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TAX DECENTRALIZATION AND ECONOMIC GROWTH IN LATIN AMERICA: EVIDENCE OF PANEL DATA: 2000-2018

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Abstract

The objective of this research is to determine the relationship between fiscal decentralization and economic growth for Latin America from a heterodox perspective based on the research question, what is the relationship between fiscal decentralization and economic growth? For this, the evidence and the empirical works, as well as the methodologies used, which are contrasted to determine their viability are widely discussed. The methodology used is an ordinary least squares model based on balanced panel data to correct possible errors, that is, a panel data specification model that measures the fixed and random effects that combine appropriate interest variables with variables of interest, control to avoid bias of mutual causality. The tests applied for the selection of the most appropriate estimators determine that the null hypothesis is accepted that a greater fiscal decentralization affects economic growth, in which the public investment of the Latin American countries from the application of decentralization, it has allowed its impact on per capita GDP to be stronger. Finally, the null hypothesis is accepted and there is no structural change in the slopes of the model in the public investment variable. So, it is not necessary to create dummy variables to pick up the change in the public investment coefficient.

Keywords: Fiscal decentralization, economic growth, panel data, GDP per capita, public investment.
JEL Codes: O43; H77; C33

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1. Introduction

The relationship between fiscal decentralization and economic growth has always been manifested from the neoclassical perspective, in which the representative agent and the stimulus of taxes on economic activity have been the ruler to determine this relationship. In addition, private income has been considered as a fundamental variable in relation to economic growth. From Tiebout, Musgrave and Oates, until today, the relationship between fiscal decentralization and economic growth has been defined from the conditionality of the inverse relationship, that is, how the level of economic growth is affected by fiscal decentralization, and all studies have marked positive relationships.

In the present study, it is a matter of turning this neoclassical understanding of measuring this relationship between economic growth and fiscal decentralization from the representative agent, to move on to a heterodox vision of measurement from the field of investment and public consumption, as determinants of economic growth, from defining the existence or not fiscal decentralization. This different approach must allow us to understand the actions of the state through public policy, to promote the conditions of economic growth, based on a process of decentralization that allows the state to generate, through investment and public consumption, the necessary conditions so that the relationship between economic growth and fiscal decentralization has a direct relationship with investment and public consumption.

This alternative approach seeks to present the role of the state as the revitalizer of the economy, hence the importance of measuring the relationship of economic growth and fiscal decentralization from the definition of investment and public consumption, as determining variables in a process of fiscal decentralization, defining for this also the existence of fiscal decentralization or not, a dummy variable, in a dynamic of change of economic growth measured from investment and public consumption, before and after decentralization.

Furthermore, this approach aims to capture the role of the state, not only as an engine of the economy in a process of fiscal decentralization, but as a determinant of social improvements. This understanding defines whether the state, at any level of government, applies a fiscal policy of greater income generation, these should via investment and public consumption generate the necessary conditions for the economy and social conditions to improve, since from the year 1980, Latin America becomes one of the geoFigureical areas that present the greatest inequality worldwide, a situation that has made it increasingly necessary to apply public policies that aim at a sustained improvement in the redistribution of income and wealth. In this sense, fiscal policy plays a fundamental role, considering fiscal policy as the set of public income and expenditure policies applied in order to guarantee the economy and the social conditions of the population, in distributive spheres (Varela, 2009).

Although the literature and evidence on the relationship between decentralization and economic growth, have been referred to the analysis of the representative agent, income and incentives to the private sector, in this study we neglect this approach to focus on investment and consumption (spending) in Latin American and its impact on economic growth. For this, we consider two stages of study, the first between 2000 and 2009, a period where there was no regulation on decentralization, and the second between (2010-2018), where regulations on decentralization already prevail.

In the international arena, the theoretical interest on the relationship between economic growth and fiscal decentralization dates back to the 50s of the previous centuries. Several studies at international level have been developed in this regard: Tiebout (1956), Musgrave (1959) and Oates (1972, 1993); and currently with studies by Martínez-Vázquez and McNab (2003), Brueckner (2006), Carrión i Silvestre, Espasa and Mora (2008); Rodríguez and Escurra (2009); Feld, Kirchhanner and Schalteger (2012); Baskaran (2012); Kappeler, Solé-Ollé, Stephan, Bird (2013), Blöchliger (2013); Cournéde, Lagos and Martínez Vasquez (2017).

All of the above have focused on the main agent and the incentive for investment and private consumption, as mechanisms for the relationship between decentralization and economic growth. In the present study, we will no longer focus on the main agent and the private sector as an engine in the relationship between decentralization and economic growth, but we will refer to the public sector as the engine of this relationship, a situation that frames us in a different approach to that traditionally He has analyzed the relationship between decentralization and economic growth.

In an alternative approach, Braña and Serna (1997), analyze the decentralization of public spending competencies, giving a different direction to the analysis of fiscal decentralization as a fundamental part of spending, that is, it is analyzed from the demand side. Likewise, there are studies as part of the analysis of the variables that would affect economic growth in relation to a greater or lesser decentralization tied to public investment spending as in De Mello (2010), Sachhi and Salotti (2011); Kappeler, et al (2013); Kis-Katos and Suharnoko (2017).
Studies of the inverse relationship, that is, how the level of economic growth is affected by fiscal decentralization have marked positive relationships as presented by Oates (1972), Woo (1977), Pommerehne (1977), Bahl and Nath (1986), Wasylenko (1987), Panizza (1999), Stansel (2005); Balaguer et al (2010); Kappeler et al (2013), Kis-Katos and Suharnoko (2017).

The aforementioned demonstrates that relationship between fiscal decentralization and economic growth. However, we must emphasize that all studies have focused on analysis at the country level, or on federations but in developed countries. In developing countries such as Ecuador there are no studies in this regard, but studies have been conducted in Colombia at the regional level but considering the restriction of the representative agent in a function of production of constant yields with standard preferences of a representative household based on the Ramsey-Cass-Koopmans model. For the Ecuadorian case, we will focus on a fiscal decentralization model focused on provincial public investment and spending as a function of public goods production that depends on the financing of public goods of the provincial councils.

2. Literature Review

2.1. Fiscal Decentralization and Economic Growth: Theoretical Studies

From the traditional view, Hatfield and Prado (2012) reviewed the classic problem of fiscal competition in the context of federal nations and derive a positive theory of partial decentralization. This theory explains that using redistributive taxes on capital to provide public goods means that high taxes establish what is supposed to result in a small stock of capital that decreases the returns of redistribution, so all this leads to a lower level of taxes on capital, and this must be done by establishing in the Constitution a partial degree of decentralization.

Martínez, Vásquez, Lago Peñas and Sacchi (2015), examine two crucial but not yet resolved issues in the decentralization literature: its correct measurement and the possible endogeneity of fiscal decentralization with many of the variables of interest that we are trying to investigate, and point out that decentralization is motivated by quite different reasons. In recent decades, a large number of countries have sought decentralization as a means to seek a more efficient and effective public sector. Other countries were disenchanted with the performance of previous planning and centralized policies. In fact, fiscal decentralization addresses how the public sector is organized and how to create opportunities for greater growth and well-being.

These authors indicate that fiscal decentralization can indirectly affect poverty and income distribution in innumerable ways (for example, through growth, the degree of institutional development, the size of government intervention in the economy, the quality of governance) and the final impact depends on the specific characteristics of each decentralization process. The relevance of this fact is that many countries simultaneously implemented policies aimed at reducing income inequality and poverty, as well as in fiscal decentralization reforms.
Davoodi and Zou (1998) analyzed the per capita growth rate in relation to the decentralization of public expenditure and income on the Gross Domestic Product in a conglomerate study of 46 countries.

