Decentralization in Colombia: A Search for Equity in a Bumpy Economic Geography

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Abstract

Colombia's decentralization was conceived to improve population's access to social services, reduce poverty and equalized well-being across the territory. However, after more than 20 years of its implementation a big gap in social achievements across municipalities remains. We analyse the spatial distribution of poverty by disentangling the role of decentralization and economic geography characteristics. We use a spatial econometric approach in order to model the spatial autocorrelation in deprivations and an Instrumental variable method to account for the possible endogeneity that arise when evaluating the impact of fiscal decentralization over multidimensional deprivation. Results suggest a strong causal diminishing effect of the share of own resources by municipalities and political participation at local level over the achievement of social minimums as depicted by the average multidimensional gap and over multidimensional poverty as well. Differentiated policies with a territorial approach that incorporate economic geography effects, and decentralization designs that take into account the heterogeneity of regions and municipalities are required in order to improve social convergence to minimums from the territories at the bottom of the distribution.

Keywords: Decentralization, multidimensional poverty, equity, spatial interdependence

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1. Introduction

Colombia's decentralization was conceived to improve population's access to social services, reduce poverty and equalized well-being across the territory. However, after more than 20 years of its implementation a big gap in social achievements across municipalities remains. According to 2005 census calculations, 48% of the national population is under multidimensional poverty[1] with astonishing differences across municipalities ranging from 14.2% to 99.6%.

Several studies have tackled the divergent economic pattern of Colombian territories over time, such as Cardenas (1993), Bonet and Meisel (1999), Acevedo (2003) and, more recently, Cortés and Vargas (2012) among others; however, most of them focus their analysis on economic convergence and their unit of analysis is *´departmentos´* (Colombian counties). In this paper we focus on social convergence at municipality level, the smallest political – administrative unit in Colombia.

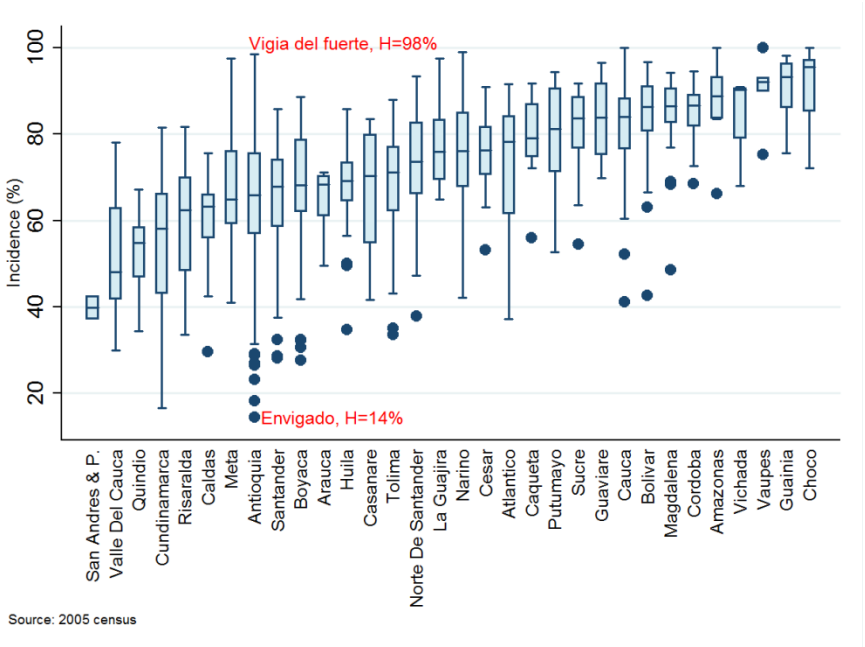
This choice is not irrelevant: one of the key insights of this study is that poverty, from a spatial dimension, needs to be understood at municipal level given the high heterogeneity that lay inside the departments in terms of economic geography and institutional capabilities of local governments. Then, poverty figures at departmental level usually hide huge differences of poverty rates across municipalities. For instance, when plotting the dispersion of multidimensional poverty incidence across Colombian municipalities and by County, as is showed in Figure 1 below; most of the Counties show a large dispersion, having counties, as for example Antioquia, with municipalities from 14% of multidimensional poverty (Envigado) up to municipalities with 99% of multidimensional poverty (Vigia del Fuerte).

We argue that rather than economic convergence, where differences across the territory are explained and even desirable because of agglomeration processes and external economies arising from urbanization, the claim should be for convergence in the minimum social achievements that allow the population to fulfil their life with valued functionings[2], which is the ultimate goal of the "Social Rule of Law State" (*Estado Social de Derecho*) specified by the Constitution of 1991.

[1] The Colombian Multidimensional Poverty Index (CMPI) is the national indicator of multidimensional poverty launched by the Colombian government in 2012. This indicator sets the socially acceptable minimums for the five most important Colombian social public policy dimensions (education of household members; childhood and youth conditions; health; employment; and access to household utilities and living conditions) and is able to capture how far from each minimum is each household (Angulo et al, 2013).

[2] According to Sen (1993) approach to well-being and advantage, the life that a person held can be seen as a finite set of doings and beings, some very basic and strongly valuated and other more complexes. Those various doings and beings are called by Sen as *functionings.*

Figure 1: Multidimensional poverty dispersion by county



In fact, the "decentralization model" conceived by the Constitution of 1991 can be understood as a rearrangement of the State and the relationships between levels of government to achieve social equity. The objectives of decentralization as stated in the Constitution are: a) to improve the access of the population to social and public services, with emphasis in education, health, water supply and sanitation; b) to target resources toward the poorest population in order to take them out of poverty; c) to diminish territorial inequalities; d) to promote productive processes to improve income and employment, and e) to improve and to deep representative and political democracy (Maldonado, 2011)

In this context, the main goal of this paper is to disentangle the effect of decentralization on multidimensional poverty gaps at municipal level in Colombia and its success or failure to overcome economic geography issues that emerge from a very heterogeneous territory. From this analysis we derived policy implications to improve social convergence and equal opportunities for all citizens despite where they were born or where they live.

The paper uses census data of 2005 and several administrative registers from Colombian agencies on household social conditions, social public expenditures and others. With this information, we analyse the spatial distribution of poverty by disentangling the role of decentralization and economic geography characteristics (such as economic density, distance from each municipality to economic agglomerations, commuting and traffic patterns by pair of municipalities, among others). We use a spatial econometric approach in order to model the spatial autocorrelation in deprivations and an Instrumental variable method to account for the possible endogeneity that could arise when evaluating the impact of fiscal decentralization over multidimensional deprivation.

Results suggest a strong causal diminishing effect of the share of own resources by municipalities over the achievement of social minimums as depicted by the average multidimensional gap and over

multidimensional poverty as well. Spatially differentiated policies and decentralization designs that take into account the heterogeneity of regions and municipalities are definitely required in order to improve social convergence to minimums from the territories at the bottom of the distribution and that the role of economic geography variables should be taken into account in the design of such policies.

The paper is organized as follows: first the Section two below describes the main features of the decentralization process in Colombia and how it was conceived to achieve social equity; subsequently, within the same Section two, we describe and conceptualize how, for the Colombian case, economic geography plays a very important role when trying to understand the channels that produce deprivation at the local level. After this conceptual background, we describe in Section three the data that we use and the empirical strategy that we pursue; finally, Section four describes the results that we obtain from our econometric models and Section five present conclusions and public policy lessons that can be derived from this particular analysis.

2. Conceptual background and stylized facts

a. Decentralization in Colombia: An Eclectic Model of Delegation and Devolution

The main argument that justifies decentralization as a tool for the achievement of social goals lies in the premise that decentralization allows the revelation of local preferences, makes possible a more adequate supply of social services and basic goods to the conditions and necessities of local populations and put citizens in direct relationship with the level of government in whose election they participate, and over whom they can exert a closer accountability.

The fundamental core of decentralization rests in the definition of competences to different levels of government, and in the allocation of resources that enable local governments to exert those competences. In general, decentralization can be understood across three main areas were local governments are empowered: fiscal, administrative and political.

The ideal model of fiscal decentralization, embedded in the so called “fiscal federalism” (Litvack et al., 1998) proposes fiscal independence of each jurisdiction over the basis of a distribution of incomes and responsibilities. In practice however, the degrees of decentralization vary. The usual models of decentralization can be put into three schemes: a) deconcentration of national agencies that imply some autonomy with control and regulation from the central government; b) delegation, for which the subnational government is able to supply some social services, under the regulation of the central government; c) devolution, which implies full autonomy in terms of competences and with the ability to generate the resources needed to exert those competences.

The current state of decentralization in Colombia is the result of 25 years of accumulation of major reforms that began with the AL No. 1 of 1986 and extend through the reforms of royalty and territorial

planning in 2011-2012. Since the beginning it was recognized that fiscal federalism was not a possibility for the large group of municipalities that lacked sources to generate their own income and that the model of fiscal federalism only could be applied, if any, to cities (Bird, 1981). The recognition of vertical and horizontal imbalances led to the design of a transfer system that would allow subnational governments to achieve the main objectives of decentralization.

