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Fiscal Decentralization and Economic Growth: Evidence from Regional-Level Panel Data for Colombia

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Fiscal Decentralization and Economic Growth: Evidence from Regional-Level Panel Data for Colombia*

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Abstract

This paper provides evidence on the positive role of fiscal decentralization on regional economic growth in Colombia since the promulgation of the Political Constitution of 1991. The empirical strategy involved the choice of a suitable estimator for the panel data approach, the Augmented Mean Group Estimator, which allows adding unobserved determinants suggested by literature to traditional long term explanatory factors. The strategy was complemented with exercises that helped us to support the results coming from (i) cross-section models for different periods and various control variables, (ii) test on the complementarity hypothesis between public goods provided by different jurisdictions (spillover effects), and (iii) an assessment of unconditional convergence in regional income differences.

Keywords: Fiscal decentralization, Economic growth, Complementarity, Panel Data Models

JEL Classification: O40, H77, C33

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1. Introduction

The decentralized provision of public goods has usually been seen as an important channel to encourage regional economic development. The canonical theoretical approach assumed that local governments are more efficient allocating public resources, since they have better information and stronger incentives to do things right than the central government. Firstly, local authorities end up supplying the goods that people prefer, as they are closer to population (Oates, 1999). Secondly, because subnational governments that provide basic services are under the scrutiny of their constituents, they have incentives to execute public policies according to the interests of the community (Tiebout, 1956). Decentralization might be also beneficial for governance and market mechanisms, favoring private activities (Tulchin and Selee, 2004; Weingast 1995). In practice, these factors may jointly lead to promote learning, experimentation and competition in the provision of collective consumption goods, thus fostering long term economic growth.

Nevertheless, the wellbeing gained from fiscal decentralized schemes has been controverted by other branches of literature. Based on scale economies, for instance, central governments might be more efficient than local ones producing public goods as well as possible, having advantages in the organization and use of technologies (Stein, 1998). In addition, local governments could be more deficient in planning and implementing projects, mainly in terms of having either uninstructed or experienced human resources (Iimi, 2005). From the perspective of political science, decentralized systems would be more exposed to risks of corruption and the rent-seeking problem, which ends up negatively affecting economic activities (Rodden and Rose-Ackerman 1997, Brueckner 2001, Fisman and Gatti, 2002, Bardhan 2005).

Empirically, there are numerous studies analyzing the effects of fiscal decentralization on economic growth, both across countries and in single cases. The results are ample and pointing in many directions. Surprisingly, early papers of the nineties provided low consensus about the benefits of fiscal decentralization on economic activity, but these findings have been changing recently (Blöchliger (2013), Hyun-A Kim (2013), Asatryan (2010) and Feld (2009)).

Fiscal decentralization was enforced in the early nineties in Colombia, after thirty years of successive efforts. By this time, most Latin American countries were strengthening the role of regional governments on economic development. As a matter of fact, this type of reform was taking place worldwide. According to different studies, 63 out of the 75 countries with a population over 5 million have undergone a major process of decentralization since 1980 (Kyu Sik Lee and Roy, 1999; Manor, 1999; Oxhorn, et.al., 2004). Therefore, decentralization became, in a broad sense, the

core of institutional reforms during the late 20th century, especially in developing countries.

Advances of decentralization in Colombia have touched many aspects. Concerning the availability of resources, the process has been based on a gradual increase of financial transfers from central to regional governments. However, the progress in devolution concerning competencies of responsibilities has been less clear. From a political standpoint, the election of mayors by popular ballot started in 1988, and the popular election of departmental governors began in 1992. The free choice of regional governors and mayors became a key strategy of democratic reformers who wanted to ensure that decentralization would make the state more accessible to citizens as well as to counterbalance the abuse of power by national leaders. Finally, central government fund transfers were supplemented in 2000 with other measures such as those to avoid financial disequilibrium of regional entities and to strengthen physical investment, simultaneously.

Regarding the literature in Colombia, some papers have analyzed the effects of fiscal decentralization on the coverage of education and health services (Melo, 2005, Faguet, et al., 2008 and Faguet, et al., 2009) and other public utilities (Sánchez, 2006). Nonlinearity between decentralization and education coverage and its impacts on quality has also been investigated (Lozano, et al., 2013). Other papers have addressed related issues such as (i) the response by different municipalities to the system for intergovernmental transfers (Loboguerrero, 2008); (ii) the fairness of the transfer system (Bonet, 2006); (iii) the relationship between decentralization and armed conflict (Sanchez et al., 2005, Villa et al. 2014); and (iv) the effect of decentralization on poverty at municipal levels (Ramirez, et al 2014).

Two decades after the adoption of the Constitution in 1991, which encouraged fiscal decentralization in Colombia, there is still no evidence to support whether it has strengthened regional economic growth or not. As we described, the nearest empirical studies have focused on assessing its impact on some productive factors, but not directly on output. This is the gap we try to fill in this paper. The paper also provides evidence on spillover effects linked to the public goods provided by different jurisdictions, as well as on regional growth convergence. Following this introduction, the paper is organized as follows: in Section 2 we briefly describe the economic model adopted to evaluate this subject; in Section 3 we discuss the links between economic theory and the statistical model to be estimated, highlighting the major empirical issues. The results are presented and discussed in Section 4. The paper concludes with some final remarks.

2. Analytical Framework

2.1. The Basic Setup

We begin employing a simple version of Barro's endogenous growth model (1990), which assumes that the government purchases a portion of private output to provide free public services to private producers (infrastructure services, property rights, etc.). Let y be the per capita output, k the private capital per labor unity, and g the government per capita purchases. The aggregate production function could be written as: $y = Ak^{\alpha}g^{\varphi}$, where $0<\alpha<1$, $0<\varphi<1$, $\alpha+\varphi=1$, and $A>0$ denotes the technological parameter. We omit the time subscripts for simplicity.

