaces; at other times, in contrast, other type of policies are centered on certain foci of the main programs of development being those recipient areas expected to have a spillover effect on neighboring jurisdictions.

Thus, within the intense debate about the effectiveness of fiscal decentralization policies, we intend to bequeath our contribution by focusing on Colombia, where a program with such significant resources as the SGR has had very mixed responses. The next sections aim to contribute to this debate.

### 3 Empirical methodology

#### 3.1 A review of the applied research on fiscal decentralization and spatial autocorrelation

Several methodologies have contributed to evaluating the quality of the design of decentralized fiscal policies considering the different profile of the areas. Below is a summary of some clarifying works on the various methodological alternatives.

The Exploratory Spatial Data Analysis (ESDA) technique has been widely used in space studies and consists of a necessary tool for the statistical analysis of geographic information, which aims to describe spatial distributions, identify outliers in space (Outliers), discover patterns of spatial association and identify possible clusters space (Perebelli et al. 2007).



The ESDA allows calculating global and local spatial autocorrelation measures, enabling the investigation of the influence of spatial effects. Thus, through formal tests, the presence of spatial autocorrelation is verified, by calculating Moran Global Statistics I and Local Index of Spatial Association—LISA. Spatial autocorrelation means that the value of a given variable in each area is influenced by the values of that same variable that occurs in neighboring areas (Almeida 2012).

Authors such as Klering et al. (2012) have analyzed the profile of socioeconomic development and fiscal efficiency in certain areas of Latin America, such as Brazil. They investigated the link between fiscal management and the socioeconomic development in Brazil through analysis of the municipal size in the linkages between indicators of fiscal capacity, social responsibility, and managerial indicators. The results showed that the small Brazilian municipalities exhibited the best management indicators, which confirmed that the strategy of decentralizing municipal public management was beneficial to improving the quality of life and social indicators. These authors concluded that there was a positive relationship between management indicators and social responsibility indicators for the analyzed Brazilian municipalities and that the size of the municipality influences this link.

However, the authors Bollino Di Vaio y Polinori (2012) used exploratory spatial data analysis (ESDA) to identify the existence of spatial overflow and spatial heterogeneity in the local government efficiency in 341 municipalities in Europe. The results showed a positive spatial autocorrelation in the levels of municipal efficiency, that is, efficient municipalities tended to be surrounded by other efficient municipalities, which supports the theory of neighboring effects.

Mourao (2019) conducted a study where he analyzed the explanatory value of spatial dependency on the value of direct awards for 308 Portuguese municipalities. To this end, referring to the data obtained from the electronic platform (BASE) provided by the Portuguese government for the period from 2009 to 2015, the author initially calculated Moran's I, which showed that the reported values were in the central part of the curve, which means that the spatial dependency pattern did not change significantly in the observed period. Then, to estimate the spatial autocorrelation, the author studied four econometric models, the SAR (Spatial Autoregressive), SAC (Spatial Autoregressive Confused), SEM (Spatial Error) and Durbin (Spatial Durbin) models, opting in the end for Durbin's dynamic spatial model to perform the analyses considering a contiguity matrix of first order.

The main results evidenced by Mourao (2019) revealed that the pattern of direct awards from neighboring municipalities influenced the size of the direct awards reported by a Portuguese municipality. In addition, the places with the highest population density tended to assume higher volumes of expenses with direct awards; likewise, a more expressive electoral victory in municipal elections allowed mayors and their cabinets to use more direct awards. In accordance with the above, the author concluded that the influence from the neighboring municipalities was significant since the Portuguese municipalities tended to replicate the size and average value of the direct prizes observed in the surrounding municipalities, which, according to the author, means that it is highly unlikely that a municipality surrounded by others that have large values of direct awards will have low values of public spending.

On the other hand, we can see that to correctly assess the different roles of regional policies, we cannot dispense with an analysis of spatial data, ideally showing that the profile of each municipality was not the same after the changes introduced by the referenced policy. This exploratory analysis of spatial data is composed by several steps, from the study of Global Moran Index and LISA analysis, exploratory spatial analysis, and a bivariate analysis of the Moran Index; later, we will also explore regressions based on spatial data.

### 3.2 Data

The used data source was the database of the Fiscal Performance Index (IDF) of the Departamento Nacional de Planeación (DNP). Our sample corresponded to the 42 municipalities that compose the Valle del Cauca department. We observed this database for two time periods, 2010 (2 years before the implementation of SGR) and 2014 (2 years after the implementation of SGR). These periods were chosen to evaluate the distribution of fiscal indicators before and after the implementation of the SGR. We could have opted for more recent years (such as 2017 or 2018), but the changes in our results would not have been relevant. In addition, we could have received criticism for using years at different distances from the implementation year of SGR.

The IDF is made up of six fiscal subindicators (see Table 1) which also have ratings ranging from 0 to 100. Therefore, the IDF is the weighted sum of six subindicators that move within the range from 0–100: (i) percentage of current income allocated to operating expenses; (ii) magnitude of debt; (iii) percentage of income corresponding to transfers plus Royalties/grants; (iv) percentage of income corresponding to own resources; (v) percentage of total investment spending; (vi) and saving capacity.

Regarding the urban and rural categorization variables, the inputs for calculating the population density were extracted from the DANE Redatam platform.