In this way, the Colombian decentralization is in practice, an eclectic model of decentralization, deconcentration and delegation. As Bird (2012) states, "it may now be argued that Colombia's real model of decentralization is perhaps best characterized as one of delegation rather than devolution". In the discussion between "devolution" and "delegation" model there are, however, important sectorial differences. For example: (i) In water supply and sewerage the system is decentralized (all the investment decisions are responsibility of subnational governments), while resources come from transfers and own resources (price charges and royalties). The recent scheme of Departmental Water Plans can be considered as a change in competences between municipalities and departments. The new scheme gives more responsibilities to departments mainly due to economies-of-scale arguments. (ii)Health services are also fully decentralized: departments and municipalities have full autonomy for budgeting and managing their own resources but this is constrained to previous certification to enable the territorial administrations for that regard. (iii) In education the scheme is more of delegation than devolution.

This model has been consistently nuanced with elements of coordination and concurrency which are becoming stronger. Since the Constitution of 1991 and Law 60 of 1993, the resources of the General System of Transfers, (*Sistema General de Participaciones*, SGP by the Spanish acronym), were earmarked to certain sectors, mainly education, health services and water supply and sewerage. The use of resources usually has been guided and monitored by the national government, in some cases with a certification from the central government of sub national governments' skills to provide these services.

In education, health services and water supply and sewerage around 90% of public investment is responsibility of sub national governments. Between them, municipalities have played a lead role in the decentralization process, while departments have played a secondary role. In 2010, out of the total public investment budget, 47% was executed by the municipalities, 22% by the counties and 31% by the national or central level. The share of sub national Governments is even more important in the case of social investment[3] (Table 1 within the Annexes report the 2010 Colombian governmental investment structure by levels of government).

To evaluate the relative degree of success of decentralization in Colombia to achieve its ultimate goals which are the improvement to the population's access to social and public services and the reduction of territorial social inequalities in Colombia, we use the Multidimensional Poverty Index (CMPI). The CMPI is a national indicator, launched by the Colombian government in 2012, that sets the socially acceptable minimums for the five most important Colombian social public policy dimensions

[3] Social investment in this case refers to CMPI related investment; which includes Education, Health, Attention to vulnerable groups, social promotion, Dwelling, Drinking water and basic sanitation, and Public services different from water and sanitation.

(education of household members; childhood and youth conditions; health; employment; and access to household utilities and living conditions) and is able to capture how far from each minimum is each household (Angulo et al., 2013); we use as our main outcome of interest, to track the effect of decentralization over it. As a result, the Section below seeks to provide the conceptual background to determine, additional to decentralization, the features that could be playing a key role when explaining multidimensional poverty and moreover the average gap to reach those social minimums.

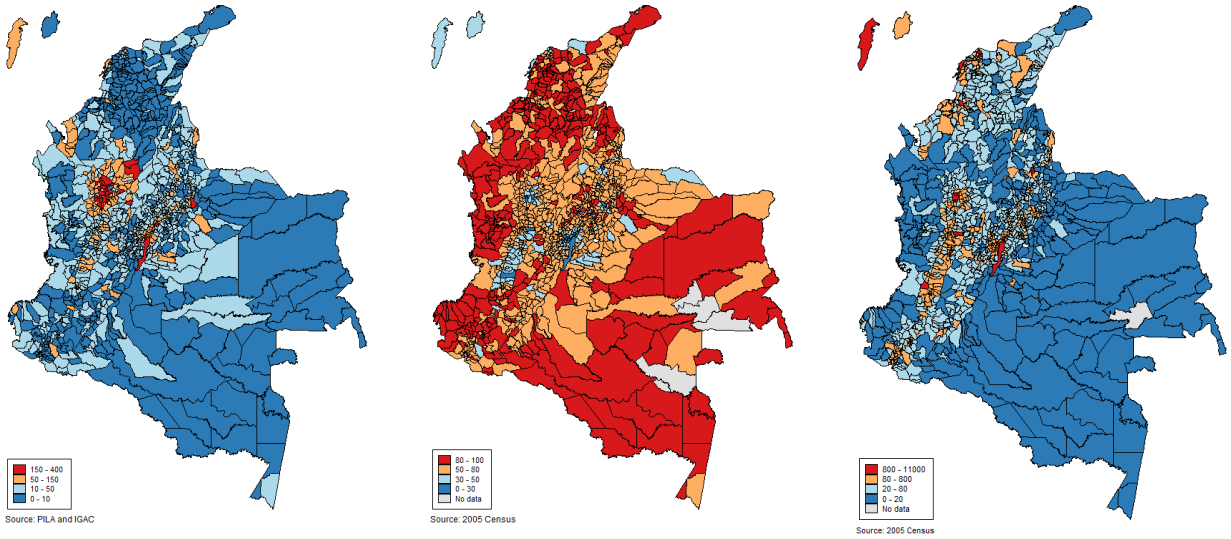
b. Social Equity and economic geography for the Colombian case

The spatial distribution of economic activities tends to be unequal and concentrated in some geographical areas as a result of market forces of agglomeration, labour migration and specialization (Harvey, 2009). Economic density is, therefore, a common characteristic of economic growth. Densification of economic activities goes at hand with densification of population (although the opposite not necessarily takes place, or not necessarily at the same pace). These endogenous dynamics imply a more efficient spatial structure of production with gains in terms of economic growth, productivity and income generation.

Colombia is not an exception. As Figure 2.a below shows, the largest number of formal businesses per squared kilometer is concentrated in Medellin and Bogota and their metropolitan areas, with 285 and 191 businesses per urban kilometer, respectively. As could be expected from an economic geography perspective, areas with higher economic density might become the ones with lower income poverty, since they concentrate the main economic activities, have a larger proportion of formal labor, and therefore higher wages and per capita labor incomes. In this sense, cities, as the geographical space with higher economic and population densities play a key potential role in the reduction of poverty. When comparing Figures 2.a and 2.b, it is evident that the agglomerations of Bogota and Medellin, that concentrate the highest number of businesses per squared kilometer, as was said before, register, at the same time, the lowest rates of multidimensional poverty incidence.

On the other hand, areas with more disperse population tend to have higher poverty levels, not only in income terms, but also in multidimensional terms: the reason is that population dispersion makes more difficult to provide infrastructure and public services, implies higher transportation costs, access to technology is more difficult, access to education and health services is lower and the quality of these services tend to be lower as well. Figure 2.c shows differences in population density across the Colombian territory. It suggests that less dense areas show indeed greater multidimensional poverty incidence (Figure 2.b).

Figure 2. Spatial distribution of economic activity, poverty and density



a) Business per urban squared Km

b) Multidimensional poverty incidence (H)

c) Density (Inhabitanst per squred kilometer)

In fact, it could be argued that in Colombia urbanization has generated higher social inclusion across municipalities (Samad et al., 2012): in 1964 there were huge gaps in access to public services between population living in large cities and urban population in small municipalities; those gaps have almost disappeared after five decades. While in 1964 only Bogota registered an average share of population with access to electricity, water and sanitation greater than 75%, in municipalities with less than 20 thousand inhabitants less than 30% of them had access to those services; in 2005 the average share of urban population with access to those services for any group of municipalities is greater than 80% (Figure 3 within the Annexes displays, in detail, the evolution in dwelling services coverage between 1964 and 2005 by size of municipality).

Urbanization can also have a significant effect reducing rural poverty. Studies such as Cali and Menon (2009) found causal effect of urbanization over poverty reduction in the surrounding rural areas of Indian districts; the authors find positive and significant spill over effects of urbanization across rural territories, rather than significant movements from rural poor population to urban areas. They argue that this poverty reduction effect of urbanization could be explained mostly by greater demand for local agricultural products, and also in a fewer extent by the increase of remittances and rural nonfarm employment. Although, there is still no study with causal evidence for the Colombian case, there is a negative relationship between urbanization ratio and poverty; in fact, the Spearman pair wise correlation between urbanization ratio and multidimensional poverty reaches -0.46 points for 2005 census data and -0.167 points between urbanization and rural multidimensional poverty.

While, urbanization and multidimensional poverty are in average negatively related, there is still a high dispersion at municipal level as shown in Figure 4.a. There are some cases with very high level of urbanization and high levels of multidimensional poverty incidence; in fact, out of 1106 municipalities 25% exhibit an urbanization rate greater than 0.5 but also multidimensional poverty greater than 50%. All this suggests that the urbanization degree, i.e., the differences in the proportion of the population living in urban areas, is not sufficient to explain poverty variation across municipalities.