In order to introduce the fiscal decentralization discussion, government purchases are disaggregated among the shares financed by central, state and local authorities (Davoodi and Zou, 1998). Without loss of generality, our setup considers only two levels: central and local governments (Kim, 2013; Iimi, 2005). If we let f denote central per-capita central government purchases, and l those corresponding to the local government, then the production function can written as:

$$y = Ak^{\alpha}f^{\beta}l^{\gamma} \qquad (2.1)$$

Where $0<\beta<1$, $0<\gamma<1$, and $\beta+\gamma=\varphi$. Therefore, the degree of fiscal decentralization is defined as local government spending relative to total public spending ($f+l$). Then, if local government expending rises relative to central one, the degree of fiscal decentralization increases, and vice-versa. Accordingly, the allocations of total government spending, g, among different government levels take the following form:

$$f = \theta_f g;\ \ l = \theta_l g\ ;\ \theta_f + \theta_l = 1 \qquad (2.2)$$

where $0 < \theta_i < 1, for\ \ i = f, l$; being θ_f the share of federal (θ_l local) government in total spending. On the side of revenue, governments fix a flat tax rate on income, τ, keeping its budget constraint balanced, $g = \tau y$. The model is closed with standard preferences for a Cass-Koopmans (1965) representative household, where c is per capita private consumption and $\rho>0$ is the time discount rate. As usual, the dynamic budget constraint of the representative agent is given by $\frac{dk}{dt} = \dot{k} = (1-\tau)y - c = (1-\tau)k^{\alpha}f^{\beta}l^{\gamma} - c$. For a given level of g and θ_i´s, the steady-state solution for per capita output growth is given by:

$$\frac{dy/dt}{y} = \frac{\dot{y}}{y} = \frac{1}{\sigma}\left[(1-\tau)\tau^{\frac{1-\alpha}{\alpha}}A\alpha(1-\theta_l)^{\frac{\beta}{\alpha}}\theta_l^{\frac{\gamma}{\alpha}} - \rho\right] \qquad (2.3)$$

Notice that the empirical, long-term relationship between fiscal decentralization and economic growth may be assessed through this Equation. Accordingly, a positive effect is achievable as long as the productivity of local government spending is larger than that of the central government spending, i, e. $\frac{d\dot{y}/y}{d\theta_l} > 0$ for $\boldsymbol{\theta_l} < \frac{\gamma}{\beta+\gamma}$. Additionally, for a given level of total government spending (as share of GDP), a reallocation of public spending among different levels of governments can lead to higher economic growth if the current allocation differs from the one resulting from a growth-maximizing expenditure problem, given by $\boldsymbol{\theta_f^*} = \frac{\beta}{\beta+\gamma}$ and $\boldsymbol{\theta_l^*} = \frac{\gamma}{\beta+\gamma}$.

2.2. Complementarity among public goods and non-observable determinants of growth

Barro's growth model was extended by Nishimura (2006) and Akai et al. (2007) to capture complementarity between public goods provided by the regions within a country. Programs provided in each jurisdiction could have a spillover effect on others, and, therefore, on national economy. Thus, the discussion about the role of government on growth is not only about benefits of the centralized versus decentralized fiscal regime, but also about spillover impacts of public goods financed across regions.

The complementarity hypothesis is incorporated through an aggregate production function for public goods, which depends partially on an ample set of public inputs financed by subnational governments (programs in education, health, infrastructure, libraries, parks, property rights, social services, etc.). In practice, it implies to allow $g = \sum_{i=1}^{I} l_i + f$ in Barro's model, where i = 1,...,I is the number of regional units.

The extended framework, called *human-fallibility model* of the government, assumes that there are J identical jurisdictions in each region i, each of them with the same number of firms and households. Some public programs might generate positive spillover effects on growth (externalities) at both inter- and intra-regional levels while others do not. If p(j) denotes the realization of public programs financed by jurisdiction j, then the aggregate public good in a region i (l_i) is a function of public services provided by J,

$$l_i = \left(\sum_{j=1}^{J} \frac{1}{J} p(j)^{\rho} \right)^{\frac{1}{\rho}}, \quad \rho \geq 0 \qquad (2.4)$$

Equation (2.4) represents the public goods production function for region *i,* which depends on inputs (programs) provided by the jurisdictions J (municipalities). Furthermore, ρ captures the degree of global [inter] complementarity between public services in the terminology of Bénabou (1996). A higher value of ρ means lower complementarity and vice versa. Empirically, it is usual to approximate the effectiveness of the public programs financed by jurisdiction j through its expenditures. In section 4.4 we will add other technical details for the estimation of ρ.

Aside from the usual factors determining long-term economic growth and the role of regional governments, an important branch of literature has focused on models in which space considerations are crucial (Breinlich, et al, 2013). This approach points out that economic activities tend to gravitate towards areas with relatively good transport links and which are close to large markets, mainly. Therefore, regional growth performance could be connected with geographic features in addition to other non-observable determinants (culture, quality of institution, etc.). If outcomes in one region are closely linked to the outcomes and characteristics of other regions (i.e. there is spatial interdependence), the econometric strategy has to take care of it. Our empirical exercises also pay special attention to these issues. We will further discuss the technical details on this subject in next section.

3. Linking the Economic Theory to a Statistical Model

The theoretical framework of the previous section suggests estimating the following reduced-form equation adapted to the panel data analysis

$$y_{it} = \boldsymbol{\beta}'_i \mathbf{x}_{it} + u_{it} \qquad (3.1)$$

for $i = 1.2, \dots, N$ regions, and $t = 1.2, \dots, T$ periods, which corresponds to a balanced panel data structure. The variables are defined in per capita terms, so that the observed output of region i at time t, $y_{i,t}$ is associated with a vector of observed explanatory variables, $\mathbf{x}_{i,t}$, and an unobservable stochastic term u_{it}. Vector $\mathbf{x}_{i,t}$ contains mainly the private capital, k_{it}, and a measure of fiscal decentralization denoted $d_{i,t}$ when it is based on public expenditure. Production technology is captured by the stochastic term.