De Melo and Barenstein (1996) in a study for 29 countries analyzed the growth rate per capita in relation to the decentralization of spending considering the tax autonomy ratio. Martínez-Vásquez and McNab (2002) in a study for 52 countries analyzed the growth rate per capita in relation to the decentralization of expenditure and the decentralization of income. Xie, Zou and Davoodi (1999) in a study for the US analyzed the per capita growth rate in relation to the decentralization of spending and the ratio of public revenue to national GDP.

There are also studies at regional level within the countries, we can mention those conducted by Zhang and Zou (2001) who in a study for 28 Chinese provinces analyzed the rate of growth of income and provincial Gross Domestic Product based on the decentralization of the expenditure, public revenues on the national Gross Domestic Product and different categories of expenditure at central and provincial level. Feld, Kirchhanner and Schalteger (2012) in a study for 26 Swiss cantons analyzed the rate of per capita per capita growth in relation to the cantonal decentralization of expenditure, cantonal decentralization of income, leveling transfers received by the canton, fiscal competence indicator and Canton fragmentation indicator.

Agundez (2002) in a study for 15 autonomous communities in Spain with a common financing regime analyzed the regional growth rate per capita based on the self-sufficiency ratio of regional public spending over regional GDP. Rodríguez et al (2009) in a study for 17 autonomous communities in Spain with a common financing regime analyzed the regional difference in the growth rate of the Gross Domestic Product per capita based on the difference in the level of regional public expenditure per capita. All these studies have determined the variables to be used to establish the relationship between fiscal decentralization and economic growth at the regional or local level.

Feld, Baskaran and Schnellenbach (2012) found that the distribution of competences between the different levels of a federal system can have very significant effects on economic growth, mainly due to the contribution that regions of a country make to economic development, so Both the central government's economic policy has an impact on regional policies. While Angus and Yang (2012) developed an endogenous growth model with indirect effects of public goods, Leviatán taxation, and mobile capital to examine the relative merits of centralized and decentralized tax systems

2.2. Fiscal Decentralization and Economic Growth: Empirical Studies

What is intended in this part is to review the empirical evidence that marks the relationship between fiscal decentralization and economic growth, for which studies that determine that relationship will be analyzed, trying to show in detail the proposals, models, contributions and limitations. In the same way, it is proposed to analyze models directed to the expenditure approach and not to the representative agent.

Heng Fu Zou in 1996 considered two levels of government, one local and one federal, both levels of government with its own income based on consumption taxes, transfers between levels of governments and budgetary balances. With this, based on the accumulation of local public capital, it draws a regional economic growth model to examine “how variations in taxes and transfers affect the long-term equilibrium values of consumption and the stock of private capital, as well as the consumption and stock of local public capital ”(Zou, 1996, p. 12).

From a dynamic system, it establishes four differential equations and four endogenous variables: public consumption and private consumption, and public capital and local private capital. This dynamic system is obtained from a utility function of the family (producer) based on private consumption (c) and local public consumption (E). Under these conditions, the total income of the local government will be determined by what it receives from the central government, this is taxes and transfers, and its expenditure determined by the consumption and local investment of the public sector. Assume again a balanced budget in such a way that you have: τs and + τc c + α $\dot{k}s$ + βE = $\dot{k}s$ + E, determining with this equation a budgetary restriction of local and central governments.

Xie et al. (1999), like Zou, determined a framework of understanding from a CES production function: $y = [\alpha k \zeta + \beta f \zeta + \gamma s \zeta + \omega l \zeta] 1 / \zeta$ with $- \infty < \zeta < 1$; where ζ is a substitution parameter, the elasticity of constant substitution. Following the same procedure as Zou (1996), the authors arrive in the long term to determine the rate of growth of per capita income, and in contrast to the previous work "determine the maximizing tax rate of economic growth (τ *)", that is, the tax rate that influences economic growth (Xie et al., 1999, p. 8).

Unlike the works of Davoodi and Zou (1998) or Xie et al. (1999), in the work of Akai & Sakata (2002) due to the condition that each local government taxes income differently, it cannot be considered a single consolidated budget restriction for the different levels of government, but two budgetary restrictions are considered different, one for the local government and one for the national government. Subsequently, in order to establish the relationship between the structure of local government revenues and economic growth at the country level, the following variables are specified: local government income and national government income that constitute "participation in the total of local revenues that involve transfers from the national government and own income, respectively"(Agúndez, 2002, p. 20).

With this statement, it defines the public expenditure ratio over national income to obtain "the value of income decentralization that maximizes the rate of local economic growth in the long term and the value of the ratio public expenditure on local income that also maximizes such growth" (Akai & Sakata, 2002, p. 25) with the objective of analyzing the distribution of local government resources to maximize economic growth from the two sources of financing, observing that according to the general case that is presented "the greater the Efficiency of the assets that finance a type of resources in the production function greater is the proportion of that type of resources in the optimal distribution "(Akai & Sakata, 2002, p. 23). Finally, the different types of taxation are defined, as well as the ratio of public expenditure to local income for particular cases.

These authors according to Xie et al. (1999) determined that when "the central transfers to the local government match the collection by the national income tax, the optimal decentralization of total local income coincides with the optimal decentralization of public expenditure" (Akai & Sakata, 2002, p. 24). Therefore, the optimal ratio of public spending to local income must necessarily have the same relationship as the tax rate applied, making this result the first model that measures the relationship between income decentralization and economic growth (Agúndez, 2002, p. 24).

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On the other hand, Zhang and Zou (2001) studied the effect of the composition of public spending on growth from what was stated by Devarajan (1996), that is, from a nested Cobb-Douglas production function, identify contributions in each level of government from different types of public spending. To do this, these authors work with an invariable tax rate with budgetary restriction that maximizes the profit reaching in the long term a higher per capita income from "the allocation of the public budget between different levels of government and different types of capital within each of these levels "(Zhang and Zou, 2001, p. 11).

For the Latin American region, Lozano and Julio (2016) establish a panel data analysis to measure the relationship between fiscal decentralization and economic growth at the level of departments in Colombia. The applied model "takes as an initial reference a simple version of the endogenous growth model of Barro (1990), according to which the government acquires a fraction of the private sector's product to provide free public services to private producers (infrastructure services, rights ownership, among others)"…" In order to introduce the discussion on fiscal decentralization, government purchases are broken down between those financed by central, local and state authorities (Davoodi and Zou, 1998).

Therefore, the discussion about the role of government in growth not only refers to the typical advantages of a centralized or decentralized tax regime, but also to the indirect effects of public goods financed by the regions. The complementarity hypothesis is incorporated through a function of aggregate production of public goods, which depends in part on a broad set of public inputs financed by subnational governments (education and health programs, infrastructure, libraries, parks, rights of property, social services, among others) "" (p. 74).

3. Methodology

3.1. Methodology for the analysis of short panel data

This sub-section presents the methodology for the econometric analysis of panel data proposed by various authors. It is exposed initially, which implies the analysis of panel data, its advantages and disadvantages. Subsequently, the different types of models that can be made in short panels are detailed. Finally, the steps and test to follow to obtain the best estimators are established.