**Table 1** Subindicators of the Fiscal Efficiency Index

Subindicator	Description	Calculus
PIGF	Percentage of current income allocated to operating expenses, which represent self-financing of the operating expenses of each municipality	$(\text{Operating expenses} / \text{current income}) * 100\%$
MD	Magnitude of debt, which is nothing more than the support of debt service	$(\text{Debt service} / \text{available Income}) * 100\%$
PIT	Percentage of income corresponding to transfers plus Royalties/grants, as a proxy of the dependency on intergovernmental transfers	$[(\text{Transfers} + \text{Royalties}) / \text{Total Income}] * 100\%$
PIRP	Percentage of income corresponding to own resources, which would only be the true generation of resources	$(\text{Tax revenue} / \text{Current revenue}) * 100\%$
PGI	Percentage of total investment spending, which is the same as the size of the investment	$(\text{Investment} / \text{Total Expense}) * 100\%$
CA	Saving capacity	$(\text{Current savings} / \text{Current income}) * 100\%$

Source: own elaboration based on the 2015 annual fiscal performance report published by the DNP

### 3.3 Global Moran Index and LISA analysis

The Global Moran Index (IM) provided a measure of spatial autocorrelation intensity for the fiscal variables in Valle del Cauca to determine if the studied pattern was grouped, dispersed or if it was completely random in terms of spatial location.

The spatial weighting matrix consists of a square matrix that contains the spatial weights of each unit on top of the other or, as Almeida (2012) puts it, it is based on contiguity, and can be defined according to the neighborhood, with both geographical distance socioeconomic, or according to the combination of both. Thus, the weighting matrix, commonly called the “W” matrix, has the purpose of capturing the effects of contiguity and neighborhood on the data (Tyszler 2006; Haddad and Pimentel 2004).

This index varies between the values of -1 and 1, where the closer to 1 the absolute value is, the higher the level of spatial autocorrelation will be. The sign is determined by the spatial distribution of the data, that is,  $IM > 0$  reports an aggregation of data points, while  $IM < 0$  translates as dispersion. On the other hand, the Moran Index needs a contiguity criterion between territorial entities, which are summarized in the following table (Table 2).

The local IM also takes values between -1 and 1; the difference is that this indicator manages to represent the magnitude of the correlation between the reported value of a variable within a certain territory, with the value taken from an identical variable (or different variable, for the bivariate version) for its neighboring entities. The local IM is defined as follows:

$$I_i = \frac{z_i}{\sum_i z_i^2 / N} \sum_{\substack{j \in j_i \\ i \neq j}} w_{ij} z_j, \quad (1)$$

where  $z_i$  corresponds to the value of region  $i$  of the normalized variable,  $z_j$  to the set of neighboring regions of  $i$ ,  $w_{ij}$  to the weight of the matrix  $W$  for all  $i \neq j$ , and the term  $w_{ij} z_j$  to the spatial lag of  $Z$ . Furthermore, the index is represented graphically with a Moran scatter diagram.

The derived popular diagram—the Moran scatterplot—shows the relationship between a specific variable and its spatial lag and classifies this statistically significant relationship into one of four possible quadrants.

To explore in greater detail, the dependence of the values computed for fiscal efficiency in Valle del Cauca, we were also interested in exploring the bivariate Moran scatter plot. The related Moran’s  $I$  statistic is written as follows:

**Table 2** Contiguity criteria of the spatial weight matrix available in GeoDa

Contiguity criteria	Number of neighboring spaces	Description
Rook	4	All those who are located on its sides (up, down, left and right) will be considered neighbors of $i$
Queen	8	They will be considered neighbors of $i$ all those that are located towards its sides (up, down, left and right) and towards its diagonals

Source: Anselin and Rey (2014)

**Table 3** Cluster spatial groupings derived from the local IM

Cluster type	Description
High–high	It occurs when a territorial entity presents a value above the average in a certain variable $xx$ , and at the same time it is surrounded by neighboring areas that also report values above the average using the variable $zz$ as a reference point
Low–low	It occurs when a territorial entity presents a value below the average in a certain variable $xx$ , and at the same time it is surrounded by neighboring areas that also report values below the average using the variable $zz$ as a reference point
Low–high	It occurs when a territorial entity presents a value below the average in a certain variable $xx$ , and at the same time it is surrounded by neighboring areas that report values above the average using the variable $zz$ as a reference point
High–low	It occurs when a territorial entity presents a value above the average in a certain variable $xx$ , and at the same time it is surrounded by neighboring areas that report values below the average using the variable $zz$ as a reference point
Non-significant relationship	It occurs when the value of the variable studied for a given territorial entity is not significantly correlated with the values reported by neighboring areas
<b>Clustering of the Moran scatterplot (bivariate, variable X versus W_Z)</b>	
W_Z	<div> <div>II</div> <div>Low–high</div> <div>III</div> <div>Low–low</div> <div>X</div> </div> <div> <div>I</div> <div>High–high</div> <div>IV</div> <div>High–low</div> </div>

Source: Anselin and Rey (2014)

$$I_B = \frac{\sum_i (\sum_j w_{ij} z_j * x_i)}{\sum_i x_i^2}, \quad (2)$$

where  $z_i$  corresponds again to the values of region  $i$  of the normalized variable,  $Z_{ji}$ , and  $w_{ij}$  are the weights of matrix  $W$  for all  $i \neq j$ . The term  $w_{ij} z_j$  is the spatial lag of  $Z$ . The bivariate Moran scatter plot will enlighten us about how different values of a given variable  $Z_j$  surround a given space  $i$  in which an  $x$ -value has been observed. The generated quadrants for bivariate Moran analysis are summarized in Table 3.