Estimation of (3.1) raises several econometric concerns, mainly related to presence of unit roots and co-integration; the spatial interdependence among inputs and outcomes; the existence of response heterogeneity to observed and unobserved

variables; the choice of parameters of interest; the possible endogeneity of regressors, and the asymptotic approximation of estimators due the moderate size of our sample.

To deal with the aforementioned issues, we chose the Augmented Mean Group (AMG) estimator proposed by Eberhardt & Bond (2009), Eberhardt & Teal (2010) and Bond & Eberhardt (2013). The following Equations, which along with (3.1) represent our model, show the advantages of employing AMG estimation:

$$u_{it} = \alpha_i + \boldsymbol{\lambda}'_i \mathbf{f}_t + \varepsilon_{it} \tag{3.2}$$

$$x_{mit} = \pi_{mi} + \boldsymbol{\delta}'_{mi} \mathbf{g}_{mt} + \rho_{1mi} f_{1mt} + \cdots + \rho_{nmi} f_{nmt} + \upsilon_{mit} \tag{3.3}$$

$$\mathbf{f}_{.mt} \subset \mathbf{f}_t \quad \mathbf{f}_t = \boldsymbol{\mathfrak{d}}' \mathbf{f}_{t-1} + \boldsymbol{\epsilon}_{1t} \quad \mathbf{g}_t = \boldsymbol{\kappa}' \mathbf{g}_{t-1} + \boldsymbol{\epsilon}_{2t} \quad \boldsymbol{\epsilon}_t = [\boldsymbol{\epsilon}'_{1t} \quad \boldsymbol{\epsilon}'_{2t}]' \tag{3.4}$$

Equation (3.2) links the unobservable component of output, u_{it}, to a vector of unobservable time-varying factors which are common across regions, $\mathbf{f}_t$, to an unobservable fixed regional effect term, α_i; and a noise term ε_{it}. Because factors loadings $\boldsymbol{\lambda}_i$ are region-dependent but not time-dependent, $\boldsymbol{\lambda}'_i \mathbf{f}_t$ depends on both time and region. Clearly, the unobserved component of output not explained by $\mathbf{x}_{it}$ depends on $\mathbf{f}_t$. In line with the literature on economic growth, such component u_{it} should be associated with the unobservable TFP, which is in turn determined by region-specific circumstances, α_i, and a set of common factors $\mathbf{f}_t$.

Equation (3.3) relates each explanatory variable $x_{.mit} \subset \mathbf{x}_{it}$, with the common factors $\mathbf{f}_{nmt} \subset \mathbf{f}_t$, an *n* sub-vector of the factors driving output, as well as with a vector of unobservable factors that depends on the regressors and is common across regions, $\mathbf{g}_{mt}$. Individual explanatory variables also depend on a set of regional fixed effects, π_{mi}, and an error term, υ_{mit}. Furthermore, this model addresses potential regressor-endogeneity-issues by letting $\mathbf{f}_{nmt}$ affect contemporaneously output and each individual explanatory variable. Finally, Equation (3.4) states that each vector of unobservable dynamic factors follows a VAR(1) process. The standard assumptions are imposed on model's noises; ε_{it}, υ_{mit} and $\boldsymbol{\epsilon}_t$.

A key feature of our dataset is the potential presence of unit roots. The main economic argument in favor of a unit root in output is the relative persistence of TFP and output innovations. In turn, co-integration between the observables y_{it} and $\mathbf{x}_{it}$, and the unobservable vector of factors, $\mathbf{f}_t$, may arise as $\varepsilon_{it} = y_{it} - \boldsymbol{\beta}'_i \mathbf{x}_{it} - \alpha_i - \boldsymbol{\lambda}'_i \mathbf{f}_t$ can be made stationary under very mild conditions (Eberhardt & Teal, 2010; and Bond & Eberhardt; 2013). Prior to the estimation of the $\boldsymbol{\beta}_i$'s in Equation (3.1), these conjectures should be verified through standard unit root and co-integration tests.

Cross-section dependence among inputs and outcomes arises through the inclusion, as regressors, of unobservable time varying factors $\mathbf{f}_t$ and $\mathbf{g}_t$, which are

common across regions. So, since $y_{it} = \beta'_i(\pi_{mi} + \boldsymbol{\lambda}'_{mi}\mathbf{g}_{mt} + \rho_{1mi}f_{1mt} + \cdots + \rho_{nmi}f_{nmt} + \upsilon_{mit}) + \alpha_i + \boldsymbol{\lambda}'_i\mathbf{f}_t + \varepsilon_{it}$, the correlation between y_{it} and y_{jt} (for $\neq j$) depends on the variances of $\mathbf{g}_{mt}$ and $\mathbf{f}_t$ and the variances and covariance of the f_{jmt} involved. Therefore, model (3.1) to (3.4) allows for a great variety of cross-section dependence, thus helping eliminate mean group bias.

Another key issue in growth panel regression estimation is the potential heterogeneity of the responses of and to the observable regressors, as well as to the unobservable explanatory factors. Observed heterogeneity results from the assumption that $\boldsymbol{\beta}_i$'s are Gaussian random vectors with fixed vector mean $\boldsymbol{\beta}$ and positive definite variance covariance matrix $\boldsymbol{\Omega}$. This assumption corresponds to random stationary coefficients, which contrasts with the assumption that $\boldsymbol{\beta}_i$'s were constant. In turn, unobserved heterogeneity emerges from the inclusion of unobserved factors that differentially affect both output and regressors across regions and/or time. Consequently, the model encompasses many alternative formulations of time-and-region varying heterogeneity, thus avoiding neglected heterogeneity related bias (See Bond & Eberhardt, 2013; Baltagi, Bresson & Pirotte, 2008; Hsiao & Pesaran, 2008).

Following the assumptions in the previous paragraph, the natural choice of parameters of interest is the mean $\overline{\boldsymbol{\beta}}$ of the regional vectors, $\boldsymbol{\beta}_i$. Two reasons justify this choice. On the one hand, system dynamics has to be treated as a nuisance because of the moderate size of our data panel. On the other, estimation of individual coefficients is not consistent (Coakley, Fuertes & Smith, 2006), but averaging across individual estimates still permits a consistent estimation of long run (co-integration) coefficients.