3.2. Types of models for panel data analysis

Generally, the starting point in longitudinal models is the grouped Ordinary Least Squares (MCO) model. According to Cameron and Trivedi (2009, p. 248), in this estimate the variations within (in time for an individual) and between (for individuals at the same time) are used simultaneously. The resulting estimators are consistent if the appropriate model is that of random effects and inconsistent in the opposite case. In addition, it assumes that the regressors do not relate to the error. It presents the following form in equation (1), where a common intercept is included and the individual effects (α-α) focus on zero:

$$y_{it} = \alpha + \beta_k X'_{it} + (\alpha_i - \alpha + \varepsilon_{it}) \quad (1)$$

This type of model has a variation, when considering the structure of the errors, giving rise to a grouped model FGLS or estimator of the averaged population. In it you can specify if the model presents, by way of example an autoregressive process of order one with the following specification of the error (2), where the model error presents a significant lag:

$$\mu_{it} = \rho_1 \mu_{it-1} + \varepsilon_{it} \quad (2)$$

The random effects estimator is consistent if this model is appropriate. This model assumes that the time-invariant component of the error can be treated as random and also does not relate to the regressors. It captures both individual effects over time and those between individuals. It presents the following specification containing a weighting and unobserved heterogeneity (3):

$$(y_{it} - \widehat{\theta}_i \bar{y}_i) = (1 - \widehat{\theta}_i)\alpha + (X_{it} - \widehat{\theta}_i \bar{X}_i)' \beta_k + \left\{(1 - \widehat{\theta}_i)\alpha_i + (\varepsilon_{it} - \widehat{\theta}_i \overline{\varepsilon_{it}})\right\} \qquad (3)$$

According to Cameron and Trivedi (2009, p. 256), the component (θ_i)ˆ is estimated consistently as shown in equation (4) It is worth mentioning that if (θ_i)ˆ= 0, then it is a case of grouped regression MCO. While if (θ_i)ˆ= 1, the model implies fixed effects.

$$\theta_i = 1 - \sqrt{\frac{\sigma_\varepsilon^2}{(T_i \sigma_\alpha^2 + \sigma_\varepsilon^2)}} \qquad (4)$$

The fixed effects model (within) eliminates the individual effects not observed through the calculation of means. So, αi is removed from the equation. The model is consistent when appropriate, and inconsistent if the random effect is ideal. Efficient estimators are achieved despite endogeneity with the invariant component at the time of error. The model specification is as follows (5), an estimated intercept is included in the STATA program that expresses the average of the individual effects of αi, and the large means of: $\bar{\bar{y}}$, $\bar{\bar{X}}$, $\bar{\bar{\varepsilon}}$ (6).

$$(y_{it} - \bar{y}_i) = (X_{it} - \bar{X}_i)' \beta_k + (\varepsilon_{it} - \overline{\varepsilon_{it}}) \qquad (5)$$

$$(y_{it} - \bar{y}_i + \bar{\bar{y}}) = \alpha + \left(X_{it} - \bar{X}_i + \bar{\bar{X}}\right)' \beta_k + (\varepsilon_{it} - \overline{\varepsilon_{it}} + \bar{\bar{\varepsilon}}) \qquad (6)$$

Finally, if the fixed effects model is appropriate, one way to treat the endogeneity caused by omitted variables that do not change over time, is by calculating the estimator of the first differences. It provides better estimators than those of fixed effects if the regressors present lags in the first order. Present the following specification (7):

$$(y_{it} - y_{it-1}) = (X_{it} - X_{it-1})' \beta_k + (\varepsilon_{it} - \varepsilon_{it-1}) \qquad (7)$$

3.3. Process for selecting the appropriate estimators in panel data

According to Álvarez, Perdomo, Morales and Urrego (2013, p. 374), the beginning of the process consists in choosing between grouped least squares and fixed or random effects. So we start from the Breusch and Pagan test, which allows us to distinguish whether there are constant effects in the error term, which would imply a residual autocorrelation.

In that sense, an estimate of grouped least squares must be made and the Lagrange multiplier estimator applied to accept or reject the hypothesis. As a null hypothesis, there is no evidence of constant effects on the error, resulting in grouped MCOs presenting better estimators than fixed or random effects models.

If the null hypothesis is rejected in the previous test, it should continue to verify whether the fixed effects model prevails over the random effects model or vice versa. For which the Hausman test is applied, which raises as a null hypothesis the non-existence of endogeneity in the model, resulting in accepting the hypothesis that the estimators for random effects are adequate, otherwise the effect model must be applied fixed. In summary, the test compares the coefficients of both models and analyzes whether the differences are systematic.

Additionally, tests must be carried out to verify if the variables of the model have a unit root (non-stationarity). In addition to verifying the assumptions to obtain the best linear estimators: i) no high correlation between the regressors - not perfect multicollinearity; ii) constant variance of errors –homocedasticity-; iii) no serial correlation and / or autocorrelation in the model. To deal with heterocedasticity and that statistical inference is not prone to error, in STATA it is possible to use robust standard errors or cluster errors.

In addition, there is evidence of one (or several) components that vary between individuals but not in the time present in the error, which implies that there is heterogeneity not observed in the model. Therefore, fixed effects and random effects models prevail over the grouped MCO model. In addition, through the Hausman test it is observed that the appropriate model that provides better estimators is that of Fixed Effects.

However, because the series have a unit root, that is, they are stationary (variance and constant mean over time) in first differences, it is necessary to perform a transformation to avoid spurious regressions (finding false relationships due to trend factors). In that sense, an estimate of fixed effects is made by first differences, subtracting the first lag in time to each observation of the panel and estimating by MCO. So, the model would be defined as follows (8), it should be clarified that the sub-indices of the slopes were maintained, although their values and interpretation are not the same as the base model.

$$pibppl_{il} = \propto + \beta_1 cgpl_{il} + \beta_2 igpl_{il} + \beta_5\, ppil_{il} + \beta_6 inf_{il} + \beta_7 rcel_{il} + \beta_8 pobl_{ij} + \mu_{il} (8)$$

To facilitate nomenclature, in the regressions used in Stata, the first differences are identified by putting the capital letter "D" before each variable, for example: D_LNPPI expresses the first difference of the natural logarithm of the Investment of the GADs per capita. If constant (β_0) is included in the model, it implies that the original model has a temporal tendency as follows (9):

$$\delta t - \delta(t-1) = \delta \qquad (9)$$

When transforming the variables, the interpretation of the estimators changes, so that, for example, the coefficient of D_LNCGPL in the grouped MCO model expresses how much the difference (in two consecutive years) of the CGPL changes (β_1 / 100) when it increases in 1% the difference of the natural logarithms (percentage variation) of the total income of the natural resources with respect to the GDP. That is, it approximates the impact of a percentage variation that has the weight of income towards the variation in units of the CGPL. The application of natural logarithms approximates the results to this type of analysis. For variables that do not have a logarithm, it is considered as a change in the increase in units compared to a change of the same type. This is because in general terms the estimators are explained as follows:

$$\beta_k = \frac{\Delta E\left(\frac{y}{x}\right)}{\Delta \ln (x)} \approx \frac{\Delta E\left(\frac{y}{x}\right)}{\frac{\Delta x}{x}} \quad (10)$$

$$\frac{\beta_k}{100} \approx \frac{\Delta E\left(\frac{y}{x}\right)}{100 * \frac{\Delta x}{x}} \quad (11)$$

If the process of selecting better estimators and analysis of invariant component over time is replicated (see annexes), there is no evidence of constant effects on the model. Therefore, MCO and FGLS prevail over fixed or random effects. Additionally, to check if the estimators are appropriate, it is evident in the Hausman test with a 95% confidence level that random effects prevail in first differences. Giving green light, to the analysis of the estimators obtained by MCO and FGLS.