### 3.4 Exploratory spatial analysis

Now, we will proceed to another step in this spatial analysis regarding the effect of the SGR on the structural disparities found for the regions in the Colombian Valle del Cauca. Therefore, we used the criteria to define the rural and urban municipalities in the observed Valle del Cauca. First, a center–periphery criterion was used, where those municipalities located in the metropolitan area of Cali were considered the only urban municipalities. These were Cali, Palmira, Yumbo, Jamundí, Florida, Pradera, Candelaria and Dagua. On the other hand, the population density criterion was also used, which, according to the Organization for Economic Cooperation and Development (OECD), defines rural communities as those territories in which the population density is less than 150 inhabitants per square kilometer.

The following subsections (3.4.1–3.4.4) will analyze the regional differences before and after the establishment of the identified policy, the SGR.

### 3.4.1 Fiscal performance from the perspective of the metropolitan area (before the SGR)

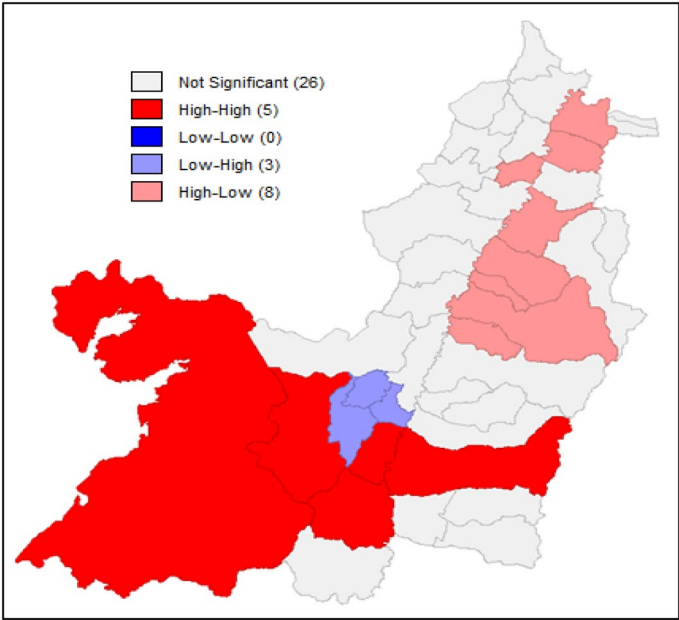
In this case, the municipalities were considered urban if they belonged to the Cali metropolitan area, for which the value of 1 was assigned as a dichotomous variable (0 in the case of those that were not).

Additionally, the Queen contiguity criterion was used since it included a greater number of bordering polygons within the map. For discussing the spatial weight matrix, we opted for assessing the number of neighbors provided for each spatial unit considering different approaches. The most common contiguity approaches are the rook approach, the bishop approach, and the queen approach. With rook contiguity, neighbors are connected by a common side; with queen contiguity, neighbors are connected by at least a common point; with bishop contiguity, neighbors are connected by only a single point (being a non-neighbor a spatial unit without a single common point or with more than one single point). Considering the standard statistical process, we must reject the approaches which do not detect a given number of neighbors or which overestimate the respective number of neighbors. For instance, if there are 9 spatial units in a sample of squares in a chessboard, we can have 0 neighbors at the minimum (if these units are 9 isolated islands, which is actually unlikely in the chessboard); but, at the maximum, we can have a sum of 40 neighbors/squares for a chessboard's individual square. Therefore, if an approach provides 0 neighbors, it shall be rejected, as well as if it provides a computation of more than 40 neighbors for our sample of 9 squares/units. Depending on the number of administrative/spatial units, most of cases in a reasonable large region (for instance, a region with 100 municipalities) will have a mean value of 6 neighbors. As a rule of thumb, the approach providing the highest number of non-zero weights shall be chosen. The two options available in GeoDa provided the following values for non-zero weights: rook, 0.34%; and queen, 0.78%. So, we opted for the queen contiguity approach. Let us also clarify that distance-band weights which optimize that indicator were the distances computed considering Euclidean distance between spatial units' centroids (if compared to Manhattan distance). Although GeoDa's limitations on providing an extensive number of criteria, we suggest the work of Earnest et al. (2007) for a good discussion on the issue.

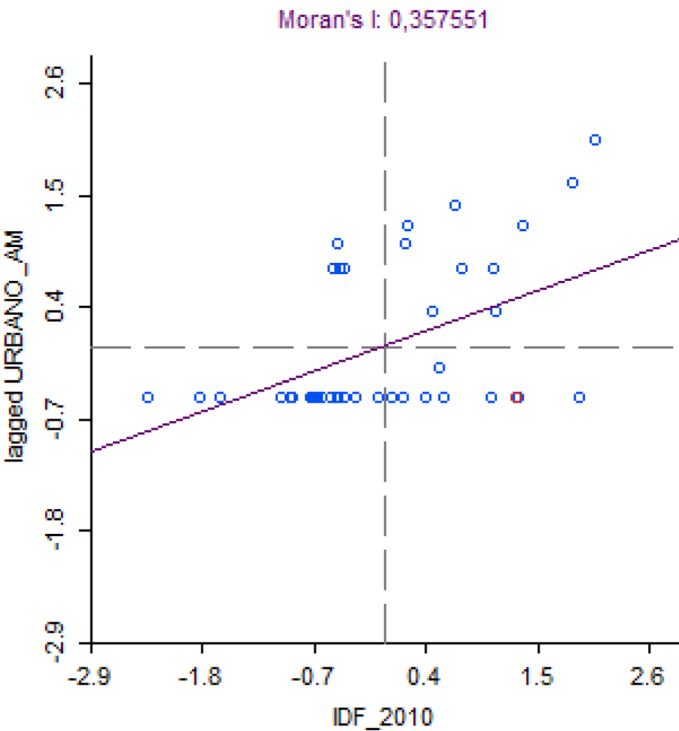
The Moran Index in Fig. 1 tells us that five municipalities had a high rating in the Fiscal Performance Index and in turn were surrounded by municipalities belonging to the metropolitan area of Cali (or that were part of it). These municipalities were Buenaventura, Dagua, Cali, Yumbo and Palmira.