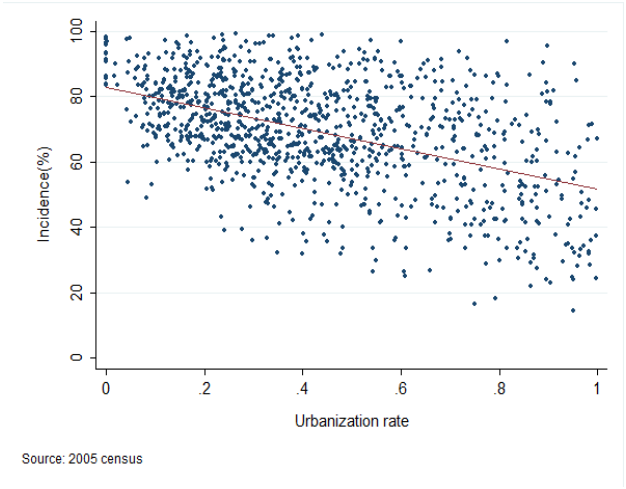
As the report of the World Bank (2009) emphasizes, as important as density, is distance to densities. Two municipalities can have the same density and the same urbanization rate, but if one of them is close to an important urban center and the other is far from any, the first municipality can, potentially, take advantage of the agglomeration economies associated with the nearby city. It means, to take advantage of scale and specialization economies (for example manufacturing firms located around urban centers), network economies, pooling or clustering of economic resources, learning economies, etc.

Indeed, (i) density and (ii) distance to density could be analyzed, as suggested by Machado (2011), as a joint phenomena by aggregating them into one indicator, a rurality index - RI.[4] As can be seen in Figure 4b, we find a strong positive relationship between multidimensional poverty incidence and the rurality degree of a municipality: less rural municipalities tend to have a lower incidence. More rural municipalities tend to have a higher incidence. However, in the middle range there can be observed a high dispersion of poverty incidence between municipalities with similar rurality degree. To disentangle the factors that explain such patterns is one of the main objectives of this paper.

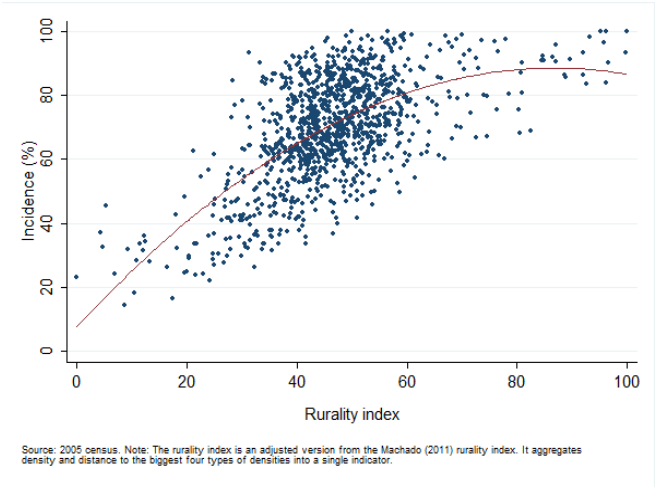
It is worthy to note that municipalities with the same RI could differ substantially in poverty terms due to differences in their endowment of natural resources, soil quality or the presence of non-renewable natural resources that act, in fact, as an economic density pole that attract capital and other productive resources. De Janvry and Sadoulet (2007) differentiates between “marginal rural areas” (MRA) and “favored rural areas” (FRA). MRA are those characterized by poor agricultural endowments, and isolated from markets and employment sources. Geographical isolation and the poor endowments convert these areas in true poverty traps. In contrast, FRA can be transformed in dynamic regions based on their comparative advantages, if they are effectively and efficiently connected with their relevant markets.

[4] Machado (2011) proposes to aggregate first four variables of distances and a variable of density by a linear combination of them in order to obtain a rurality index.

Figure 4. Dispersion of multidimensional poverty incidence across urbanization and rural index



a) Urbanization and multidimensional poverty



b) Rurality index and multidimensional poverty

On the other hand, most of the municipalities with lower rurality degree are part of what can be called the Colombia's "System of Cities". It comprises the main cities of the country larger than 100.000 habitants and their agglomerations (BM and DNP, 2012)[5]. The System of Cities comprises 151 municipalities, 56 of which are larger than 100,000 habitants. In 2010 the municipalities within the System of Cities represented 66% of total population, 80% of urban population and 81% of formal employment[6].

Figure 5 in the Annex identifies within the map the main System of Cities in Colombia. As it can be seen there, they are located mostly in the inner part of the country, on the Andean region, and far from the coasts, with the exception of the system around the Caribbean cities of Barranquilla and Cartagena. This pattern, atypical when compared with other countries in the region, is the result of two elements: a) the occupation of the territory during the Spanish colonization followed closely the spatial distribution of indigenous population, which was concentrated in the Andean region; this fact, together with a very complex geography imposed very high transportation costs that led to the conformation of many small and medium towns usually disconnected between them; b) the inheritance of several decades of an industrialization process based on an Import Substitution Strategy, concentrated on the provision of internal markets with few connections with external markets.

In terms of poverty and according to 2005 census figures, 50% of the multidimensional poor population lives in those areas. However, the poverty incidence, as expected, is in average half of

[5] The identification of the System of Cities in Colombia has been an analytical and empirical exercise carried out by the Mission of System of cities (BM & DNP, 2012). It was based in the identification of functional relationships between centers of agglomerations and their surroundings using indicators such as commuting, daily traffic flows, and travel times.

[6] Source of population figures, Dane; and PILA 2005 for employment figures.

incidence in the rest of the country; whereas 37% is the headcount within areas that belong to the System of Cities, 73% is the incidence in areas that do not belong to the System of cities. The results in terms of multidimensional poverty also hold for the comparison in terms of poverty by income lines. While in the 13 main metropolitan areas income poverty ratio was 18.9% in 2012, in the urban areas of the other municipalities was 42.2%, and in the dispersed rural areas poverty ratio was 46.8%. This means that urban areas in regions different than the main 13 metropolitan areas behave, in poverty terms, similar to rural areas, and show high incidence of poverty. This result supports the concept behind the Rurality Index: the main difference in terms of poverty is not between urban and rural areas, but between municipalities with high densities or close to towns with high densities, and municipalities with low densities and far from towns with high densities.

3. Data and Empirical Strategy

Based on the discussion presented in Section 2 above, our aim is to model deprivation at the municipality level in function of decentralization and economic geography variables, controlling by a set of covariates that include economic activity, demography and violence, among others. Therefore, we build a comprehensive database at the municipality level based on estimations from 2005 Census and Colombian fiscal administrative registers, such as: the local budgetary execution system of capturing from the National Planning Department[7], the 2003 national registers on voting from the National Registry Department, primary and secondary road network information from the System of Cities and from the National Geographical Institute (IGAC); administrative register regarding social protection affiliation for formal employees from the Social Protection Ministry; and demographic indices from the Colombian UNDP 2011 report (Machado, 2011).

a. Selection of variables

This Section below describes the selection of the variables: first our outcomes of interest; second, the indicators that we built in order to measure the decentralization degree at the municipality level, and third the approach that we use to capture economic geography variables, and the spatial economic relationships among municipalities.

[7] Information system for capturing the local budget execution (*Sistema de Información para la Captura de la Ejecución Presupuestal,* SICEP)

The dependent variable

As mentioned before, our dependent variable is the Colombian Multidimensional Poverty Index (CMPI) at municipal level. The CMPI was built by the National Planning Department based on the Alkire and Foster (2010) method for multidimensional poverty indices. The CMPI aggregates 15 indicators among the five most important social dimensions in the Colombian public policy context: household's educational condition, child and youth conditions, health, labor characteristics, and access to public services and housing conditions. One interesting feature of the CMPI is that several of the indicators that compose the index are potentially affected by public policies and social investment.

The CMPI uses poverty lines for each of the 15 indicators, and an aggregate threshold for the weighted sum of deprivations. Population under multidimensional poverty is that one with more than 33% of the weighted sum variables in situation of deprivation. The unit of analysis is the household under the assumption that deprivations are simultaneously experienced by each member of the household.

The calculation of the CMPI at municipal level used data at the individual level from the 2005 Census and computes the aggregated measures at the municipality level. There are two sources of minor differences with respect to the official CMPI calculated using the Living Conditions Survey (LCS)[8]: the first source of difference is given by slightly differences in the wording of some of the 2005 census questions and LCS questions and also the absence of some particular questions that the LCS uses. The second source of differences is given by the expression of some of the indicators of the Household education conditions and access to public utilities and housing conditions to be able to depict the full set of indicators in a cardinal scale – that is, it requires each of the indicators to be measured on a scale with meaningful value of the difference between two points, rather than just indicating the presence or absence of a certain attainment. For a complete description of the methodology to construct the 2005 census based CMPI and the transformations done over the official CMPI see Ramirez et al (2013).

Now, once dimensions, variables and cutoff points were defined; the aggregation structure that the CMPI uses is the one proposed by the Alkire and Foster (2010). This particular aggregation structure allows us to use, first a multidimensional poverty headcount (H), and second an average poverty gap ($M1$), both of them as the average at the household level across municipalities. Whereas H depicts the share of the population that is considered within each municipality as in multidimensional poor conditions, $M1$ can be interpreted as the average multidimensional gap. In particular, we use $M1$ as an opposite measure of convergence to social minimums because it expresses how distant each household is from each of the dimensional poverty lines.

[8] For a complete description of the methodology, variables selection, poverty lines and aggregate results of the CMPI between 2007 and 2010 by using the Living conditions survey see Angulo et. al. (2013).