Table 1: Analysis of classic assumptions of the model and test used.

ASSUMPTION ANALYZED	CONDITION COMPLIANCE	CAUSES OF BREACHING	CONSEQUENCES OF BREACHING	APPLIED TESTS
No perfect multi-collinearity	The model should not present perfect or very high multicollinearity. That is, the model regressors must have a weak correlation.	Some causes are: incorrect specification of the model (overdetermination), shared trend in time series data, among others.	If there is perfect multicollinearity it is not possible to calculate the estimators. The confidence intervals are wider, so there is a tendency to accept zero hypotheses.	Matrix of correlations of the regressors (determinant). Inflation factor of the variance of the regressors.
Homocedasticity	The perturbations or errors of the model must be homocedastic (have the same variance). If this is not the case, the model presents heterocedasticity.	It can be generated by: outliers, asymmetric distribution of one or more return, incorrect functional form, among others.	The model has no minimum variance, so the inference made with the calculated confidence intervals is wrong (t and F tests).	Wald test. Estimation with robust errors or cluster.
Non-autocorrelation	The model should not present disturbances that	Some causes are: inertia between the	The estimators have no minimum variance. The	Test Wooldridge.

	are related to themselves over time.	study variables, specification bias by excluded variables present in the error, incorrect functional form, among others.	problem is similar to that of heterocedasticity, so inference should not be made with the traditional hypothesis tests t and F.	Correlation of errors.
Stationarity	Variables must have a constant mean and variance over time.	Or if not, the series is non-stationary. It can be generated by autoregressive processes of different order in the variable.	Spurious regressions are calculated, with a high R2 and individual significance, but their correlation represents the trend.	Unit root test Levin, Lin and Chu. Pesaran test.
Model specification	Model specification biases should be avoided, either by sub specification or over specification.	If a variable that is relevant to the model is omitted, sub specification is available. While if you include an irrelevant variable to the model you have an over specification.	In the case of sub specification the estimators have no minimum variance and the inference with hypothesis tests is not valid. While if there is a specification in the model the inference of the parameters are less precise.	Analysis of individual and global significance. Ramsey test.

Source: Author

3.4.Model specification

The model is defined as presented in equation [12]. The variable of interest in the model is the Investment of the GADs, to demonstrate the change in the slopes of the variable caused by the application of COOTAD, two dummys have been created and dummy variables have been constructed, described in equation [12].

$$pibppl_{il} = \propto + \beta_1 cgpl_{il} + \beta_2 igpl_{il} + \beta_5\, ppil_{il} + \beta_6 inf_{il} + \beta_7 rcel_{il} + \beta_8 pobl_{ij} + \mu_{il}$$
(12)

$$pibppl_{il} = \propto + \beta_1 cgpl_{il} + \beta_3 igpld1_{il} D1 + \beta_4 igpld2_{il} + \beta_5\, ppil_{il} + \beta_6 inf_{il} + \beta_7 rcel_{il} + \beta_8 pobl_{ij} + \mu_{il} \quad (13)$$

Where:

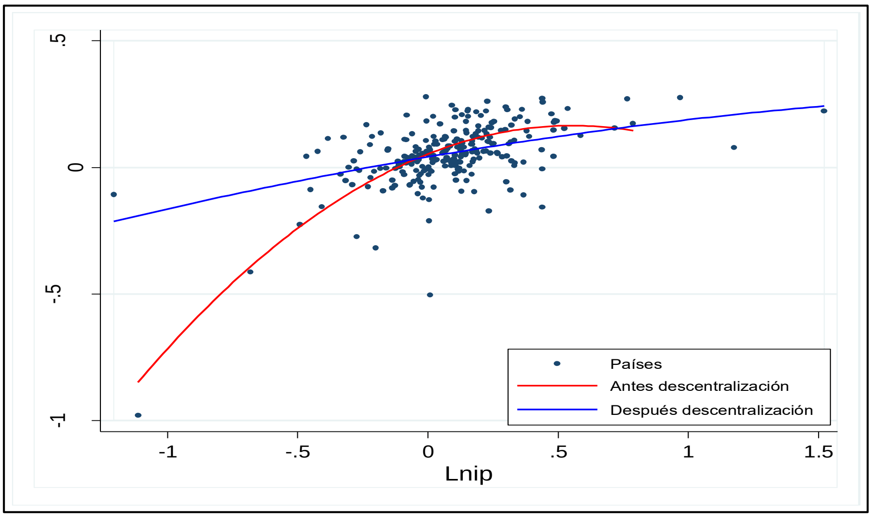
pibppl = First difference of the natural logarithm of the Provincial GDP per capita.
∝ = Trend effect of time in the model ∝_t-∝_ (t-1) = ∝.
cgpl = First difference of the natural logarithm of the Consumption of the GADs per capita.
lnppi = First difference of the natural logarithm of the Investment of the GADs per capita.
lnppid1 = First difference of the natural log of the Investment of the GADs per capita 2010-2018
lnppid2 = First difference of the natural log of the Investment of the GADs per capita 2000-2009
ppil = First difference of the natural log of income poverty.
inf = First difference of the national Inflation.
rcel = First difference of the ratio of National Foreign Trade.
pobl = First difference of the natural logarithm of the provincial Population.

4. Results

4.1. Descriptive Analysis

Figure 1 shows the evolutionary process of GDP growth per capita in Latin American countries, and in many of them, this greatest increase has occurred when public investment increases, that is, as Public Investment per capita increases, the GDP per capita also. This trend improves when the decentralization process occurs. In addition, the positive trend in all countries is shown, as greater fiscal decentralization (or going from non-decentralization to fiscal decentralization), greater public investment per capita generates greater growth per capita.

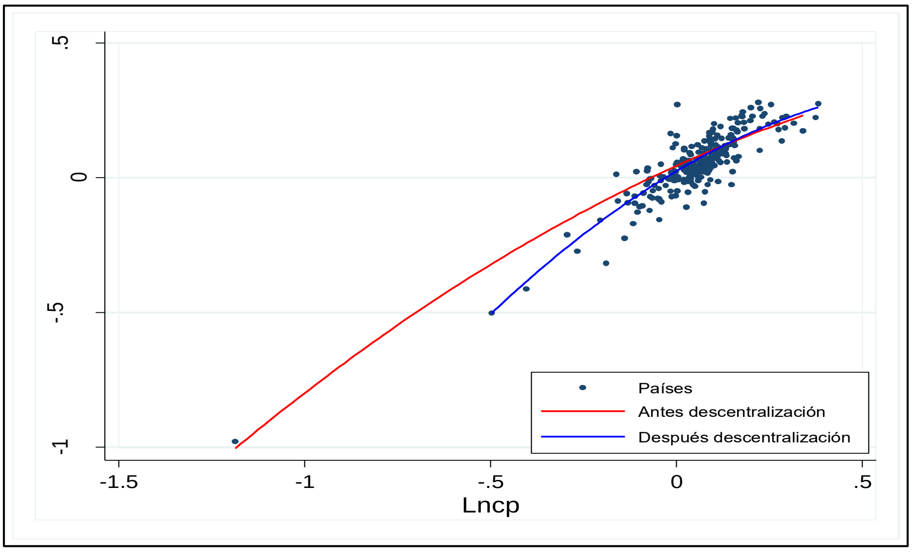
Figure 1: Relationship between GDP per capita and Public Investment, Latin America 2000-2018



Source: World Bank, ECLAC, Central Bank of Ecuador, Ministry of Economy and Finance. Elaboration: Authors.