An interesting finding was the pink area on the map in Fig. 1, which indicates the municipalities with high fiscal performance that were in turn surrounded by rural municipalities under the criterion of belonging or not to the Cali metropolitan area. These municipalities were San Pedro, Tuluá, Andalucía, Bugalagrande, Zarzal, La Unión, Obando and Cartago.

Figure 2 presents the Global Moran Index, that is, the coefficient of the slope of the line of a regression, for the 2010 IDF and the categorization of the area (by metropolitan area). The Global Moran Index reported a value of approximately 0.3576, which means that there was a significant correlation between the IDF variable for 2010 and the spatial lag of the dichotomous variable 'belonging to the Cali metropolitan area'. This evidence has relevant policy implications because it shows that efficient municipalities tend to

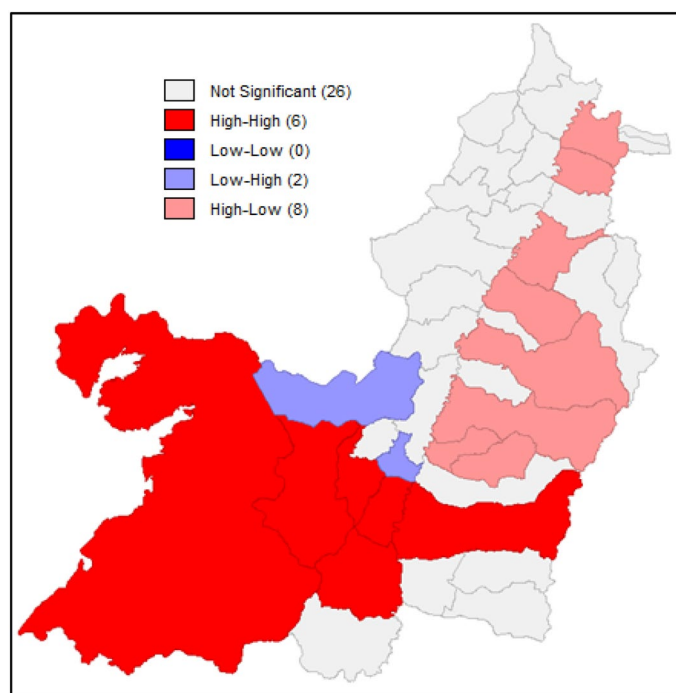


**Fig. 1** Bivariate Moran Index between the 2010 fiscal efficiency and the categorization of the area (by metropolitan area). Source: own computation based upon GeoDa (2020)



**Fig. 2** Global Moran Index for the fiscal efficiency (IDF\_2010) and the categorization of the area (by metropolitan area). Source: own computation based upon GeoDa (2020)





**Fig. 3** Bivariate Moran Index between the 2014 fiscal efficiency and the categorization of the area (by metropolitan area). Source: own computation based upon GeoDa (2020)

surround other efficient municipalities in Colombia, 2010, as well as less efficient municipalities tended to surround other less efficient municipalities, revealing the relevance for regional focus of the development and fiscal policies.

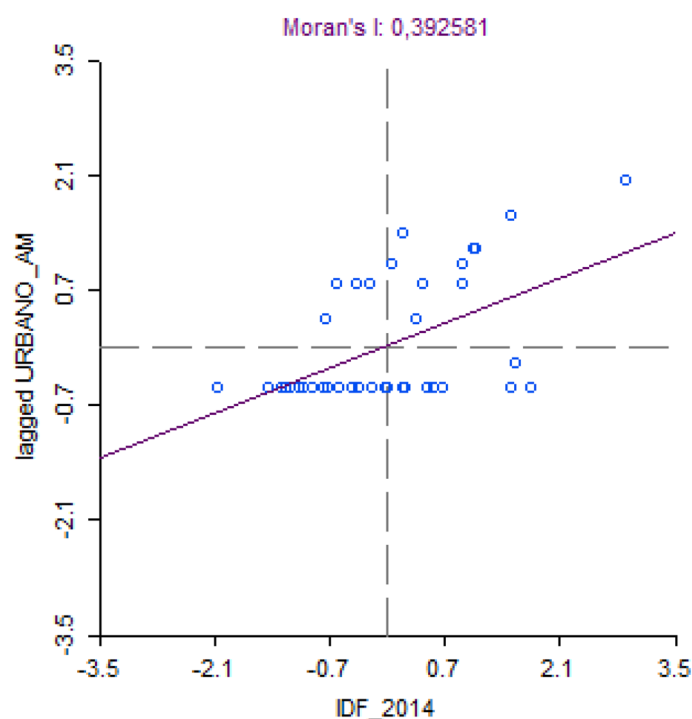
### 3.4.2 Fiscal performance from the perspective of the metropolitan area (after the SGR)

For 2014, the Moran Index (again with queen contiguity) in Fig. 3 shows that six municipalities had a high rating in the Fiscal Performance Index and in turn were surrounded by municipalities belonging to the Cali metropolitan area (or that were part of it). These municipalities were Buenaventura, Dagua, La Cumbre, Cali, Yumbo and Palmira.