Table 2. Dimensions, variables, weights and poverty lines of the implemented CMPI

Dimension	Variable	Indicator	Cutoff point
Household education conditions (0.2)	Educational achievement (0.1)	Percentage of people living 15 and older who holds at least 9 years of education	100%
	Literacy (0.1)	Percentage of people living in a household 15 and older who know how to read and write	100%
Childhood and youth conditions (0.2)	School attendance (0.05)	Percentage of children between the ages of 6 and 16 in the household that attend school	100%
	No school lag (0.05)	Percentage of children and youths (7–17 years old) within the household that are not suffering from school lag (according to the national norm)	100%
	Access to childcare services (0.05)	Percentage of children between the ages of 0 and 5 in the household who simultaneously have access to health, nutrition and education	100%
	Children not working (0.05)	Percentage of children between 12 and 17 years old in the household that are not working	100%
Employment (0.2)	No one in long-term unemployment (0.1)	Percentage of household members from the economic active population that are not facing long-term unemployment (more than 12 months)	100%
	Formal employment (0.1)	Percentage of employed household members that are affiliated to a pension fund (formality proxy)	100%
Health (0.2)	Health insurance (0.1)	Percentage of household members over the age of 5 that are insured by the Social Security Health System	100%
	Access to health services (0.1)	Percentage of household members that had access to a health institution in case of need	100%
Access to public utilities and housing conditions (0.2)	Access to dwelling services (0.1)	Percentage of dwelling services that the household has access to; this out of (i) water source, (ii) elimination of sewer waste, (iii) adequate external walls* (iv) adequate floor and[++].	100%
	No critical overcrowding (0.1)	Percentage of absence of critical overcrowding**	100%

Source: Angulo et al (2013) and Ramirez et al (2013). **Notes:** The weight assigned to each dimension and variable is shown in parenthesis. *Urban households are considered deprived in water source if they are lacking of public water system. In elimination of sewer waste if they lack a public sewer system. In Adequate external walls if the exterior walls are built of untreated wood, boards, planks, guadua or other vegetation, zinc, cloth, cardboard, waste material or when no exterior walls exist. Rural household are considered deprived in water source if the water used for the preparation of food is obtained from wells, rainwater, spring source, water tank, water carrier or other sources. In Adequate elimination of sewer waste if they use a toilet without a sewer connection, a latrine or simply do not have a sewage system. In external walls if the exterior walls are built of guadua or other vegetation, zinc, cloth, cardboard, waste materials or if no exterior walls exist. ++Households (both Urban and rural) with dirt floors are considered deprived in adequate floor. ** Deprivation is considered for: Urban households with 3 or more persons per room or Rural households with more than 3 persons per room.

The formal statement of the multidimensional poverty headcount (H) is presented below in Equation (1); in turn, Equation (2) does it for any $M\alpha$ measure as it is the average multidimensional gap when $\alpha = 1$ $(M1)$; being α to the parameter of poverty aversion as in the F-G-T measures introduced by Foster et al (1984).

$$(1) \qquad H(y,z,K,w) = \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{D} w_j g_{ij}^{0}(K)$$

$$(2) \qquad M\alpha(Y;z;K) = \frac{1}{n}\sum_{i=1}^{n}\frac{1}{d}\sum_{j=1}^{d} g_{ij}^{\alpha}(K)$$

Where, $g_{ij}^{\alpha}(k)$ is defined as shown in Equation (3) and according to the notation used here, y_{ij} corresponds to the i-household achievement for the j-dimension, z_j to the poverty threshold per j dimension, K to the aggregate threshold of multidimensional poverty, w_j to the particular weight given per each of the j variables considered, and c_i to the weighted sum of deprivations ($c_i = \sum_{j=1}^{D} w_j * g_{ij}^{0}$).

$$(3) \qquad g_{ij}^{\alpha}(K) = w_j * \begin{cases} \left(\frac{z_j - y_{ij}}{z_j}\right)^{\alpha} & if \quad y_{ij} < z_j \ \vee \ c_i \geq K \\ 0 & Otherwise \end{cases}$$

For a more comprehensive description of this counting methodology for multidimensional poverty see Alkire and Foster (2010).

Measuring decentralization

We approach decentralization in three complementary levels: fiscal, administrative and political decentralization.

Fiscal decentralization is measured by the share of own revenue in total income for the municipality. The limited fiscal decentralization in Colombia is reflected in the fact that, on average, this share is just 12%, although there are some municipalities with a share around 80%. This result reflects the importance of governmental transfers to subnational governments which is the other variable that we introduce. However, in order to identify differential effects by types of transfers we divide central government transfers between those directly associated with CMPI dimensions, and those associated with other uses, both measured in per capita terms. As shown in Table 3a, transfers directly associated with CMPI variables represent 72% of total transfers.

We also include royalties (in per capita terms) discriminating also between those directly related with CMPI objectives and those that are not. Although royalties are not part of the decentralization strategy, in 2005 they represented an important source of revenues for around 150 municipalities in which the production of minerals and hydrocarbons was important. Despite that on average, they are not as important as transfers, for some municipalities they represented up to three times the size of the maximum transfers coming from the central government.

Administrative decentralization is approached with an indicator of administrative capacity which is measured between 0 and 100. This indicator was calculated by the National Planning Department and takes into account the stability of top (non-elected) officials, educational attainment of local administration employees, relative use of information technologies, degree of process standardization, auditing capacity and internal control system performance.

Political decentralization, one of the main objectives of the Constitution of 1991, is measured by the share of total votes for departmental candidates ("*Asamblea*") from the electoral potential. Those are taken from the elections hold in 2003. The reason not to use directly the votes for municipal candidates was the large number of missing values for that year due to violence and the presence of illegal armed groups that prevented elections to take place[9].

Table 3a. Descriptive statistics: decentralization variables

Decentralization		N	Mean	Std. dev	Min	Max	Units	Source
Fiscal	Taxation capability, 2003	1094	0.12	0.11	0.00	0.82	Share (0-1)	SICEP-2005, DNP
	Per capita investment across CMPI objectives financed by SGP, 2003	1094	172.19	91.72	39.82	905.36	Per capita thousand millions	
	Per capita investment across NON-CMPI objectives financed by SGP, 2003	1094	67.55	63.44	1.22	814.93		
	Per capita investment across CMPI objectives financed by royalties, 2003	1094	23.26	127.28	0.00	2767.72		
	Per capita investment across NON-CMPI objectives financed by royalties, 2003	1094	13.35	87.96	0.00	1417.30		
Administrative	Administrative ability	1098	51.66	18.84	0.00	85.48	Index from 0 to 100	DNP (Overall performance index)
Political	Share of total votes over electoral potential, 2003	1111	0.58	0.14	0.00	1.00	Share (0-1)	National Registry Department

[9] In 2002, almost one third of the municipalities elected majors could not perform from their offices because of risks arising from the presence of these illegal armed groups that had control, at that time, over important parts of the territory.

Measuring economic geography and other controls

According to the conceptual background presented in Section 2, the most important variables coming from economic geography are densities and distances to densities. Density can be approached by population density (habitants per square kilometers), or by economic density as number of (formal) firms per square density and agricultural concentration by using the Agricultural Activity Concentration Index developed by the Ministry of Agriculture. We include both types of densities.

However, we combine population density and distances to densities in a measure that is called "Rurality Index" because what we intent to capture is the underlying concept of rurality more than each of its components. The original concept comes from Machado (2011). On the basis of that approach we, first, aggregate into one indicator for each n-municipality ($Average\ Dist_n$), the following four meaningful distances: (i) distance to the closest municipality of at least a million inhabitants; (ii) distance to the closest municipality between 400 and 1000 thousand inhabitants; (iii) mean distance to municipalities between 200 and 399 thousand inhabitants and (iv) mean distance to the 50% closest municipalities between 100 and 199 thousand inhabitants. Second, we express density as the number of inhabitants per squared kilometer in each k-municipality ($Density_n$). Third, we obtain a first stage rurality index for each municipality as $RI_n = ln(Average\ Dist_n / Density_n^2)$ and finally we expressed the definite rurality index for each municipality n as a relative function of the first stage RI_n for each municipality and the distribution of it across all N municipalities as is expressed below in Equation (4).

$$(4) \qquad RI_n^* = 100\left[\frac{RI_n - min(RI_n)}{max(RI_n) - min(RI_n)}\right]$$

The other economic geography variables included in the econometric exercises are the urbanization rate (proportion of the population living in the urban areas of a municipality), the size of the urban area (approached by the population size of the municipality), and a dummy variable that specifies whether a municipality belongs to the Colombian System of Cities mentioned before. The descriptive statistics for these economic geography variables are presented in Table 3b within the Annexes.

Finally, in order to control for other important phenomenon that may alter the average deprivation multidimensional rate at the municipality level we include variables to account for the variability induced by the spread of the violence in the territory, demographic characteristics that could produce greater vulnerability of some municipalities and investments of the National Government done over the municipalities to alleviate poverty, such as the conditional cash transfer program '*Familias en Accion*'. Table 3c within the Annexes reports the descriptive statistics for these three particular controls.

a. Empirical strategy

Accounting for spatial interdependence

Given that neither poverty nor economic activity are randomly allocated across the national territory (as was illustrated in Figure 2 when describing our conceptual background), estimation procedures need to take explicitly into account the existence of spatial correlation. In order to do so, we define the geographical relationship between any two municipalities by contiguity as illustrated by Definition 1 below. In this case, two municipalities are considered neighbors when their two geographical polygons are adjacent, meaning that they share a common boundary.