The last feature of our dataset is its moderate size, (N=24 regions and T=23 years) which requires a particular type of asymptotic treatment on parameter estimators to ensure its consistency[1]. According to Eberhardt & Teal (2010), the *AMG* slope vector parameters are ($T \to \infty$, $N \to \infty$, $\sqrt{N}/T \to 0$) consistent, which fits our purposes as the number of time periods would increase faster than the number of regions. Furthermore, under unit roots and co-integration, *AMG* estimators may converge faster than the usual $\sqrt{T}$ or $\sqrt{N}$ rate of convergence of stationary panels. Through the use of panel data structure, unit roots and co-integration, the moderately-sized panels such as the one in this paper are common for this type of analysis[2].

[1] Different from micro-panels (large N and small T) and macro- panels (large T and small N).

[2] For instance, Eberhardt & Teal (2010) report a country productivity analysis on N=48 countries and T=24 years on average, and Dell'Erba & Sola (2013) analyze the impact of fiscal policy on sovereign interest rates in a panel of N=17 countries and T=23 years using a similar approach.

4. Results

4.1. The Dataset

Our dataset contains yearly records of the variables described in Annex for 24 Colombian regions spanning the period 1990-2012. Unfortunately, there is not enough information for all the regions in the country (32), but the regions in our sample (24) explain on average 97.7% of the national GDP. The variables employed in the panel data regression are described at the top side of the Annex, while in the middle and bottom sides we added other variables used in the cross-section exercises, as well as those required to assess the complementarity effect among public goods.

Two special remarks on the dataset must be made. The first is referred to the fiscal decentralization indicator based on expenditures, d_{it}, which is the most relevant in our framework. The public spending executed in region i takes into account both local and departmental governments, including transfers made from the central government. Similarly, and for reasons of robustness, we included two additional indicators on fiscal decentralization based on their revenues: the share of its own revenue over the total, and the tax autonomy degree. The second has to do with estimation of the private stock of capital at a regional level, k_{it}, because this information is not available, unfortunately.

We started using the initial value of aggregate stock of capital calculated by the DNP (National Planning Department) with the permanent inventories methodology. This value is updated using the net investment from the national accounts with a standard yearly depreciation rate of 4.92%. The following step involved identifying the public component of capital along the time period (and therefore the private component), using the expenditures in infrastructure as weights (a proxy of public investment) as a percentage of total investment coming also from national accounts. In the final step, regional distribution of private capital is proxied through two complementary tools: firstly, by applying the output distribution among regions as weights under the standard assumption that capital and output grow at equal rates in the steady state. Secondly, by taking into account the regional distribution of capital of the manufacturing firms, which were identified through the Annual Manufacturing Survey.

4.2. Unit Roots and Cross-Section Dependence

Before presenting our results, some statistical properties of the variables involved in the panel data models should be examined briefly (unit root, stationarity and cross-section dependence). Firstly, the standard unit root tests discard the presence of unit roots in the variables included in equation 3.1 (for different versions) and, therefore,

such equation does not correspond to a co-integrated panel. The results of Table 1 show p-values well below 0.05 for the corresponding Levin, Lin, and Chu unit root tests (Levin, Lin, & Chu, 2002). In turn, the optimal number of lags show that there is little self-correlation in the variable-wise. The higher number of optimal lags appears in the fiscal decentralization based on expenditures (3 lags), while the rest of variables require only 1 lag for whiteness. These findings were also corroborated with other panel unit root tests (Im, Pesaran and Shin, 2003) with the same results. Therefore, the different versions of equation 3.1 correspond to stationary panels.

Table 1: Levin-Lin-Chu Non-Stationarity Test: For variables to include in the different models of equation 3.1

Variable	Coefficient	t-value	t-star	p-value	lag
y_{it}	-1.07	-17.22	-8.70	0.00	1
k_{it}	-1.21	-18.32	-10.11	0.00	1
d_{it} − expedit share	-0.27	-7.87	-2.06	0.02	3
d_{it} − tax autonomy	-0.34	-9.41	-4.11	0.00	1
d_{it} − revenue share	-0.25	-9.10	-3.63	0.00	1

H0: The process is non-stationary

H1: The process is stationary

Source: Calculations by the authors

Secondly, the Pesaran's (2004) CD test strongly suggests the existence of variable-wise cross-sectional dependence among the 24 regions in Colombia. Indeed, results contained in the third column of Table 2 show extremely low p-values for the null of cross-sectional independence among regions and the levels of simple and absolute correlation (columns 3 and 4, respectively) show a moderate relationship among variables, suggesting that cross-sectional dependency is pervasive in our dataset.

Table 2. Pesaran CD Cross-Section Dependence Test: For variables to include in the different models of equation 3.1

Variable	CD-test	p-value	corr	abs(corr)
y_{it}	21.80	0.00	0.28	0.31
k_{it}	37.31	0.00	0.48	0.48
d_{it} − expedit share	47.92	0.00	0.62	0.71
d_{it} − tax autonomy	38.49	0.00	0.49	0.55
d_{it} − revenue share	38.37	0.00	0.49	0.66

Note: Under the null hypothesis of cross-section independence CD ~ N(0.1)

Source: Calculations by the authors

Finally, in order to explore the existence of unobservable dynamic factors such as sources of growth, we performed a Principal Components Analysis (PCA) on all the series of the regional GDP growth. The results of Table 3 reveal that the first principal component explains 35% of the correlation between regions, while the second and third components explain 12% and 9%, respectively. All these results suggest that dynamic factors might be required to explain the total variation of regional economic growth in Colombia as is indeed considered by the AMG estimator used in this paper.