On the other hand, the pink area on the map, that is, the municipalities with high fiscal performance that are surrounded by rural municipalities identified Geneva, Guacarí, Buga, Tuluá, Bugalagrande, Zarzal, Obando and Cartago.

Regarding the implementation of the SGR in 2012, there were no appreciable changes in the distribution of fiscal performance, and about the categorization of the areas, some municipalities remained in the pink zone, while other new municipalities joined it. It is important to mention that these municipalities have coincidentally shown notable advances in development in the last decade, so they could be considered the most urban municipalities among those which did not belong to the Cali metropolitan area.

The Global Moran Index in Fig. 4 reported a value of approximately 0.3926, which means that there was a significant and positive correlation between the IDF variable for 2014 and the spatial lag of the dichotomous variable related to belonging to the metropolitan area of Cali. We can conclude that 11 municipalities changed their color (previous cluster). Therefore, about three-quarters of the municipalities kept the cluster,



**Fig. 4** Global Moran Index for the fiscal efficiency (IDF\_2014) and the categorization of the area (by metropolitan area). Source: own computation based upon GeoDa (2020)

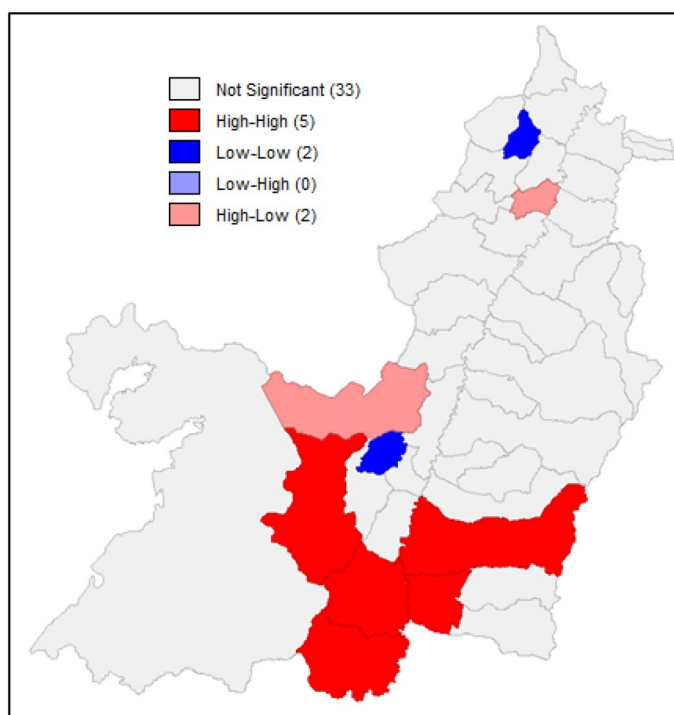
converging with the idea of dominating effects coming from path dependence and contributing to the ineffectiveness of the policy in terms of structural changes in the fiscal efficiency of the focused spaces.

### 3.4.3 Fiscal performance from the perspective of population density (before the SGR)

For this analysis, a dichotomous categorization variable was no longer used. Instead, population densities were used since they are widely used in studies carried out for the territory, and some of these have been carried out by the DNP. Following this concept, and according to the DNP (2014), municipalities with a population density of less than 150 inhabitants per km<sup>2</sup> were considered rural and those with a higher density were considered urban.

The results of the Bivariate Moran Index of Fig. 5 (with queen type contiguity) showed us that the municipalities of Dagua, Cali, Jamundí, Candelaria and Palmira were municipalities with high fiscal performance in 2010, and in turn, they were surrounded by municipalities with high population densities. From the foregoing, it is highlighted that all municipalities except for Candelaria belonged to the metropolitan area of Cali, so under both criteria, they were considered urban municipalities.

On the other hand, Calima (El Darién), which is a municipality that was considered rural based on the population density criterion, had a high fiscal performance in 2010 and is surrounded by municipalities with high population densities. In addition, La Unión (a municipality considered urban based on the population density criterion) presented a high fiscal performance and in turn was surrounded by municipalities with low population density.



**Fig. 5** Bivariate Moran Index between the 2010 fiscal efficiency and the population density. Source: own computation based upon GeoDa (2020)