However, this definition does not necessarily capture economic geography or the intensity of their relationship. The second definition is therefore, an economic-based neighborhood where the economic geography proximity for any two pair of municipalities is based on several indicators as is shown by Definition 2 below.

> **Definition 1: Contiguity-based neighborhood.** *Two municipalities are considered neighbors when their two geographical polygons are adjacent, meaning that they share a common boundary.*

> **Definition 2: Economic-based neighborhood.** *Two municipalities are said to be neighbors when they exhibit at least one out of the four following phenomenon: (i) Share a common boundary, (ii) The distance between them do not exceed 92 kilometers, (iii) they have reported commutation process in the 2005 census or (iv) They had daily traffic between 2002-2004 according to the national administrative registers of daily traffic.*

Under the first definition we typified pairs of municipalities by whether or not they are neighbors; whereas in the second definition we are able to not only describe which municipalities we consider as neighbors, also to measure the intensity of the connection between them; this, by using the aggregation of those four components into a single indicator; indicator that that ranges from zero to 1 and that was constructed as an additively separable linear transformation from its components.

According to these two definitions of neighboring we compute a Moran index for spatial autocorrelation. The Moran I index is a measure of spatial autocorrelation developed by Moran (1950); it ranges from -1 to 1 under specific assumptions of normality and expresses how similar are the values of a particular variable (in our case multidimensional poverty) from one municipality to the others; this, by weighting each of the pair wise comparisons with the weighting matrix derived from the above mentioned definitions of neighborhood. Despite this index does not consider an explicit alternative

hypothesis to test its implicit null hypothesis as is pointed out by Arbia (2006) and by Burridge (1980), among other scholars; we use the Moran' Index as intuitively exploratory for the notion that positive spatial interdependence means that nearby values of multidimensional poverty tend to be similar, low values are located near low values and high values are located near high values. We find, as shown in Table 4, a very high spatial autocorrelation of deprivation in comparison with other outcomes in the spatial econometric literature. This finding is consistent with some previous findings for Colombia such as Galvis and Meisel (2012) for county income poverty and Angulo et al (2012) for the multidimensional headcount ratio.

The existence of this non random spatial correlation of our outcome of interest has strong implications for econometric estimation that go beyond some traditional error consequences, as we discuss in the following Section when presenting the econometric model that we pursued.

Table 4. Moran index for spatial autocorrelation of multidimensional poverty

Variable	Contiguity-based neighborhood	Economic-based neighborhood
Multidimensional headcount ratio (H)	0.602***	0.476***
Adjusted headcount ratio (M0)	0.650***	0.561***
Average gap (M1)	0.669***	0.611***

Source: 2005 census. Notes: *** indicates 1% of statistical significance. Results derived from 1,111 municipalities.

The model and econometric issues

In order to understand and model poverty as a phenomenon with strong spatial interactions, we use a spatial econometric approach, as has been done in the literature for a wide variety of economic related topics as house pricing, violence and crime, social movements, and political science issues, among others; examples of these are studies such as Ioannides (2002), Mears and Bhati (2006), Swaroop and Morenoff (2006) and Franzese and Hays (2008), respectively.

As some econometric and statistical textbooks state, ignoring the spatial dependence across observations of the dependent variable by estimating an Ordinary Least Squares (OLS), or even when using a fixed effect model, produces inefficient and inconsistent estimators of the coefficients and the sampling variance on top of that is also bias and underestimated; conducting this to have overestimated R^2, t and F statistics. In case that spatial dependence is just attacking the model's errors the estimators will be unbiased but inefficient (Arbia, 2006; p.90, Wooldridge, 2002; p.134).

Traditionally, two kinds of specifications have been used to consider spatial interdependence. The first one is the spatial autoregressive model (SAR), introduced by Cliff and Ord (1981). This specification accounts for the existence of spatial spillovers in the dependent variable, where the value taken by the $i-th$ observation on y, depends on the value of the $j-th$ observation for the same y. This specification considers this interaction among data via the introduction of a spatial lag in the right-hand-side of the model representing the relation of each observation with the neighboring outcomes. Excluding this spatial lag in the presence of spatial autocorrelation in the dependent variable, implies an omitted variable problem.

The second most well known specification for spatial econometrics is the spatial autoregressive error model, the SARE; this model accounts for spatial dependence on the disturbances. However, even though the SARE model accounts for spatial correlation, the expected value of the dependent variable in a model like this one is the same than in a traditional OLS; meaning that this model excludes by construction any possibility of spillover effect, and for sufficiently large samples the estimators for this kind of model are equal to the OLS ones.

Now, a generalized version of the aforesaid two specifications is the spatial autoregressive model with spatial autoregressive disturbances (SARAR), proposed by Anselin and Florax (1995). The SARAR model while accounts for spillover effects also it does for spatial autocorrelation of the errors (correlation among unobservables), both at the same time.

Due to the features of our data and our interest to understand poverty as an economic geography phenomenon with strong spillovers across geographical units, we focus our interest on a specification that allows us to test at the same time the spillover effect from neighbor municipalities and to take properly into account the correlation across spatial units among unobservables, a SARAR specification. The SARAR model can be described as is shown by Equations (5) and (6) below. From there, H refers to our outcome of interest, the multidimensional headcount or it could be stated for the average multidimensional gap ($M1$) as well; W and M are the spatial weighting matrices; λ and ρ are the spatial autoregressive parameters which account for the intensity of the spatial correlation, the first one in terms of the lagged values of the dependent variable; *i.e* the value of the dependent variable but in the neighbor municipalities; and the second one in terms of the spatial autocorrelation given by unobservables; finally $\mathcal{E}$ refers to the remaining error term which should be now independently and identical distributed.

$$(5) \qquad H = \lambda W_H + X\beta + u$$
$$(6) \qquad u = \rho M_u + \mathcal{E}$$

According to this specification, if $\rho = 0$ we are in presence of a spatial autoregresive model; in turn if $\lambda = 0$ the specification gets reduced to the SARE model; and if both parameters are equal to zero$(\lambda = 0, \rho = 0)$, it reduces to the linear regression model.

Now, since the spatial lag term (W_y) is endogenous because the double causality between it and the dependent variable, the estimation procedure must account for this in order to obtain consistent estimators. Then, in terms of the estimators, the literature explores two different options for the SARAR

model; the maximum likelihood estimator (ML) and the generalized spatial two-stage least squares (GS2SLS). Kelejian and Prucha (1999), identify at least two sensible problems related with the ML estimator: (i) There is not general statistical theory for this estimator, and finally (iii) there is not large sample theory for the SARAR model.

In particular, we follow the Kelejian and Prucha (1999), Kelejian and Prucha (2004), and Arraiz (2010) approach of estimation for the SARAR model by implementing the GS2SLS estimator, as follows: first we use as valid instruments for the endogenous W_y, the spatial lags of the variables contained in X, then we estimate the instrumented specification by the generalized-method-of-moments and finally we perform a spatial Cochrane-Orcutt transformation to obtain more efficient estimates for β and λ.

Besides this endogenity issue mentioned above, we are concerned for the possible endogenity coming from the fiscal decentralization variables that are indeed our main explicative variables of interest. Since most of the governmental expenditures are defined based on municipality poverty criteria we might be in presence of a double causality problem. As a first measure to tackle this potential problem, we use the lagged values of such variables as a proxy of the contemporary ones; meaning that instead of using the 2005 values of them we use the 2003 registers. However, this ad-hoc solution for our main parameter of interest could have not only problems of interpretability or precision; also does not allow us to test further whether the solution dealt properly with the problem or not. Then, beyond that, we found statistical evidence that indicated us that our main parameter of interest (Taxation ability) is not exogenous yet; this, by performing a Durbin-Wu-Hausman test[10], which uses as null hypothesis exogeneity of tax ability and rejecting such hypothesis under a 1% of statistical significance.

Now, for this specific case where there is evidence of endogeneity from one of the explicative covariates in the context of the SARAR model described previously, Drukker et al (2013) developed the Equations (7) and (8) model; where, in comparison with Equations (4) and (5), there is an additional term composed by a vector Q of endogenous explicative variables, and π its parameters of interest.

$$(7) \qquad H = Q\pi + \lambda W_H + X\beta + u$$
$$(8) \qquad u = \rho M_u + \varepsilon$$

We estimate the Drukker et al (2013) specification for the model instrumenting taxation ability. As instrument for taxation ability we use the share of blank votes over the total votes for the local elections of 2003. The election of this instrument is based on the argument that many citizens do not pay taxes because they hardly trust the political institutions, and their way to express this perception is by voting blank on the electoral process. In this regard, Persson and Tabellini (2003), when compiling several previous theoretical knowledge on the effect of political process over economic policymaking and empirically testing its behavior by the use of a large multicounty data set, they argue for a clear relationship between electoral outcomes and policy decisions. On the other hand, the validity of our instrument is based on the absence of any theoretical linkage between poverty outcomes and the blank votes share, besides that, some previous evidence for the Colombian case has been considered, for example, Horbath (2004) studies the connection between electoral outcomes and poverty level at a

[10] For a comprehensive explanation of the Durbin-Wu-Hausman test see Cameron (2005).

county level, using data for the 2002 elections, he finds a systematic and strong correlation between some poverty measures and political participation, nevertheless, he does not find any correlation between the blank votes share and the same poverty measures.