Thus, Argentina, which begins a process of decentralization in 2010, GDP per capita improves, going from $ 8,357.5 in 2000 to $ 10,428.7 in 2010, reaching 2017 at 14,485.7, although 2018 decreases dramatically to 8,756, 6 dollars. In the same way, per capita investment has the same trend, going from $ 83.6 in 2000 to $ 281.6 in 2010, to reach $ 558.6 in 2014, and ending a decline in 2018 with 277.6 Dollars. This clearly shows that public investment within a decentralization process is a determining factor in the improvement of the GDP of the countries. Also, Figure 2 shows the same trend of decentralization in the relation GDP pc and Public Consumption per capita. In other words, the greater the growth in public consumption per capita, the GDP pc is higher, even more so when a process of fiscal decentralization has occurred.

Figure 2: Relationship between GDP per capita and Public Consumption, Latin America 2000-2018

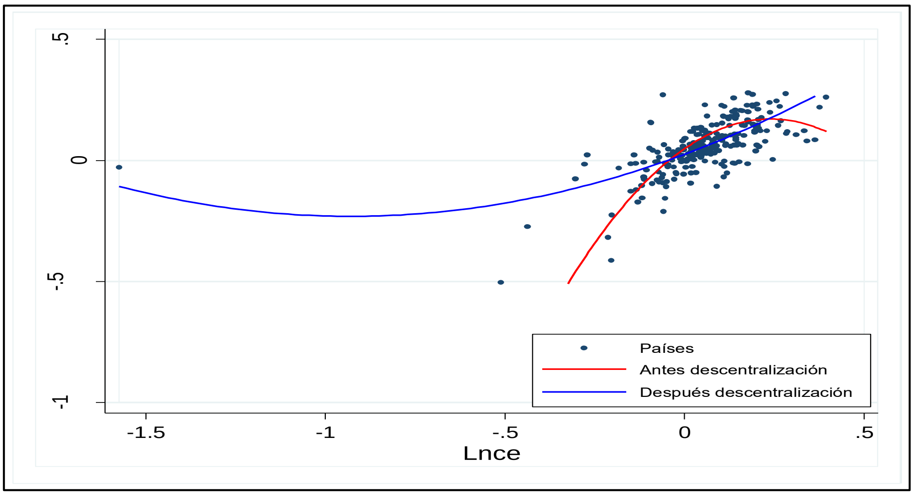


Source: World Bank, ECLAC, Central Bank of Ecuador, Ministry of Economy and Finance. Elaboration: Authors.

In Ecuador, for example, the GDP pc goes from 1,444.6 dollars in 2000 to 4,633.6 in 2010, when the decentralization process begins. This goes hand in hand with the growth of public consumption per capita that goes from $ 202.2 in 2000 to $ 653.3 in 2010. Already in the decentralization process, GDP pc increases to $ 6,344.9 in 2018, in conditions where public consumption per capita increases to $ 968.2 in 2018. The positive trend in figure 2 shows this directly proportional relationship between GDP pc and Public consumption pc, and upon greater decentralization, the trend is better.

Figure 3 also shows a positive relationship between GDP pc and the ratio of foreign trade, in all Latin American countries. This positive trend shows that if exports grow higher than imports, GDP pc will be higher, although this relationship is not directly marked by whether or not it has a decentralization process, this positive relationship of the foreign trade ratio (higher exports over imports) With respect to GDP pc, it is determined because a country with a positive foreign trade ratio does not generate a balance of payments problem, and therefore that country does not need to borrow to cover a trade deficit, but rather, has greater availability to allocate resources towards investment or public spending.

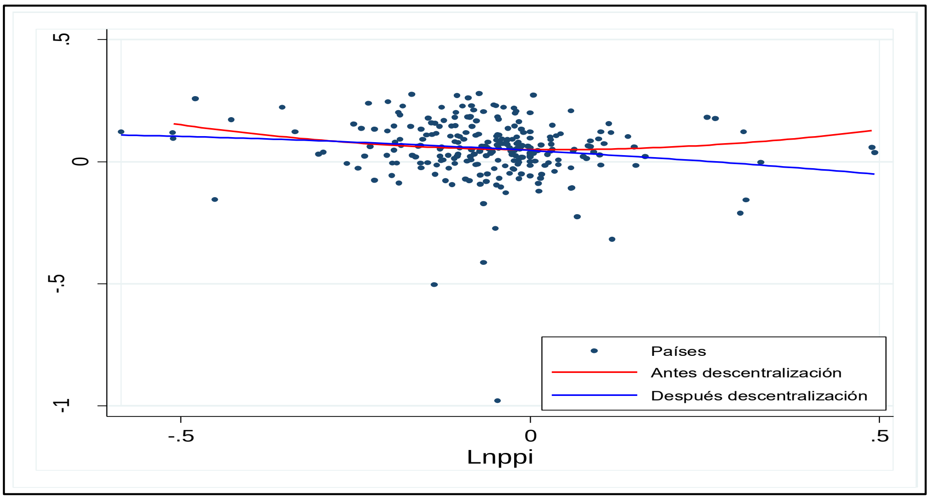
Figure 3: Relationship between GDP per capita and Foreign Trade, Latin America 2000-2018



Source: World Bank, ECLAC, Central Bank of Ecuador, Ministry of Economy and Finance. Elaboration: Authors.

In the Ecuadorian case, without decentralization the GDP pc and the foreign trade ratio are lower, with respect to values per capita in the process of decentralization. Thus, the GDP pc before decentralization is $ 4,231.62 on 2009 (the year before fiscal decentralization) and $ 6,344, 87 in 2018 (8 years after the decentralization process), the same happens with the trade ratio abroad, which went from $ 3,978.59 in 2009 (the year prior to fiscal decentralization) to $ 6,282.4 on 2018 (8 years after the decentralization process). This condition shows that is greater in the process of decentralization, the foreign trade improves, as a result of the increase in consumption and public investment, with a higher GDP pc. This relationship is shown in all countries, in the same way.

Figure 4: Relationship between GDP per capita and Poverty by Income, Latin America 2000-2018

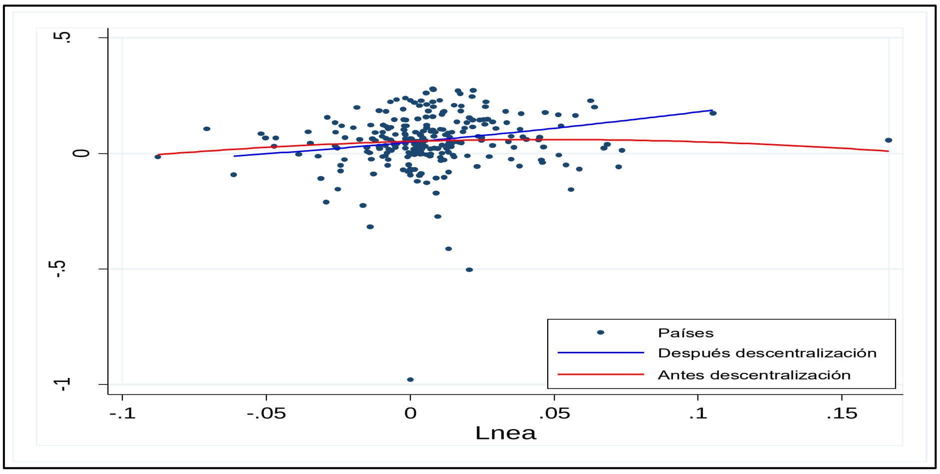


Source: World Bank, ECLAC, Central Bank of Ecuador, Ministry of Economy and Finance. Elaboration: Authors.