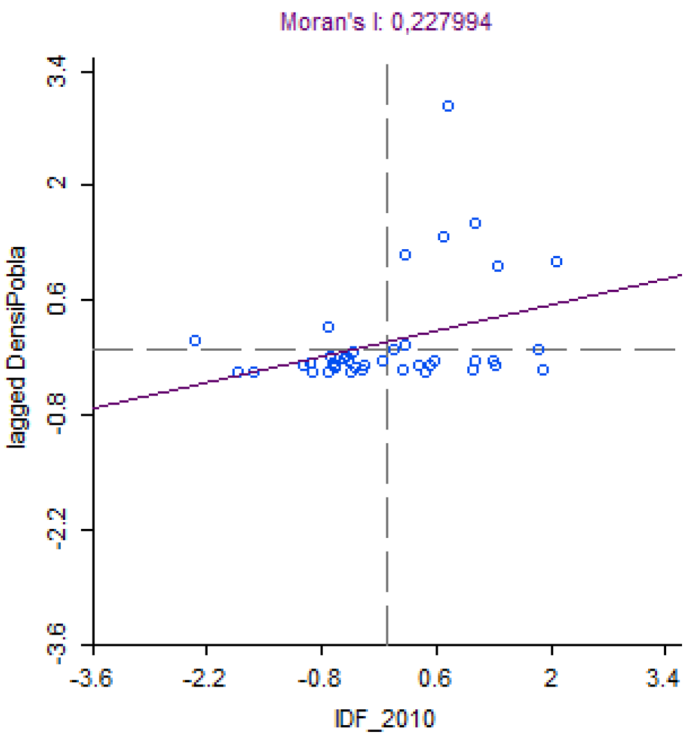
The Global Moran Index in Fig. 6 reported a value of approximately 0.228, which means that there was a positive correlation between the IDF variable for 2010 and the spatial lag of the population density variable.

#### 3.4.4 Fiscal performance from the perspective of population density (after the SGR)

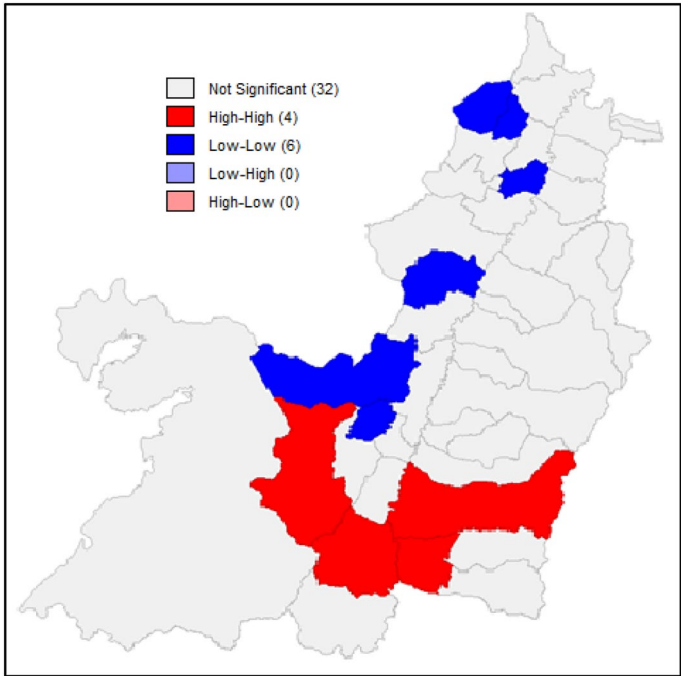
The results of the Bivariate Moran Index in Fig. 7 show us that Dagua, Cali, Candelaria and Palmira were municipalities with high fiscal performance in 2014 and in turn were surrounded by municipalities with high population densities. From the foregoing, it is highlighted that all the municipalities except for Candelaria belonged to the metropolitan area of Cali, so under both criteria, they were considered urban municipalities.

Additionally, six municipalities with low fiscal performance were identified and were surrounded by municipalities with low population density: Restrepo, Calima (El Darién), Trujillo, La Unión, Algeria and Cairo. Of these municipalities, it should be noted that only La Unión was considered an urban municipality based on the criterion of population density.

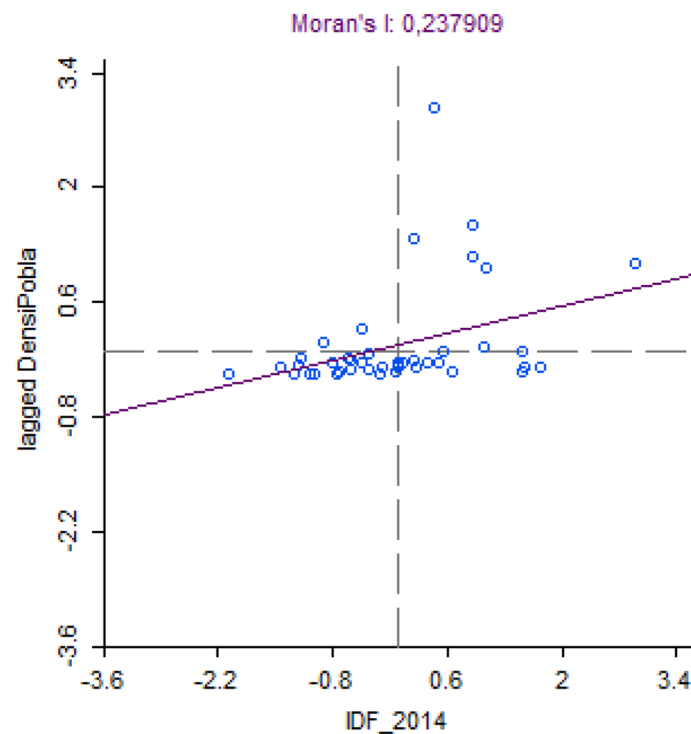
Figure 8 presents the Global Moran Index, that is, the coefficient of the slope of the line of a given regression, for the 2014 IDF and the categorization of the area (by population density). The Global Moran Index reported a value of approximately 0.24, which means that there was again a positive correlation between the IDF variable for 2014 and the spatial lag of the population density variable (the data are slightly spatially aggregated). 5 municipalities changed their previous cluster according to the Bivariate Moran Index, reinforcing again the latent path dependence.