Finally, it is worth noting here before describing the results in Section four below, that for the estimation procedure the independent variables were included by groups to attempt to determine whether or not we lose effect of some of the covariates given the introduction of the control variables. Firstly, as our main explicative variables, we introduce the variables that intent to measure decentralization; then, we introduce the variables related to location and size, such as the rurality index, and urbanization rate, among others; the third and final group refers to economic concentration, infrastructure, violence and demography. Additionally, for all the specifications we include county dummies in order to control for unobservables commonly shared among municipalities that belong to the same county. The results presented, include the OLS and the SARAR estimators, for the latter we consider both spatial-weighting-matrices described aforesaid.

4. Results

Table 4a shows the estimation results of multidimensional poverty incidence (H) and the multidimensional gap ($M1$) for the OLS estimation (OLS), the SARAR estimation using the contiguity matrix (S-Cont), and the SARAR estimation using the economic-geography matrix (S-EG); this three first models by only introducing as explanatory variables the decentralization covariates. Then, we present as columns four, five and six the same models but adding to them the location and size covariates. In turn, Table 4b shows the estimation with the full set of covariates, first in column one for the OLS, then column two for the SARAR estimation using the contiguity matrix, column three for the SARAR estimation using the economic-geography matrix, column four for the SARAR instrumenting of the own resources ratio, i.e., the ability of municipalities to generate their own income through taxes and other fiscal instruments this in presence of the contiguity matrix (S-IV-Cont), and the column five for the SARAR IV by now in presence of the economic geography matrix (S-IV-EG).

First, it should be noted that spatial spillovers are statistically significant (lambda coefficient) in all the proven specifications and therefore, deprivation is strongly defined by geographical interactions that should be taken into account when designing public policy interventions.

With respect to the decentralization variables, those municipalities with a higher own resource share tend to have a lower poverty incidence, even after taking into account economic activity (business per urban squared km). It should be noted that this effect becomes even stronger when using instrumental variables to correct for the potential endogeneity of this variable. Fiscal decentralization, measured by the own resource share has also a strong negative effect on poverty gap, meaning that municipalities with a larger fiscal capacity tend to have a population under poverty that is “less poor” than the municipalities with lower fiscal capacity.

Governmental transfers for CMPI related expenditures (education, health and drinkable water and sanitation) have a negative effect on poverty incidence, after correcting for spatial correlation. Nevertheless, its effect is much lower than the effect of the own resources ratio on poverty incidence. However, the most significant effect of CMPI related expenditures is its negative impact on poverty gap. This is an expected result in the sense that governmental transfers to CMPI related uses have the explicit purpose of decreasing the coverage gap in education, health, drinkable water and sewerage. This effect is robust to the introduction of economic geography variables, and to the introduction of economic activity and other control variables.

On the other hand, governmental transfers for other uses as well as royalties do not appear to have a significant effect on poverty incidence or poverty gap[11].

Administrative capacity of local administrations has a negative effect on poverty incidence and poverty gap, but the strength of this effect somehow diminishes after controlling for spatial correlation and fiscal decentralization endogeneity. It is possible, in fact, that those municipalities with a higher local administrative capacity are the ones with a higher share of own resources.

On the contrary, the degree of political participation has a strong and robust negative effect on both, poverty incidence and poverty gap: municipalities with higher participation of citizens in the electoral process tend to have lower multidimensional poverty incidence, and their population under poverty tend to be less poor than municipalities with lower political participation.

Economic geography variables have a significant effect on poverty incidence and with the expected sign: more rural municipalities (measured by the Rurality Index) tend to have a higher poverty incidence and a higher poverty gap. It means that municipalities with lower population density and/or more distant to cities with more than 100 thousand habitants are, in average, poorer than other municipalities, and that their population under poverty is poorer that the other municipalities.

At the same time, the urbanization ratio (i.e., the share of population living in the urban area of the municipality) has a negative effect on both, poverty incidence and poverty gap. On the other hand, municipalities with more population have a lower poverty incidence (with a weaker negative effect on poverty gap), although this effect disappears when correcting by instrumental variables. There is, also, an *additional* negative effect on poverty incidence for those municipalities that belong to the System of Cities as defined in Section 2. This means that to be part of the System of Cities in Colombia is a "bonus" to decrease poverty incidence.

On the other hand, there is a very strong negative effect of formalization on poverty incidence, measured by the number of formal firms per square kilometers in the urban area. This effect is also observed on poverty gap at a 5% level of significance. Both effects remain even after controlling the potential endogeneity of fiscal decentralization variable by using IV.

[11] Although in the case of royalties not related with CMPI components there is some effect at 10% of significance, it disappears after controlling for the possible endogeneity of fiscal decentralization using IV.

It is interesting to note that the variable (primary and secondary) roads per square kilometer has a significant negative effect on poverty gap although this variable does not appear significantly related with poverty incidence. It means that those municipalities with a larger number of kilometers of primary and secondary roads per square kilometer tend to have a "less poor" population than other municipalities with a smaller number of roads per square kilometer[12].

Finally, the most important national program of conditional cash transfer to alleviate poverty (Familias en Acción) appears positively and significantly related with poverty incidence and, in a less extent, with poverty gap. This results probably reflects just the focalization of the program in the poor population which, as we have seen trough the research, is not randomly distributed in the space but tend to concentrate in some regions more than in others.

5. Conclusions

Poverty is (also) a spatial issue. Poverty is not randomly distributed in the territory but tend to concentrate in some regions more than in others. Therefore, strategies to overcome poverty need to be complemented with a territorial approach and take into account that deprivation is strongly defined by geographical interactions as well.

Colombia's decentralization was conceived to improve population's access to social services, reduce poverty and equalized well-being across the territory. However, after more than 20 years of its implementation a big gap in social achievements across municipalities remains. The main goal of this paper was to disentangle the effect of decentralization on multidimensional poverty incidence and gaps at municipal level in Colombia and its success or failure to overcome economic geography issues that emerge from a very heterogeneous territory. To address this task we model poverty as a phenomenon with strong spatial interactions, and we use a spatial econometric approach that accounts for spillover effects and for spatial correlation of the errors, correcting also for potential endogeneity of the fiscal decentralization variable.

The results of the econometric estimations show that the share of own resources in total income of municipalities has a strong causal negative effect over the achievement of social minimums as depicted by the average multidimensional gap and over multidimensional poverty as well. The effect of governmental transfers (SGP) is more important reducing poverty gap than reducing poverty incidence. On the other hand, political decentralization, measured by citizen participation in local elections, has also a strong negative effect on poverty gap and incidence.

[12] Due to data limitations, it was not possible to include tertiary roads, a variable that probably has a stronger relationship with poverty incidence, mainly in the rural sector.