Table 3. Principal Component Analysis of Regional GDP Growth

Order	Eigenvalue	Difference	Proportion	Cumulative
1	8.35	5.51	0.35	0.35
2	2.84	0.78	0.12	0.47
3	2.06	0.09	0.09	0.55
4	1.97	0.41	0.08	0.63
5	1.56	0.17	0.07	0.70
6	1.39	0.36	0.06	0.76
7	1.03	0.14	0.04	0.80
8	0.89	0.19	0.04	0.84

Source: Calculations by the authors

In all, the time series panels containing regional per capita output growth, the growth of private capital, and the different fiscal decentralization indicators are stationary. Furthermore, there is clear evidence over cross-region dependency which may be related to spillovers and geographical correlation. Finally, there is evidence of the existence of unobserved factors driving output, f_t, which may account, partially at least, for variations of output growth.

4.3. Growth Regression Model

Table 4 shows the results of the model described by equations 3.1 to 3.4 based on the AMG estimator, which was designed for moderate panel size and was used in the presence of heterogeneous slope coefficients across regions and possible correlation across the panel members. The sign of parameters are those expected theoretically, and the model seems to explain growth mechanisms aptly.

The key coefficients of fiscal decentralization are positive and significant in a statistical sense, with semi-elasticity larger than one, implying that the transfer of fiscal functions to sub-national governments have strengthened economic growth. The smaller coefficient on the tax autonomy indicator is not surprising because there

is a limited space for subnational governments to manage their own taxes. Due to the increasing role of intergovernmental transfers into regional government expenditures, it is reasonable to argue, however, that fiscal decentralization has also been associated to the strengthening of regional income bases.

Table 4. Panel Data Results
Dependent Variable: GDP Per-capita (Annual Growth Rate)

Variables	(1)	(2)	(3)
Fiscal Decentralization (Expendit. Share, d_{it})	1.5404***		
Fiscal Decentralization (Revenue Share, d_{it})		1.5100*	
Fiscal Decentralization (Tax Autonomy, d_{it})			0.1302***
Private Capital Per-cap, k_{it}	0.6026***	0.6110***	0.5946***
Common Factors Effect, λ_i	0.7672***	0.8461***	0.8084***
Constant (regional fixed effect) , $\propto_i$	-0.0325***	-0.0231**	-0.0507***
Number of obs. = 528			
Number of groups = 24			

*** p < 0.01, ** p < 0.05, * p < 0.1
The common dynamic process included as an additional regressor.
Source: Calculations performed by the authors.

The positive links found between fiscal decentralization and regional economic growth in Colombia is consistent with most recent papers on this subject. Nonetheless, some of them have argued that such relationship is positive but nonlinear, suggesting a hump-shaped association (Akai et. al. 2007; Blöchliger, 2013). The "optimal" level of decentralization derived from this discussion fixes therefore, a limit beyond which additional decentralization may restrain rather than encourage economic activity. We explore this hypothesis using the Colombian data, but no evidence was found perhaps because the series are not long enough.

Regarding the other results, the expected sign of the private capital parameter is confirmed with highest statistical significance across the models as well as the reasonable size of the elasticity. However, what is more remarkable is the positive result for the common unobservable factors that help to explain the economic growth of regions directly as well as factor accumulation and their productivity. In the theoretical setting of Eberhardt & Bond (2009), the unobservable factors represent especially the total factor productivity of the production function. Nevertheless, some particular differential aspects that have been recognized by the literature as crucial determinants of development across countries (regions), such as culture, habits, climate, geographical aspects, quality of institutions, etc., (Acemoglu, et al 2005),

which could also be included as non-observable factors. Due to the unavailability of data for these estimations, we were not able to distinguish among parameters, unfortunately.

In order to check the validity of our previous results, residual unit root tests and cross-sectional dependence tests were performed for the residuals of each estimated panel. The results in Table 5 confirm the absence of unit roots since the p-values are well below 0.05. Table 6, in turn, presents strong evidence of lack in residual cross dependence since the p-values range from 0.45 to 0.77, thus suggesting that models successfully explained this data feature.

Table 5. Levin-Lin-Chu Unit Root Test: For residuals of panel with different fiscal decentralization indicators

Residuals from Panel with each Fiscal Decentralization Indicator	Coefficient	t-value	t-star	P > t
d_{it} − expediture share	-1.15	-26.48	-21.40	0.00
d_{it} − tax autonomy	-1.09	-25.04	-19.85	0.00
d_{it} − revenue share	-1.13	-25.81	-20.64	0.00

Source: Calculations by the authors

Table 6. Pesaran CD Cross-Section Dependence Tests: For residuals of panel with different fiscal decentralization indicators

Residuals from Panel with Fiscal Decentralization Indicator	CD-test	p-value	corr	abs(corr)
d_{it} − expediture share	-0.30	0.76	0.00	0.20
d_{it} − tax autonomy	0.76	0.45	0.01	0.20
d_{it} − revenue share	-0.29	0.77	0.00	0.21

Note: Under the null hypothesis of cross-section independence CD ~ N(0.1)
Source: Calculations by the authors

Furthermore, a PCA analysis of the residuals of each panel estimated reveals that commonality is greatly reduced. The results from Table 7 show an important reduction of the correlation share of the first residual principal component with respect to the common correlation of GDP growth in Table 3. Therefore, an important share of commonality was captured by the model, thus validating our empirical strategy.

Table 7. Principal Component Analysis of the Residuals with Different Indicators of Fiscal Decentralization

	d_{it} − expediture share		d_{it} − tax autonomy		d_{it} − revenue share	
Order	Proportion	Cumulative	Proportion	Cumulative	Proportion	Cumulative
1	0.19	0.19	0.19	0.19	0.21	0.21
2	0.13	0.32	0.12	0.31	0.13	0.33
3	0.12	0.44	0.12	0.43	0.12	0.46
4	0.09	0.54	0.11	0.54	0.10	0.56
5	0.08	0.62	0.09	0.63	0.08	0.64
6	0.08	0.70	0.07	0.69	0.08	0.72
7	0.06	0.76	0.05	0.75	0.05	0.77
8	0.05	0.81	0.05	0.80	0.05	0.82

Source: Calculations by the authors

Table 8 shows the results of the growth-regression model, this time in cross-section dimension as an alternative setup to allow introducing other type of controls. Each column represents the model estimated for each indicator of fiscal decentralization in different periods. We are interested in verifying here the fiscal decentralization effects on regional economic growth by controlling the initial level of output and human capital, measured through the initial level in the coverage of education. As can be seen, the sign of parameters for fiscal decentralization and private capital remain at highest level of statistical significance. Additionally, we remark the negative and significant parameter found for the initial GDP level, suggesting convergence in regional economic growth in Colombia. We will return later with formal tests on this subject. In turn, we found an unexpected sign for the parameter of initial human capital which is not exclusive for our paper and requires a more detailed analysis (see Davoodi and Zou, 1998).