**Fig. 6** Global Moran Index for the fiscal efficiency (IDF\_2010) and the categorization of the area (by population density). Source: own computation based upon GeoDa (2020)



**Fig. 7** Bivariate Moran Index between the 2014 fiscal efficiency and the population density. Source: own computation based upon GeoDa (2020)



**Fig. 8** Global Moran Index for the fiscal efficiency (IDF\_2014) and the categorization of the area (by population density). Source: own computation based upon GeoDa (2020)

### 3.5 Parametric regressions—spatial error models, spatial lag models, and space–time regressions

After the previous steps, which are descriptive steps in the analysis of spatial data, we also explored spatial error models and spatial lag models.

As Anselin (1992) observed, a further step in the analysis of spatial data is to test hypotheses (associated to variables) able to explain the spatial autocorrelation. In our case, we wanted to test two major hypotheses regarding the spatial distribution of fiscal efficiency throughout the Colombian municipalities in the Valle del Cauca in the period around the implementation of the SGR/2012 (between 2010 and 2014). Therefore, we intend to analyze whether the condition of a municipality belonging or not to the metropolitan area is a significant dimension and whether the effects from higher population densities are significant in our case.

For testing such hypotheses, we must refer to some models such as the spatial error model or the spatial lag model. We will include the variables that were previously analyzed in this paper (population density and the urban-metropolitan profile) as explanatory variables, following authors such as Stanic et al. (2020) or Garcia-Rodriguez and Redmond (2020), who suggested that these variables are relevant proxies for sociocultural and institutional dimensions that spatially characterize the municipalities in fiscal terms. The descriptive statistics for these variables are available upon request.

Let us consider the usual Ordinary Least Squares model  $Y_i = X_i\beta + e_i$ . Therefore, the spatial error model considers the following error term  $e_i = \lambda W_i e_i + u_i$  while the spatial lag model considers the following alternative form  $e_i = \rho W_i w_j + u_i$ . As a result, a spatial

**Table 4** Spatial error model, spatial lag model and spatiotemporal results

Variables	Spatial error model ( $\lambda$ )		Spatial lag model ( $\rho$ )		Spatiotemporal regression
	2010	2014	2010	2014	2014
Dep.Variable (Spat.Lag2014)				0.398** (0.163)	-0.118 (0.217)
Dep.Variable (Spat.Lag2010)			0.377** (0.165)		0.213 (0.201)
Dep.Variable (lag, 2010)					0.556*** (0.080)
Density	0.002 (0.001)	0.001 (0.001)	0.002 (0.001)	0.001 (0.001)	-5e-5 (8e-4)
Urban	3.391* (2.001)	2.781* (1.561)	3.211* (2.011)	2.878* (1.607)	0.829 (1.087)
Constant	68.50*** (1.549)	69.46*** (1.202)	42.03*** (11.521)	41.225*** (11.471)	20.131* (11.852)
$\lambda/\rho$	0.363** (0.179)	0.365** (0.168)	0.377** (0.165)	0.398** (0.163)	-0.118 (0.217)
Log-likelihood	-130.981	-123.998	-133.834	-123.121	-104.002
Diagnostics for spatial dependence					
Wald test	52.733	49.327	55.981	41.180	1.280
Likelihood ratio test	55.481	49.988	59.770	49.864	9.364
Lagrange multiplier test	33.442	42.213	57.776	45.550	5.554

\*  $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ 

error model highlights the importance of the observed residuals in the OLS estimation from neighboring spaces while spatial lag model highlights the significance of the observations of the dependent variable in the neighboring spaces. For our cases, the spatial lag model will try to explain the distribution of the fiscal performance by adding the fiscal performance observed in the surrounding area; the spatial error model will try to explain the distribution of the fiscal performance across municipalities of Valle del Cauca by adding the statistical residuals observed in the surrounding area (usually related to omitted explicative variables). As Anselin (1992) claims, spatial errors may be interpreted as a violation of the traditional OLS assumption of uncorrelated error terms. In the case of spatial errors, this is related to the omission of relevant and spatially correlated covariates/exogenous variables. In the case of spatial lags models, the statistical significance of spatial lags indicates the existence of diffusion processes, meaning that events in one place increase the likelihood of similar events in adjacent places.

For each moment in the observed period, our analysis included three tests for spatial error dependence (Moran's I, simple Lagrange multiplier of  $\lambda$ , and robust Lagrange multiplier of  $\lambda$ ) and two tests for spatial lag dependence (simple Lagrange multiplier of  $\rho$  and robust Lagrange multiplier of  $\rho$ ). Independent of the situation observed on the various moments, all tests provided significant values (p-value lower than 0.100; full results available upon request). This means that effects coming from close municipalities cannot be dissociated from a model for explaining the fiscal heterogeneity in Valle del Cauca.

Given the stability of our explanatory variables over the years (actually, these variables are computed yearly by the official National Statistics Institute), we only show the spatial error model and the spatial lag model for two observed dates (the full range of estimations are available under request). In the last column of Table 4, we also show the results



for our spatiotemporal regression in which we include not only the spatial lag for our dependent variable, but also its time-lags.