Figure 4 shows an inversely proportional relationship between GDP pc and income poverty, determined in the process of fiscal decentralization. In other words, as decentralization becomes greater, GDP pc will be greater and consequently income poverty will decrease. In the Ecuadorian case, income poverty is 64.7% on 2000 and it drops to 32.76% on 2010, before fiscal decentralization. In the process of fiscal decentralization, on 2010, income poverty is decreasing in Ecuador until reaching 21.5% on 2017. In addition, the GDP pc before decentralization is $ 4,231.62 on 2009 (year prior to fiscal decentralization) and from $ 6,344, 87 in 2018 (8 years after the decentralization process), while income poverty decreased by almost 13 percentage points, going from 36% (year prior to fiscal decentralization) to 23% , 2% on 2018 (8 years after the decentralization process), there are other factors that allow this reduction, those factors are mainly due to public investment. In other words, this inverse relationship between GDP pc and income poverty is actually marked by greater investment by the central government, in social areas.

Figure 5 shows a growing trend after decentralization in the relationship between GDP pc and adequate employment, in all Latin American countries. In other words, a greater process of fiscal decentralization accompanied by greater investment and public consumption per capita generates more adequate employment. Although there is a slight decrease on 2009 and 2015, possibly due to the impact of the world economic crisis, the Figure clearly shows an improvement in employment in decentralization processes. In the case of Ecuador, a more directly proportional relationship appears, but that does not happen with other countries such as Paraguay, for example. In Ecuador, for 2009, the year before decentralization, the adequate employment rate was 60.7%, while in 2018, 8 years after decentralization, the adequate employment rate increased to 66%.

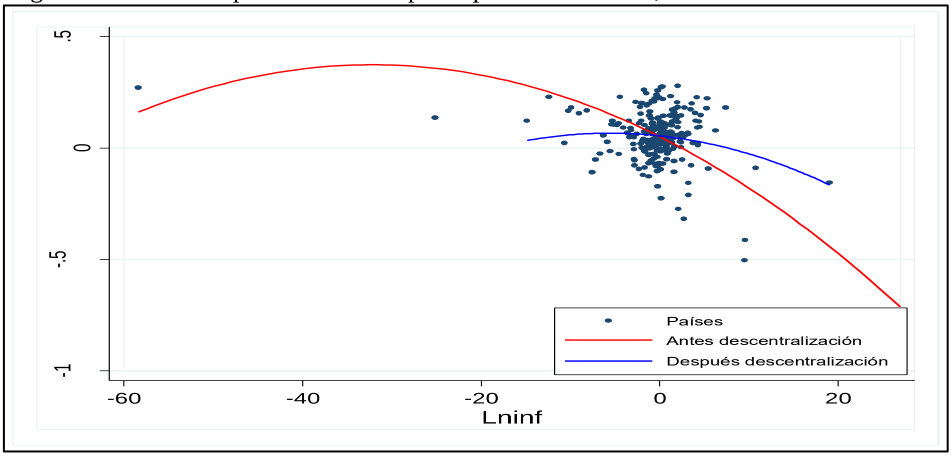
Figure 5: Relationship between GDP per capita and Adequate Employment, Latin America 2000-2018



Source: World Bank, ECLAC, Central Bank of Ecuador, Ministry of Economy and Finance. Elaboration: Authors.

Figure 6 illustrates a more stable inflation relationship in decentralization processes. Furthermore, this better behavior of inflation is accompanied by stability in GDP pc, produced because as the fiscal decentralization process manifests itself, public investment pc determines a higher GDP pc. In other words, in processes of greater decentralization, both GDP pc and inflation are more stable than in processes of fiscal non-decentralization.

Figure 6: Relationship between GDP per capita and inflation, Latin America 2000-2018



Source: World Bank, ECLAC, Central Bank of Ecuador, Ministry of Economy and Finance. Elaboration: Authors.

4.2. Empirical evidence

To present the results obtained from the 2000-2018 panel, 8 different models were carried out, with their different corrections for heterogeneity, autocorrelation, heterocedasticity, contemporary correlation; as well as the Ramsey, Wald, Breusch and Pagan, Hausmann, and Wooldridge tests. The models used were as follows:

1. The Pooled OLS model to omit the space and time dimensions of the pooled data and only calculate the usual OLS regression.

2. The model of random effects (Random Effects) that allows us to suppose that each transversal unit has a different intercept, it is assumed that the intercept of the regression is the same for all the transversal units.

3. The Fixed Effects model that does not assume that the differences between states are random, but constant or "fixed" —and therefore we must estimate each intercept.

4. The term fixed effects model (grade 1 autoregressive (AR1) that controls for the dependence of t with respect to t-1, which is performed when there is an autocorrelation problem.

5. The heteroskedasticity correction model (FGLSH), although the Breusch and Pagan Test works, according to Greene (2000), this and other tests are sensitive to the assumption about the normality of the errors; Fortunately, Wald's Modified test for Heteroskedasticity works even when that assumption is violated. For this reason, running this model corrects this problem.

6. The contemporary correlation model (FGLSC) to correct correlation problems when the observations of certain units are correlated with the observations of other units in the same period of time. In other words, we have contemporaneously correlated errors if there are unobservable characteristics of certain units that are related to unobservable characteristics of other units.

7. The autocorrelation correction model (FGLSHA) is used to address the violation of the OLS estimators when the errors of different units are correlated (contemporary correlation), or when the errors within each unit are temporarily correlated (serial correlation), or both.

8. The heteroskedasticity correction model, contemporary correlation and autocorrelation that is used to solve together with Feasible Generalized Least Squares (FGLS) estimators with Corrected Standard Errors for Panel (Panel Corrected Standard Errors or PCSE). Since Beck and Katz (2001) demonstrated that PCSE standard errors are more accurate than FGLS. Since then, many papers in the discipline have used PCSE in their panel estimates.

The results obtained from the econometric panel data model are presented in Table 2 to the first differences in the series of 14 Latin American countries in the period 2000-2018. It is evident that, in all the models, there is a positive and significant impact of investment and public consumption towards GDP per capita. According to decentralization, there are two effects: public investment per capita has a greater impact on processes after decentralization, while public consumption per capita generates a greater impact on processes without decentralization.