Table 8. Cross-section Results
Dependent Variable: GDP Per-capita (Average Annual Growth Rate)

	Expenditure Share	Revenue Share		Tax Autonomy
Variables	1990-2012	1990-2012	2000-2012	2000-2012
Fiscal Decentraliz. Indicator d_i	0.1588***	0.1324***	0.4002***	0.0312***
Private Capital k_i	0.4127***	0.6260***	0.9318***	0.7697***
Initial Level GDP Per-capita	-1.10e-08***	-1.12e-08***	-1.11e-08***	-9.83e-09**
Initial Level Education Coverage	-0.0181***	-0.0307***	-0.0554***	-0.0382***
Constant	0.0354***	0.0412***	0.0525***	0.0308***
Number of obs.	22	22	24	23

Source: Calculations by the authors

4.4 Complementarity among public goods

To empirically assess complementarity between public goods provided by subnational governments (section 2.2), we follow the strategy proposed by Akai et al. (2007) which starts by linearizing the production function of section 2.1

$$lnY_{i,t} = B + (1-\beta)lnK_{i,t} + \beta\left(lnl_{i,t} + lnN_{i,t}\right) \qquad (4.1)$$

where $lnY_{i,t}$ is the logarithm of the per capita gross domestic product of region *i*, $lnK_{i,t}$ is the logarithm of the per capita private capital and $lnN_{i,t}$ is the number of workers per capita in each region, calculated as the ratio of the economically active population over the total population. In turn, the value of $ln\, l_{i,t}$ corresponds to the logarithmic form of equation (2.4), where *p(j)* denotes the realization of public programs financed by jurisdiction *j*. That is,

$$lnl_{i,t} = \frac{1}{\rho} ln \left\{ \frac{1}{J} \sum_{j=1}^{J} p_t\,(j)^{\rho} \right\} \qquad (4.2)$$

For the case of Colombia, we construct $lnl_{i,t}$ by defining $p_t(j) = m_j + d_j$, where m_j is the expenditure made by municipality j and d_j is the municipality´s share (aliquot) in the department expenditure to which it belongs. The size of the population, *pop*, of each municipality with respect to its department is used to weight such aliquot, so $d_j = \frac{pop_j}{pop_i} l_i$. As is suggested by the literature, public expenditure relevant for this calculation includes especially those related with capital formation (investment), which has a higher power to generate spillovers. So, infrastructure expenditures made in region i on roads, electricity, parks, mass transit system and so on, could have beneficial effects on neighboring regions by considerations of space or geographical dependence, and vice versa. The parameters are estimated from the following second order non-linear equation by pooled non-linear least squares,

$$\widehat{\boldsymbol{\theta}} = \underset{\boldsymbol{\theta} \epsilon R^2}{\operatorname{argmin}} \left\{ \sum_{t=1}^{T} \sum_{i=1}^{N} \left(lnY_{i,t} - \left[B + (1-\beta)lnK_{i,t} + \beta(lnl_{i,t} + lnN_{i,t}) \right] \right)^2 \right\} \qquad (4.3)$$

where $\boldsymbol{\theta} = [\beta, \rho]^{\boldsymbol{T}}$ is the parameter vector. The estimation was carried out by unrestricted numerical minimization of the right-hand side term of equation (4.3)

using the SAS/IML software. The data covers the thirteen most representative regions of the Colombian labor market for the period 2001-2012.[3] The results are summarized in Table 9 and compared with previously estimations made by Akai et al (2007) for the United States.

Table 9. Estimation of the Complementarity Effect of the Public Goods
Dependent Variable: Log of GDP Per-capita (Thirteen Most Representative Regions)

Parameter	Colombia: 13 Regions for 2001-2012 Authors' Calculations			USA : 50 States for 1992-1997 Akai et. Al. (2007)		
	Estimate	T Statistic	P Value	Estimate	T Statistic	P Value
B	3.38	11.63	0.000	3.35	3.67	0.000
β	0.47	5.19	0.000	0.34	5.35	0.000
ρ	0.78	3.26	0.000	0.48	3.98	0.000

Source: Calculations by the authors

The null hypothesis of $\rho = 0$ is rejected with 1% significance level, so that the resulting value of ρ is significantly positive for Colombia. As is prescribed theoretically, this is the case when public goods provided at subnational levels are complementary among themselves, or they have spillover effects across regions, ultimately strengthening economic growth at the national level. From comparing with the U.S., we conclude that regional public goods in Colombia have a lower complementary effect because the larger parameter ρ, the lower its effect (section 2.2). The private capital parameter (1- β) is highly significant and close to what was obtained through the panel data regressions. In turn, the value of B must be taken cautiously, since this is not a dynamic growth analysis; therefore, implications for the Solow residual are not entirely clear.

4.5. Regional growth convergence

An important feature of this dataset is the large gap in per capita GDP levels among regions in Colombia. In 2010, for instance, the richest regions (Casanare and Meta) attained almost 7 times more that the poorest (Sucre, Nariño and Chocó), being the national average around of COP$7.8 million (see Lozano et. al., 2013) The natural question is if such cross-regional differences in per capita incomes have been temporary or permanent. If the differences are temporary, unconditional convergence

[3] The labor market data was taken from Colombia's Statistical Office (DANE). They report information only for the most representative 13 regions. Because of changes in the surveys, information is available from 2001 to 2012.