Table 4a: Determinants of Multidimensional Poverty

	Multidimensional poverty incidence (H)						Multidimensional poverty gap (M1)					
	OLS	S-Cont	S-EG	OLS	S-Cont	S-EG	OLS	S-Cont	S-EG	OLS	S-Cont	S-EG
Tax ability	-0.46043***	-0.28087***	-0.35265***	-0.25180***	-0.16520***	-0.16232***	-0.15492***	-0.09772***	-0.10798***	-0.07705***	-0.04892***	-0.04213***
	(0.03416)	(0.04108)	(0.03727)	(0.02691)	(0.03105)	(0.02760)	(0.01749)	(0.01545)	(0.01507)	(0.01602)	(0.01504)	(0.01350)
SGP CMPI	-0.00003	-0.00009	-0.00001	-0.00007	-0.00012***	-0.00006	-0.00007**	-0.00007**	-0.00004	-0.00009***	-0.00009***	-0.00006***
	(0.00006)	(0.00007)	(0.00008)	(0.00005)	(0.00004)	(0.00004)	(0.00003)	(0.00003)	(0.00004)	(0.00003)	(0.00003)	(0.00002)
SGP non-CMPI	0.00040***	0.00040***	0.00045***	-0.00007	0.00002	0.00000	0.00016***	0.00016**	0.00017**	-0.00002	0.00001	0.00000
	(0.00010)	(0.00014)	(0.00015)	(0.00008)	(0.00007)	(0.00006)	(0.00005)	(0.00007)	(0.00007)	(0.00005)	(0.00004)	(0.00004)
Royalties CMPI	-0.00004	-0.00004	-0.00004	-0.00001	-0.00001	-0.00001	0.00000	0.00000	-0.00000	0.00000	0.00001	0.00001
	(0.00010)	(0.00007)	(0.00008)	(0.00007)	(0.00005)	(0.00005)	(0.00005)	(0.00004)	(0.00004)	(0.00004)	(0.00003)	(0.00003)
Royalties non-CMPI	-0.00003	-0.00002	-0.00001	-0.00004	-0.00003*	-0.00002	-0.00002	-0.00002	-0.00001	-0.00002	-0.00002*	-0.00001
	(0.00005)	(0.00002)	(0.00002)	(0.00004)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00001)	(0.00002)	(0.00001)	(0.00001)
Administrative ability	-0.00126***	-0.00083***	-0.00074***	-0.00072***	-0.00045**	-0.00028	-0.00063***	-0.00042***	-0.00031**	-0.00040***	-0.00028**	-0.00016
	(0.00027)	(0.00025)	(0.00025)	(0.00021)	(0.00019)	(0.00018)	(0.00014)	(0.00013)	(0.00013)	(0.00012)	(0.00012)	(0.00011)
Political desc.	-0.15274***	-0.08911***	-0.08873***	-0.10222***	-0.07312***	-0.07021***	-0.09976***	-0.06370***	-0.05963***	-0.07159***	-0.05846***	-0.04408***
	(0.03113)	(0.02688)	(0.02722)	(0.02414)	(0.02374)	(0.02145)	(0.01594)	(0.01513)	(0.01453)	(0.01437)	(0.01525)	(0.01316)
Urbanization				-0.20693***	-0.22900***	-0.23307***				-0.06521***	-0.07490***	-0.07527***
				(0.01564)	(0.01592)	(0.01519)				(0.00931)	(0.00982)	(0.00925)
System of cities				-0.04038***	-0.03172***	-0.05101***				-0.00378	-0.00321	-0.01009*
				(0.01017)	(0.01149)	(0.01095)				(0.00605)	(0.00594)	(0.00547)
Pop. Size				-0.02313***	-0.02872***	-0.02872***				-0.00431	-0.00933*	-0.01020**
				(0.00850)	(0.00794)	(0.00733)				(0.00506)	(0.00480)	(0.00446)
Rurality Index				0.00399***	0.00314***	0.00270***				0.00233***	0.00162***	0.00137***
				(0.00041)	(0.00041)	(0.00039)				(0.00024)	(0.00026)	(0.00022)
Constant	0.84226***	0.32218***	0.18812***	0.74631***	0.56413***	0.31559***	0.32071***	0.15024***	0.08978***	0.23490***	0.17545***	0.08492***
	(0.02372)	(0.05838)	(0.05126)	(0.03031)	(0.05557)	(0.05158)	(0.01215)	(0.02100)	(0.01770)	(0.01804)	(0.02322)	(0.01913)
.....Controlling by county dummies (32 counties).....												
Observations	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060
R-squared	0.52695			0.73397			0.60744			0.70165		
Lambda		0.68457***	0.88683***		0.29233***	0.68722***		0.61100***	0.85492***		0.35148***	0.75224***
		(0.05945)	(0.06340)		(0.07115)	(0.06837)		(0.05599)	(0.05425)		(0.06930)	(0.05329)
Rho		-0.44143***	-0.10022		0.33831***	0.49185***		-0.34146***	-0.39608***		0.16952**	-0.16194
		(0.09533)	(0.12900)		(0.07226)	(0.08383)		(0.09517)	(0.13013)		(0.08613)	(0.14106)

Table 4b: Determinants of Multidimensional Poverty

	Multidimensional poverty incidence (H)					Multidimensional poverty gap (M1)				
	OLS	S-Cont	S-EG	S-IV-Cont	S-IV-EG	OLS	S-Cont	S-EG	S-IV-Cont	S-IV-EG
Tax ability	-0.19498***	-0.14063***	-0.13953***	-0.39291***	-0.18851***	-0.05377***	-0.03551**	-0.03056**	-0.05669***	-0.05414***
	(0.02653)	(0.03056)	(0.02777)	(0.12077)	(0.07087)	(0.01615)	(0.01461)	(0.01360)	(0.02711)	(0.02729)
SGP CMPI	-0.00005	-0.00010**	-0.00004	-0.00013**	-0.00005	-0.00007***	-0.00008***	-0.00006**	-0.00009***	-0.00005**
	(0.00004)	(0.00004)	(0.00004)	(0.00005)	(0.00004)	(0.00003)	(0.00003)	(0.00002)	(0.00003)	(0.00003)
SGP non-CMPI	-0.00009	0.00001	0.00001	0.00002	0.00001	-0.00003	0.00001	0.00000	0.00001	0.00000
	(0.00007)	(0.00007)	(0.00006)	(0.00008)	(0.00007)	(0.00005)	(0.00004)	(0.00004)	(0.00005)	(0.00004)
Royalties CMPI	0.00000	-0.00001	-0.00001	-0.00003	-0.00002	0.00001	0.00001	0.00001	0.00001	0.00001
	(0.00007)	(0.00005)	(0.00004)	(0.00005)	(0.00004)	(0.00004)	(0.00003)	(0.00003)	(0.00003)	(0.00003)
Royalties non-CMPI	-0.00004	-0.00003*	-0.00002	-0.00002	-0.00002	-0.00003	-0.00002*	-0.00002	-0.00002	-0.00002
	(0.00003)	(0.00001)	(0.00001)	(0.00002)	(0.00001)	(0.00002)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Administrative ability	-0.00047**	-0.00037**	-0.00024	-0.00026	-0.00021	-0.00029**	-0.00022*	-0.00013	-0.00020*	-0.00013
	(0.00020)	(0.00019)	(0.00018)	(0.00019)	(0.00018)	(0.00012)	(0.00012)	(0.00011)	(0.00012)	(0.00011)
Political desc.	-0.10101***	-0.07263***	-0.06243***	-0.07264***	-0.06281***	-0.07195***	-0.05785***	-0.04226***	-0.05813***	-0.04205***
	(0.02391)	(0.02291)	(0.02114)	(0.02335)	(0.02117)	(0.01456)	(0.01514)	(0.01343)	(0.01519)	(0.01339)
Urbanization	-0.21245***	-0.22834***	-0.23249***	-0.21806***	-0.23050***	-0.06851***	-0.07660***	-0.07749***	-0.07485***	-0.07810***
	(0.01508)	(0.01570)	(0.01496)	(0.01678)	(0.01499)	(0.00918)	(0.00968)	(0.00910)	(0.00998)	(0.00924)
System of cities	-0.03092***	-0.02424**	-0.04465***	-0.01964*	-0.04258***	0.00010	-0.00031	-0.00823	0.00096	-0.00901
	(0.01002)	(0.01132)	(0.01097)	(0.01182)	(0.01148)	(0.00610)	(0.00585)	(0.00552)	(0.00621)	(0.00590)
Rural Index	0.00359***	0.00271***	0.00232***	0.00257***	0.00229***	0.00199***	0.00126***	0.00105***	0.00123***	0.00106***
	(0.00043)	(0.00045)	(0.00042)	(0.00049)	(0.00043)	(0.00026)	(0.00027)	(0.00024)	(0.00027)	(0.00024)
Business per urban squared km	-0.00064***	-0.00042***	-0.00035***	-0.00032***	-0.00033***	-0.00026***	-0.00016***	-0.00012**	-0.00014**	-0.00013**
	(0.00007)	(0.00011)	(0.00010)	(0.00011)	(0.00010)	(0.00005)	(0.00006)	(0.00005)	(0.00006)	(0.00005)
Roads per squared km	0.00356	-0.00068	-0.00173	0.00031	-0.00155	-0.00331	-0.00562***	-0.00556***	-0.00552***	-0.00562***
	(0.00372)	(0.00483)	(0.00393)	(0.00535)	(0.00401)	(0.00227)	(0.00195)	(0.00180)	(0.00201)	(0.00181)
National program (familias en accion)	0.00004***	0.00003***	0.00002***	0.00002**	0.00002***	0.00002**	0.00001**	0.00001*	0.00001*	0.00001*
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Constant	0.78588***	0.60375***	0.36842***	0.67399***	0.38579***	0.26453***	0.20391***	0.11415***	0.21402***	0.11124***
	(0.03244)	(0.06279)	(0.05118)	(0.07257)	(0.05600)	(0.01975)	(0.02558)	(0.02060)	(0.02879)	(0.02132)
.....Controlling by population size, county dummies (32 counties), demography, violence and agro concentration										
Observations	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060
R-squared	0.75633					0.71417				
Lambda		0.28887***	0.65279***	0.21840***	0.63437***		0.35227***	0.73133***	0.32755***	0.73707***
		(0.06765)	(0.06215)	(0.07302)	(0.06584)		(0.06701)	(0.05293)	(0.07357)	(0.05394)
Rho		0.25900***	0.42207***	0.26213***	0.41641***		0.14529*	-0.17425	0.16374*	-0.17233
		(0.07515)	(0.09815)	(0.06089)	(0.10010)		(0.08538)	(0.14133)	(0.08575)	(0.14108)

Geography is relevant to explain multidimensional poverty incidence and poverty gap. Higher incidence and poverty gap are associated with: a) a higher degree of rurality (lower densities and/or larger distances to densities); b) a lower urbanization rate; c) municipalities that are not part to the Colombian System of Cities. These results support the conclusion that the main difference in terms of poverty in Colombia is not between urban and rural areas, but between municipalities with high densities or close to towns with high densities, and municipalities with low densities and far from towns with high densities.