Table 2: Econometric Model Results, Latin America 2000-2018

Variable	MCO (1)	EA (2)	EF (3)	AR1 (4)	FGLSH (5)	FGLSC (6)	FGLSHA (7)	FGLSCA (8)
lnipsd	.12047475***	.12518566***	.12835083***	.11434156***	.12608589***	.10102858***	.11912324***	.09712954***
lnipcd	.03303982*	.03164152*	.03062708*	.04300891**	.04994615***	.03598811***	.05787951***	.04209329***
lncpsd	.52561969***	.51963683***	.51568029***	.53511478***	.52458437***	.52312235***	.53313259***	.52634599***
lncpcd	.7202313***	.72144066***	.72204181***	.70701805***	.69628216***	.67989077***	.68923933***	.67371089***
lncesd	.291002***	.29478152***	.29781627***	.30117286***	.29757497***	.30619302***	.30634766***	.31451226***
lncecd	.11945474*	.11764838*	.11638794*	.12098985*	.14203499***	.11213607***	.14360335***	.11479884***
infsd	-.00294632***	-.00303338***	-.00309342***	-.00295514***	-.00289161***	-.00361158***	-.00289168***	-.00359133***
infcd	-.0012676	-.00110309	-.00099052	-.00110281	.00011521	-.0016428***	.00032251	-.00147886***
lnppisd	.0083599	.00311514	-.00126755	.01796154	-.01180195	-.00266847	-.00518892	.00364227
lnppicd	-.04253462*	-.03660966	-.03256611	-.05080212*	-.04167019*	-.03826087***	-.0453136*	-.04219796***
lneasd	-.17633366	-.18142996	-.18217191	-.14599634	-.22223492	-.17768257*	-.16453264	-.14576963*
lneacd	.50829436**	.51885813**	.52518621**	.47906542**	.40862625***	.5399689***	.38380472***	.52224707***
_cons	-.00308173	-.00290944	-.00280079	-.00354923	-.00340403	.0011664	-.00392494	.00056687
N	252	252	252	252	252	252	252	252
r2	.85894693		.86455732					
re_o								
r2_b		.65739286	.6475475					
r2_w		.86450567	.86455732					
sigma_u		.01444556	.01292429					
sigma_e		.04859954	.04859954					
rho		.08117753	.06604999					

*Elaboration: Authors. Note: d: * p<.15; ** p <.05; *** p<.01*

In order to present Table 2, the first-order Wooldridge autocorrelation test was previously performed, as well as the regression correlation matrix, and the autocorrelation correction, which presented an adequate fit of the model, as presented in tables 3, 4, 5. It is important to note that even though we have modeled temporal and spatial heterogeneity in our model, the equation may be poorly specified in other respects. Recall that according to the Gauss-Markov assumptions, the OLS estimators are the Best Linear

Bias Estimators (MELI) as long as the errors are independent of each other and are identically distributed with constant variance. Unfortunately, these conditions are often violated in panel data: independence is violated when errors from different units are correlated (contemporary correlation), or when errors within each unit are temporarily correlated (serial correlation), or both. In turn, the "identical" distribution of errors is violated when the variance is not constant (heteroskedasticity). In this section we will address the problem of serial correlation or "autocorrelation"; that is, when errors are not independent with respect to time. In our example, it is highly likely that the level of spending at t is associated with the level of spending at t-1.

There are many ways to diagnose autocorrelation problems. However, each of these tests works under certain assumptions about the nature of the individual effects. Wooldridge developed a very flexible test based on minimum assumptions that can be run on Stata with the xtserial command. The null hypothesis of this test is that there is no autocorrelation; naturally, if it is rejected, we can conclude that it does exist, for this we carry out the autocorrelation test, as Table 5 indicates.

Table 3: Wooldridge test in first differences, Latin America 2000-2018

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
F (1, 13) = 0.000
Prob > F = 0.9838

Elaboration: Authors

The test indicates that we have an autocorrelation problem that needs to be corrected. One way to do this is through a term fixed effects model (ρ) Grade 1 autoregressive (AR1) that controls for the dependence of t with respect to t-1. The AR1 model with fixed effects is specified as: $Y_{it} = v_i + \beta_1 X_{1it} + e_{it}$, where $e_{it} = \rho e_{i,t-1} + \eta_{it}$, that is, errors have a first-degree correlation, ρ.

Table 4: Correlation matrix of the regressors in first differences, Latin America 2000-2018

	Lnipsd	lnipcd	lncpsd	lncpcd	lncesd	Lncecd	infsd
Lnipsd	1.000						
Lnipcd	-0.0356	1.000					
Lncpsd	0.6614	-0.0450	1.000				
Lncpcd	-0.0510	0.4162	-0.0645	1.000			
Lncesd	0.4074	-0.0589	0.6070	-0.0844	1.000		
Lncecd	-0.0279	0.2467	-0.0353	0.5237	-0.0462	1.000	
Infsd	-0.4441	0.0228	-0.3867	0.0327	-0.1580	0.0179	1.000
Infcd	0.0002	0.0383	0.0002	-0.1333	0.0003	-0.1383	-0.0001

Lnppisd	-0.0978	0.0585	-0.1454	0.0838	-0.1734	0.0459	0.0688
Lnppicd	0.0454	-0.0763	0.0575	-0.2083	0.0752	-0.1318	-0.0291
Lneasd	0.3420	-0.0535	0.2703	-0.0767	0.2128	-0.0420	-0.0738
Lneacd	-0.0237	0.1028	-0.0300	-0.0535	-0.0392	-0.0700	0.0152

	Infcd	lnppisd	lnppicd	lneasd	lneacd
Infcd	1.000				
Lnppisd	-0.0003	1.000			
Lnppicd	-0.1091	-0.0746	1.000		
Lneasd	0.0002	-0.1606	0.0683	1.000	
Lneacd	0.0956	0.0389	-0.0353	-0.0356	1.000

Elaboration: Authors.

In table 5, correction of the autocorrelation, we can see how investment and public consumption do not present autocorrelations and are significant at 99% with a chi2 probability of 100%.

Table 5: Autocorrelation Correction, Latin America 2000-2018

Cross-section time-series FGLS regression						
Coefficients	generalized least	squares				
Panels:	heteroskedastic					
Correlation:	common AR (1)	coefficient for all panels			(-0.0855)	
Estimated covariences		14		Number of obs =		252
Estimated autocorrelations		1		Number of groups =		14
Estimated coeficients		13		Time periods =		18
				Wald chi2(12) =		1889.24
				Prob >chi2 =		0.0000
Lnpibp	Coef.	Std. Err.	z	P>|z|	[95% Conf.Interval]	
Lnipsd	.1191232	.0245967	4.84	0.000	.0709145	.167332
Lnipcd	.0578795	.0149701	3.87	0.000	.0285386	.0872204
Lncpsd	.5331326	.0452295	11.79	0.000	.4444845	.6217807
Lncpcd	.6892393	.0396902	17.37	0.000	.6114479	.7670307
Lncesd	.3063477	.048948	6.26	0.000	.2104113	.4022841
Lncecd	.1436033	.0249644	5.75	0.000	.0946741	.1925326
Infsd	-.0028917	.000625	-4.63	0.000	-.0041167	-.0016666

Infcd	.0003225	.001233	0.26	0.794	-.0020942	.0027392
Lnppisd	-.0051889	.029533	-0.18	0.861	-.0630726	.0526948
Lnppicd	-.0453136	.0232661	-1.95	0.051	-.0909144	.0002872
Lneasd	-.1645326	.18585	-0.89	0.376	-.528792	.1997268
Lneacd	.3838047	.1318786	2.91	0.004	.1253274	.642282
_cons	-.0039249	.0030826	-1.27	0.203	-.0099668	.0021169

Elaboration: Authors.

Finally, we run the autocorrelation model to find out if the problem was corrected, and the results show us the improvements in pc GDP due to increases in public investment after decentralization with a significance of 1%.