(to a common long-run level) may be occurring. This situation is usually captured by the unconditional β-convergence test. Now, if income differences are temporary but there remain doubts whether the dispersion of these differences is declining over time, then the σ-convergence test helps solve this uncertainty. In contrast, if the differences are permanent, a crucial inquiry is to determine if permanence reflects a structural heterogeneity between regions or simply the role of initial conditions in determining long-run outcomes. In practice, the conditional β-convergence test implies employing an ample set of controls in the estimation.[4]

In order to formalize empirically the convergence hypothesis, the initial level of output is typically correlated with its growth rates. For the case of relatively homogeneous groups of economic units at regional level (as states of the US or Australia, provinces in Canada, prefectures in Japan, and counties in Sweden), the unconditional β-convergence hypothesis has been typically applied. In this case, controls are not used in estimation. Even though there is some variation in estimated convergence rates at international level, the range is relatively small: between 1% and 3%, per year (Barro and Sala-i-Martin, 1992).

Figure 1(left panel) and Table 10 show the results of the unconditional β-Convergence in economic growth for Colombian regions. The average growth rate of each region's per capita income for 1980-2012 is shown on the vertical axis, and is negatively related to the log of per capita income in 1980, which is shown on the horizontal axis. Clearly, there is a phenomenon in which a poor region tends to catch up with a rich one in terms of the level of per capita income, and the gap is closed at a yearly rate of 0.86%. When public accounts are subtracted from the overall GDP, with the idea of obtaining a measure of Private GDP, the yearly rate falls to 0.66%.

The unconditional β-Convergence test is performed also for the period after the promulgation of the political constitution of 1991, which encouraged fiscal decentralization in Colombia. Table 10 clearly shows that the gap in per capita income between poor and richer regions closes at a greater yearly rate of 1.61% for the more recent period (1.24% with private accounts exclusively). These simple exercises would lead us to recognize the positive contribution of subnational governments in recent times to close the differences of economic growth among regions. As we stated at the beginning of the paper, the main argument in favor of decentralization claims that subnational governments have a better understanding of local needs. If local governments have made progress in meeting uncovered needs, then they would play an important role in the regional income convergence.

[4] If initial conditions determine long-run outcomes and countries with similar initial conditions exhibit similar long-run outcomes, then it's possible to talk of convergence clubs (Durlauf, et. al, 2005).

Figure 1: Convergence Test for Regional Economic Growth in Colombia

Unconditional β-Convergence σ-Convergence

Table 10. Test of Unconditional β-Convergence of the Regional Economic Growth in Colombia

	Growth of Regions for 1980-2012 Authors' Calculations		Growth of Regions for 1990-2012 Authors' Calculations	
	Total GDP	Private GDP	Total GDP	Private GDP
Constant	0.15286	0.11871	0.2691	0.20688
β	-0.00857	-0.00656	-0.01611	-0.0124
P Value	0.027	0.097	0.002	0.012
R^2	0.2029	0.1204	0.2812	0.1880

Source: Calculations by the authors

Finally, we performed the σ-convergence test, according to which convergence implies a decline in the standard deviation of the logarithm for per capita product across regions in Colombia from 1980 to 2012. Figure 1 (right panel) clearly shows the decreasing dynamic of this dispersion between 1980 and mid-2000. However, it starts to increase afterwards, curiously.

5. Concluding Remarks

In this paper we provided empirical evidence on the role of fiscal decentralization in Colombia's regional economic growth. The period analyzed covers the last two decades, which is suitable since the Political Constitution of 1991 tried to encourage regional

development. Also, around this time, most Latin American countries reinforced the role of regional governments in their development strategy, thus turning decentralization into the core of institutional reforms at the end of the 20th century, especially in developing countries.

The empirical strategy involved the choice of an adequate technique for the panel data approach which would allow us to include an ample set of factors suggested by the literature as a determinant of economic growth, as well as the successful management of the main econometric problems. The Augmented Mean Group (AMG) estimators proposed by Eberhardt & Bond (2009), Eberhardt & Teal (2010) and Bond & Eberhardt (2013) helped us with these purposes. The strategy was complemented with other empirical tools such as the cross-section models for different periods, together with the use of other controls, the tests on unconditional convergence in regional income differences, and, especially, the proofs on the complementarity hypothesis between public goods provided by different jurisdictions.

Our results confirm the positive link between fiscal decentralization and economic growth across regions in Colombia with a semi-elasticity parameter larger than one, implying that the transfer of fiscal functions to sub-national governments has been conducive to economic growth. These results are robust to the three most used indicators of fiscal decentralization: one based on expenditures and two based on their revenues. The relationship found is also consistent with recent papers on this subject, even though no evidence was found over its nonlinearity.

The positive effects of fiscal decentralization on regional growth were also confirmed through cross-section models controlling the initial level of output and human capital. The expected signs on parameters of the remaining factors explaining growth are confirmed, as is the reasonable size of their elasticities. Nevertheless, the positive result for the common, non-observable factors that help explain economic growth directly as well as factor accumulation is also remarkable. Among them is total factor productivity, which could be affected in turn by differential aspects across regions such as culture, habits, climate, geographical aspects, quality of institutions, and so on. Although in comparison with the U.S. regional public goods in Colombia have a lower complementary effect, there is no doubt of their positive contribution to aggregate economic growth.

Finally, we tried to assess whether the per capita income differences among regions in Colombia has been declining, given the huge discrepancies observed three decades ago. Through unconditional β-Convergence and σ-convergence tests we found that the gap in per capita income between poor and richer regions closes at a yearly rate of 1.61% for the most recent period, and that the dispersion of these income differences is declining over time. Based on these results, we highlight the positive contribution of governmental activities.