The estimations also show a very strong negative effect of formalization on poverty incidence, measured by the number of formal firms per square kilometers in the urban area, and in a less extent on poverty gap.

Spatially differentiated policies and decentralization designs that take into account the heterogeneity of regions and municipalities are definitely required in order to improve social convergence to minimums from the territories at the bottom of the distribution, and the role of economic geography variables should be taken into account in the design of such policies. In particular, Colombia has a pending agenda to decrease rural poverty (in the sense depicted by the Rurality Index).

The findings of the paper also suggest some topics that should be part of an agenda for adjusting and reforming the decentralization model in Colombia. One of them is the need to strengthen the subnational revenue system to increase the share of own generated resources by municipalities. In practical terms, the focus of this policy should be the medium and large cities. Cities should be given more autonomy and more capability to increase their own resources, and to set its own programs with the correspondent responsibility toward their own citizens.

In order to increase the share of own resources at subnational level a reform of the transfer system is in order, as has been extensively discussed by Bird (2012). The purpose in this case is the design a transfer system that takes into account the potential revenue-raising capacity of each municipality and does not disincentive its own fiscal effort.

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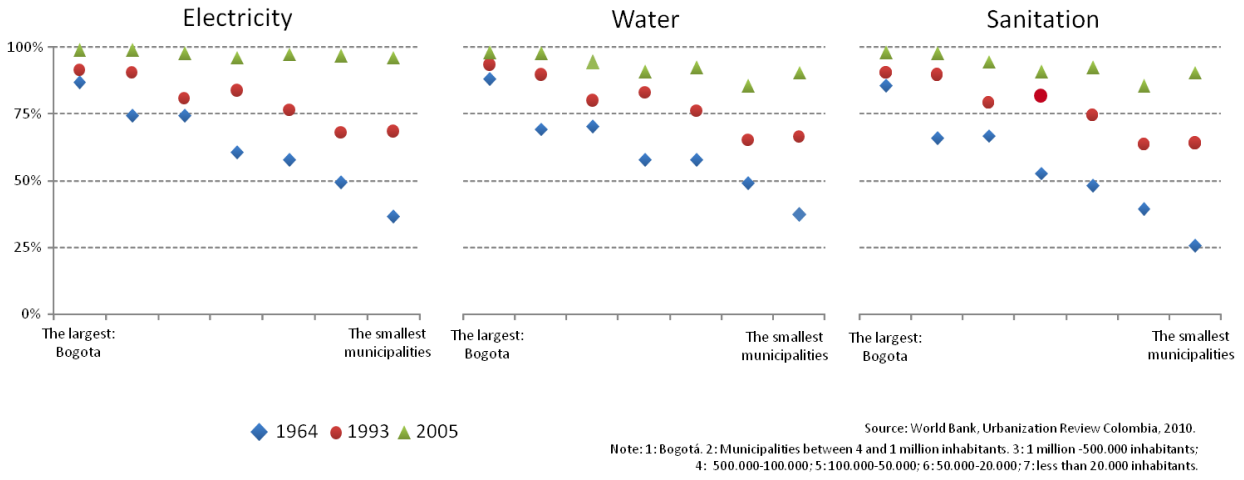
Annexes

Table 1. Governmental investment structure by levels of government

	Billions of 2010 Colombian pesos				(%)			
	Central government	Counties	Municipalities	Total	Central government	Counties	Municipalities	Total
Total Investment	**22.2**	**15.4**	**33.0**	**70.5**	**0.31**	**0.22**	**0.47**	**1.00**
CMPI related investment	**11.5**	**12.3**	**24.2**	**47.9**	**0.24**	**0.26**	**0.51**	**1.00**
Education	1.0	7.3	9.2	17.5	0.06	0.42	0.53	1.00
Health	1.6	3.3	9.1	14.0	0.12	0.24	0.65	1.00
Attention to vulnerable groups, social promotion	6.2	0.3	1.2	7.8	0.80	0.04	0.16	1.00
Dwelling	0.7	0.2	0.7	1.6	0.44	0.12	0.44	1.00
Drinking water and basic sanitation	0.3	1.0	3.5	4.8	0.06	0.21	0.73	1.00
Public services different from water and	1.7	0.1	0.4	2.2	0.74	0.06	0.20	1.00
Other non-CMPI related investment	**10.7**	**3.1**	**8.8**	**22.6**	**0.47**	**0.14**	**0.39**	**1.00**

Source: National Planning Department, 2010 administrative fiscal registers

Figure 3: Percentage of urban population with access to public services across type of municipalities



Source: World Bank, Urbanization Review Colombia, 2010.
Note: 1: Bogotá. 2: Municipalities between 4 and 1 million inhabitants. 3: 1 million -500.000 inhabitants; 4: 500.000-100.000; 5: 100.000-50.000; 6: 50.000-20.000; 7: less than 20.000 inhabitants.

Figure 4: The System of Cities in Colombia

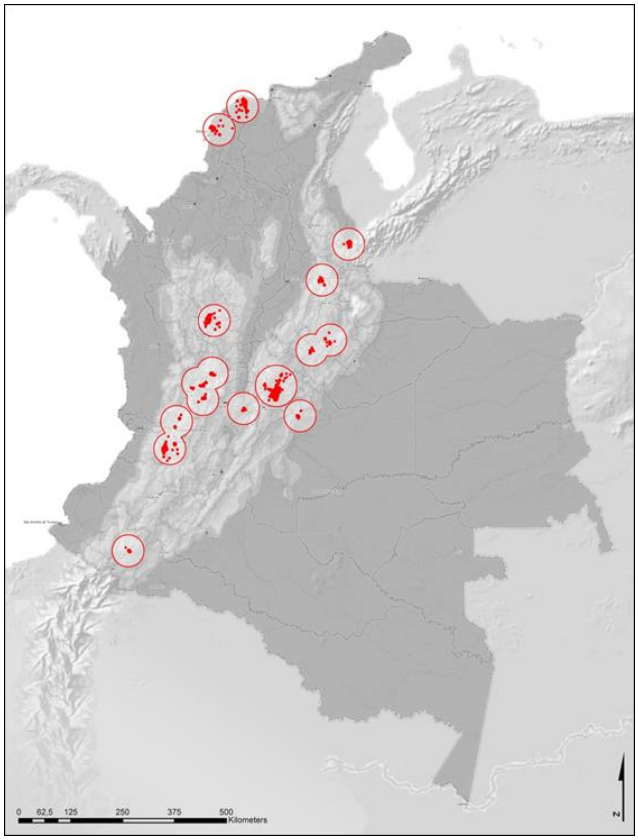


Table 3b. Descriptive statistics: economic geography

	Economic geography	N	Mean	Std. dev	Min	Max	Units	Source
Location and size	Urbanization	1111	0.43	0.25	0.00	1.00	Share (0-1)	2005 Census
	Population size	1111	0.06	0.23	0.00	1.00	[0,1], 1= Municipality with 30.000 or more inhabitants. 0= Municipalities with less than 30.000 inhabitants.	2005 Census
	System of cities	1111	0.14	0.34	0.00	1.00	[0,1], 1=belongs to the system of cities. 0= Do not belong	System of cities mission
	Rurality Index (aggregates a, b, c, d and e)	1111	46.68	12.58	0.00	100.00	Index from 0 to 100	Based on UNDP, 2011
	a. Population density	1092	140.59	576.70	0.16	10682.55	Inhabitants per squared kilometre	2005 Census
	b. Distance to the closest municipality of at least a million inhabitants	1092	165.88	102.90	0.00	955.54	kilometres	Euclidean distances based on map information
	c. Distance to the closest municipality between 400 - 1000 thousand inhabitants	1092	151.07	117.49	0.00	980.37	kilometres	
	d. Mean distance to municipalities between 200 and 399 thousand inhabitants	1092	399.12	107.81	270.41	1147.87	kilometres	
	e. Mean distance to the 50% closest municipalities between 100 and 199 thousand inhabitants	1092	244.72	84.94	155.61	1007.62	kilometres	
Connectivity	Kilometres of primary and secondary roads per squared kilometres of the municipality	1096	1.23	0.88	0.00	13.33	kilometres	IGAC and System of cities
Economic density	Business per urban squared km	1111	28.66	43.55	0.00	396.18	# of business per urban squared kilometre	PILA and IGAC.
	Agro-concentration	1111	0.20	0.40	0.00	1.00	[0,1], 1=municipalities with greater concentration of agricultural activity. 0=municipalities without agricultural vocation	DNP

Table 3c. Descriptive statistics: other controls

Other controls	N	Mean	Std. dev	Min	Max	Units	Source
Violence. Number of attack from FARC, ELN and paramilitary groups from 1998-2002.	1111	7.34	15.70	0.00	219.00	Number	National Police
Central government investment. Municipal aggregated payment made for the national conditional cash transfer program: '*Familias en accion'* during 2003.	1111	178.67	306.60	0.00	2609.27	Million of pesos	DNP, 2003
Demographic vulnerability. Average share of children, women and elderly at home	1111	52.60	20.50	0.00	100.00	Share (0-100)	UNDP, 2011