### 3.6 Synthesis of the empirical analysis

First, Table 4's results confirm which we have already verified upon discussing earlier figures—there are two general types of clusters in the figures and in our regressions. The figures showed that the fiscal efficiency index tended to be higher in the municipalities surrounded by high contemporary values of population density, which was associated with the urban areas of region but also correlated with the concentration of economic activities of high added value (Wheaton 1974) and high worker remuneration (Tirole 1995).

On the other hand, the Colombian areas with the lowest rates of fiscal performance were surrounded by rural areas, with the proper limitations associated with these areas in Latin America in the field of human development (Venables 2003).

Discussing the effects triggered by the SGM policy in the distribution of fiscal performance, it should be noted that these effects were not yet significant. Actually, we found that they only contributed to the continuation of the previous fiscal profile for a vast majority of the observed municipalities.

Therefore, we suggest that future revisions of these legislative pacts must have more focused mechanisms for each cluster of municipalities that depend not only on the urban/rural status, but also on the level of fiscal performance and on more detailed indicators, such as the Human Development Index or its components.

Our regressions also deserve some additional insight. Considering the first four columns of Table 4, we can observe the estimated spatial error models and the estimated spatial lag models for two different periods (in 2010, which was two years before the establishment of SGR, and in 2014, which was two years after the establishment of SGR). Considering the estimated values, we observed that the urban characteristic of each municipality (i.e., belonging to the metropolitan area of Cali) was more significant than population density 'per se' for influencing its level of fiscal efficiency. Overall, the spatial parameters (Lambda in spatial error models and Rho in spatial lag models) were statistically significant. This showed that there was spatial autocorrelation in our estimates, proving the influence of neighboring municipalities on the fiscal efficiency of a given space.

In addition, it is important to highlight that the SGR was implemented with the intention of reducing regional fiscal disparities, however, what the results of this article showed is that departments such as Valle del Cauca, which has always been prosperous before and after the reform, it is the one that continues to have the highest levels of fiscal performance (especially the area located to the south, near the city of Cali, capital of the department, which is where the most urban municipalities are located).

However, when we explored simple models of spatiotemporal regressions by including time-lags of the dependent variable, we observed that past values of the fiscal efficiency indexes had the most significant values (nullifying all the spatial parameters); therefore, we can claim that, although there was contemporaneous influence from neighboring spaces, it is relevant for a given municipality to increase its own levels of fiscal efficiency

to develop its own paths of improvement, given the path dependence on the own past values.

#### 4 Conclusions, implications, and further challenges

This work was the first work to discuss the capacity of a preeminent program of decentralized grants to reach the goal of reducing inequality between Colombian municipalities. We therefore observed the ‘Sistema Generale de Regallos’ (SGR), which was implemented in 2012. Considering the spatial analysis methods, we verified that the structure of the spatial distribution of fiscal performance was not affected by the implementation of the SGR between rural and urban municipalities by using different criteria to differentiate the observed municipalities. We observed that the municipalities belonging to the metropolitan area had the best fiscal performance; however, there were also some municipalities that stood out as a ‘pink zone’ on the map for the different periods of observation, with these areas being territorial entities with high fiscal performance that were surrounded by rural municipalities.

It is important to make the caveat that those municipalities that fell in that pink area of the map (check again Figs. 3 or 5) were municipalities that under other criteria could be considered urban municipalities since they had a level of economic development that was not far from that of the municipalities belonging to the Cali metropolitan area.

From the population density criterion, the conclusion was quite different since it was evident that the urban municipalities under this criterion that belonged to the Cali metropolitan area, along with a few other municipalities that were close to these, were still in the red area of the map (with the best fiscal indicators) in the periods before and after the implementation of the SGR. These were municipalities with high fiscal performances surrounded by municipalities with (also) high population densities.

Considering the density criterion, in 2010, only two municipalities fell in the pink zone. Two years after the implementation of SGR, in 2014, a marked blue zone expanded, suggesting that after the implementation of the SGR, more rural municipalities began to share a neighborhood effect of low levels of fiscal efficiency in Valle del Cauca, which emerged as a relevant challenge for further observations and studies on the topic.

For future work, we intend to recur to the Colombian National Department of Planning (Departamento Nacional de Planeación) which has a public database with the estimation of expenditure efficiency and efficacy for all Colombian municipalities since 2006. Considering data from this source, we also intend to analyze more detailed indicators of fiscal efficiency (either considering expenditures or revenues). The possibility of updating data as soon as official sources release their latest versions is considered as a further challenge important for studying the peace effect on our observed dimensions – recall that OCAD PAZ is the fund created to finance projects associated with the allocation of peace; this fund was created in 2017–2018, and the final agreement of the peace process was signed in 2016. Since our article used data from 2010 and 2014, we could not consider our data as significantly affected by the peace process, although we realize the peace process inserts important challenges on fiscal issues. We also intend to extend this study to other policies of fiscal decentralization in Latin America to verify the capacity of each policy in each endogenous context to motivate significant differences in our regional clusters. Finally, we also intend to develop spatial analysis techniques that

consider panel data allowing us to detail the changes that took place during the long term of the observation period, namely, the highly relevant challenges derived from our spatiotemporal regressions.

#### Acknowledgements

The authors acknowledge the contributions provided by two anonymous reviewers. Remaining limitations are authors' exclusive ones.

#### Funding

This paper is financed by National Funds of the FCT—Portuguese Foundation for Science and Technology within the project UIDB/03182/2020.

Received: 21 October 2020 Revised: 28 May 2022 Accepted: 10 July 2022

Published online: 05 August 2022

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