Annex. Dataset Description

Panel Data Models

Variable	Description
$y_{i,t}$	Per capita regional real GDP based on product and population data from the Colombian statistics bureau (DANE). Y_{it}/P_{it} P_{it}: regional population
$k_{i,t}$	Per capita private capital. Additional information on its construction can be found in section 4.1. K_{it}/P_{it}
$d_{i,t}$	FD-Expenditure Share $\frac{RE_{it}}{\sum_{i=1}^{24} RE_{it} + CE_t}$ RE_{it} : Government expenditure of region *i.* CE_t : Central Government expenditures Source: Authors' calculation based on DNP* data
$d_{i,t}$	FD-Tax Autonomy $\frac{AT_{i,t}}{TR_{i,t}}$ $AT_{i,t}$: Taxes over which subnational governments have some degree of autonomy from the general government tax revenue. TR_{it}: Total tax revenues of each region. Source: Authors' calculation based on DNP data
$d_{i,t}$	FD-Total Revenue $\frac{T.REV_{it}}{\sum_{i=1}^{24} T.REV_{it} + C.REV}$ $T.REV_{it}$: Total revenue of region *i.* *C.REV:* Central Government total revenue. Source: Authors' calculation based on DNP data

Other Models

Variable	Description
$lnN_{i,t}$	Number of workers per capita. $\frac{Economically\ Active\ Population}{Total\ Population}$ Source: DANE
$lnl_{i,t}$	Logarithm of the aggregate public good in a region, *i*.

	$$lnl_{i,t} = \frac{1}{\rho} ln \left\{ \frac{1}{J} \sum_{j=1}^{J} p_t\,(j)^{\rho} \right\}$$ ρ: Degree of global [inter] complementarity between public services.
$p_t(j)$	Realization of public programs financed by jurisdiction *j.* $$p_t(j) = m_j + d_j$$ m_j: Expenditure of municipality j. Source: Authors' calculation based on DNP data
d_j	Size of population, *pop*, of each municipality with respect to its department. $$d_j = \frac{pop_j}{pop_i} l_i$$ Source: DANE
$d_{i,t}$	Average fiscal decentralization indicator $$\frac{\sum_{t=1}^{22} d_{i,t}}{n}$$ Source: Authors' Calculation
Initial level variables	Population initial level: 1990 population. Education initial level: 1996 education coverage level. Source: DANE

* DANE: Departamento Nacional de Estadística
DNP: Departamento Nacional de Planeación

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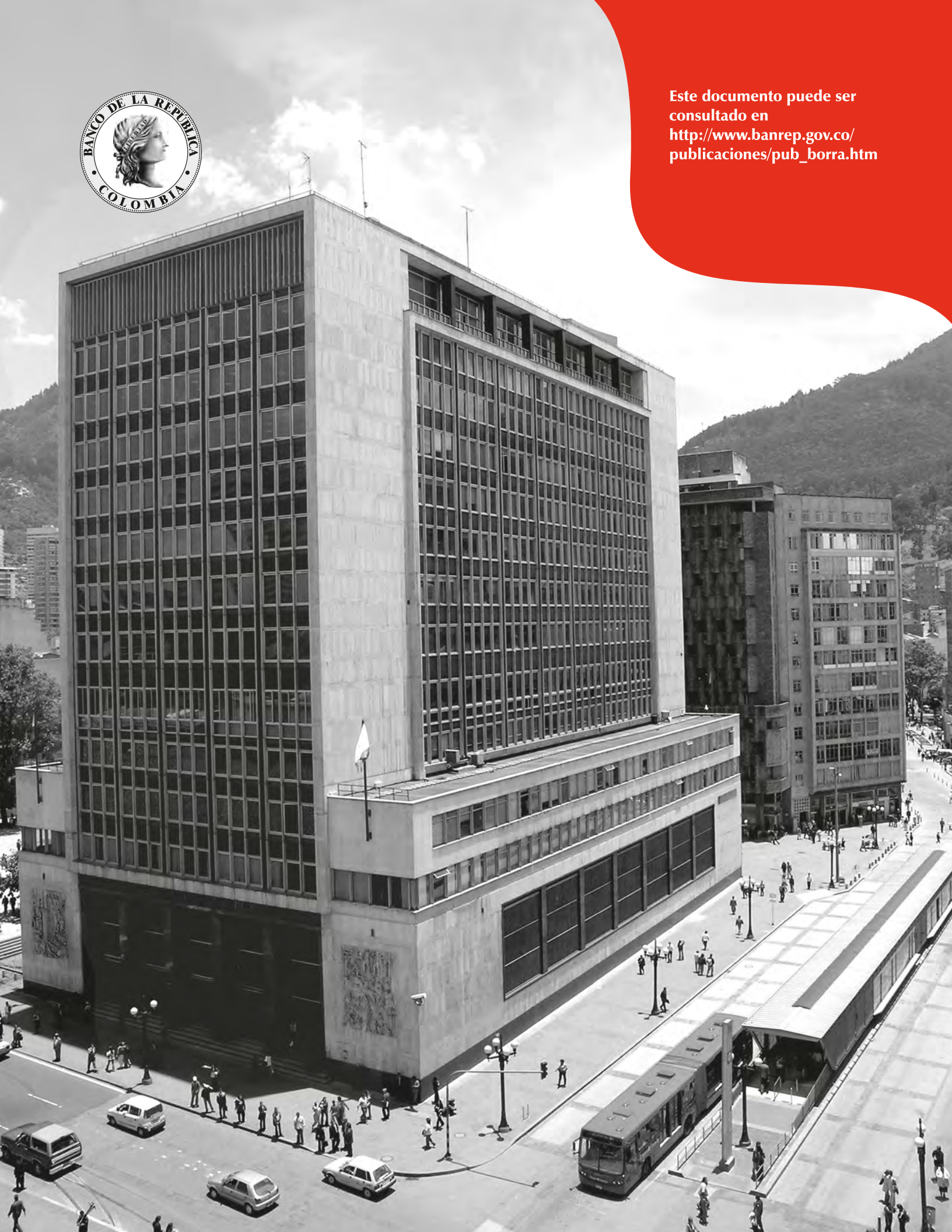

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