Table 6: Autocorrelation Model, Latin America 2000-2018

Cross-section time-series FGLS regression						
Coefficients generalized least squares						
Panels:	Heteroskedastic					
Correlation:	common AR (1) coefficient for all panels				(-0.0855)	
Estimated covariences		14		Number of obs	=	252
Estimated autocorrelations		1		Number of groups	=	14
Estimated coeficients		13		Time periods	=	18
				Wald chi2(12)	=	1889.24
				Prob >chi2	=	0.0000
Lnpibp	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval]	
Lnipsd	.1191232	.0245967	4.84	0.000	.0709145	.167332
Lnipcd	.0578795	.0149701	3.87	0.000	.0285386	.0872204
Lncpsd	.5331326	.0452295	11.79	0.000	.4444845	.6217807
Lncpcd	.6892393	.0396902	17.37	0.000	.6114479	.7670307
Lncesd	.3063477	.048948	6.26	0.000	.2104113	.4022841
Lncecd	.1436033	.0249644	5.75	0.000	.0946741	.1925326
Infsd	-.0028917	.000625	-4.63	0.000	-.0041167	-.0016666
Infcd	.0003225	.001233	0.26	0.794	-.0020942	.0027392
Lnppisd	-.0051889	.029533	-0.18	0.861	-.0630726	.0526948
Lnppicd	-.0453136	.0232661	-1.95	0.051	-.0909144	.0002872
Lneasd	-.1645326	.18585	-0.89	0.376	-.528792	.1997268
Lneacd	.3838047	.1318786	2.91	0.004	.1253274	.642282
_cons	-.0039249	.0030826	-1.27	0.203	-.0099668	.0021169

Elaboration: Authors

Table 7 describes the tests applied to select the most appropriate estimators. The null hypothesis (Ho) that the model does not present omitted variables with the Ramsey Test is accepted. The null hypothesis (Ho) is accepted that the model does not present problems of heteroscedasticity with the Wald test. The model does not present first order autocorrelation, the Wooldridge Test is accepted because there is no autocorrelation. With the Breusch and Pagan Test, OLS estimators prevail over fixed effects (EF) or Random Effects (EA). And with the Hausman test the fixed effect estimators (EF) prevail. These tests show that the model is properly adjusted.

Table 7: Tests applied to the model in first differences Latin America, 2000-2018

Test	Null Hypothesis (Ho)	Prob>" Estadíst ics"	Result
Test Ramsey	Model does not present omitted variables	0.0176	Ho accepted with significance of 1%
Test de Wald	Sigma (i) ^ 2 = Sigma ^ 2 for all i, there is constant variance	0.0000	Constant variance Ho is rejected and we accept Ha for heteroskedasticity
Test Wooldridge	No first order autocorrelation	0.9838	Ho is accepted with a significance of 1%.
Test Breusch y Pagan	Non-observable component that generates heteroscedasticity. Var(u)=0	0.3393	Ho is accepted. MCO model prevails before EF or EA.
Test Hausman	Non-systematic difference in the coefficients	0.2592	Ho prevails EF model over EA.

Elaboration: Authors.

Table 8 presents the interpretation of the regressor coefficients for the pooled OLS model. To summarize, a positive effect of decentralization is observed, measured by government consumption per capita, going from an effect of 0.58% to 0.71%. Additionally, it is observed how other control variables used in the model negatively affect GDP per capita, such as inflation and income poverty (significant at 20%). For their part, foreign trade and adequate employment positively affect GDP per capita. The rest of the model results are presented in annexes.

Table 8: Interpretation of grouped model OLS betas Latin America, 2000-2018.

Variable	Nomenclature B	Significative:	Value B	Interpretation
Lnipsd	β_1	1%	0. 1204748	Faced with a 1% increase in lnipsd differences, on average lnpibp differences are expected to increase by 0.12%.
Lnipcd	β_2	14%	0. 0330398	Faced with a 1% increase in lnipcd differences, it is expected that on average lnpibp differences will increase by 0.03%.

Variable	Nomenclature B	Significative:	Value B	Interpretation
Lncpsd	β_3	1%	0. 5256197	Faced with a 1% increase in lncpsd differences, on average lnpibp differences are expected to increase by 0.52%.
Lncpcd	β_4	1%	0. 7202313	Faced with an increase of 1% in the differences in lance, it is expected that on average the differences in lnpibp will increase by 0.29%.
Lncesd	β_5	1%	0. 291002	Faced with an increase of 1% in the differences in lance, it is expected that on average the differences in lnpibp will increase by 0.11%
Lncecd	β_6	13%	0.1194547	Faced with a unit increase in the differences in inf it is expected that on average the differences in pibpl will decrease by 0.002%.
Infsd	β_7	1%	-0. 0029463	Faced with a unit increase in the differences in inf it is expected that on average the differences in pibpl will decrease by 0.001%.
Infcd	β_8	53%	-0. 0012676	Faced with a unit increase in the differences in inf it is expected that on average the differences in pibpl will decrease by 0.001%.
Lnppisd	β_9	76%	0.0083599	Faced with a 1% increase in lnppi differences, it is expected that on average lnpibp differences will increase by 0.01%.
Lnppicd	β_{10}	12%	-0. 0425346	Faced with a 1% increase in lnppi differences, it is expected that on average lnpibp differences will decrease by 0.04%.
Lneasd	β_{11}	69%	-0. 1763337	Faced with a 1% increase in line differences, it is expected that on average the lnpibp differences will decrease by 0.17%.
Lneacd	β_{12}	2%	0. 5082944	Faced with a 1% increase in line differences, it is expected that on average the lnpibp differences will increase by 0.50%.

Source: Authors

Table 9 shows how the unit root test shows the correction and adjustment of the model with a significance level of 100%.

Table 9: Unit Roots Test Latin America, 2000-2018

Test de raíces unitarias: Levin-Lin-Chu unit-root			
		Statistic	p-value
Lnip	Unadjusted t	-12.1526	

	Adjusted t*	-6.0960	0.0000
Lncp	Unadjusted t	-10.6973	
	Adjusted t*	-4.4153	0.0000
Lnce	Unadjusted t	-11.1249	
	Adjusted t*	-4.4670	0.0000
Inf	Unadjusted t	-20.4291	
	Adjusted t*	-12.9796	0.0000
Lnppi	Unadjusted t	-12.9493	
	Adjusted t*	-6.0184	0.0000
lnea	Unadjusted t	-13.7053	
	Adjusted t*	-7.7150	0.0000

Elaboration: Authors.

4.3. Structural change test:

To verify if the results presented in the three models correspond to a structural change in the slopes of investment and consumption per capita of the governments, the following chow test or structural change test is applied, described in equation [8].

$$Fexp = \frac{\frac{SCR_R - SCR_{SR}}{q}}{\frac{SCR_{SR}}{n-k}} \qquad (8)$$

Donde:

Fexp= Xperimental stadísticos $Fexp \sim F_{n-k}^{q}$

q = Number of parameters subjected to contrast.

n = Number of observations included in the sample.

k = Number of parameters to estimate of the model under alternative hypothesis.

In such a way that the restricted model is defined as follows [1 and 2]:

$lnpibp_{il} = \propto + \beta_1 lnip_{il} + \beta_2 lncp_{il} + \beta_3 \, lncpcd_{il} + \beta_4 lnce_{il} + \beta_5 inf_{il} + \beta_6 lnppi + \beta_7 lnea_{ij} + \beta_8 lnpob_{ij} +_{ij} \mu_{il}$ (1).

l = 1 al 10 (In the case of Latin America it depends on the decentralization process of each country).

$lnpibp_{il} = \propto + \beta_1 lnip_{il} + \beta_2 lncp_{il} + \beta_3 \, lncpcd_{il} + \beta_4 lnce_{il} + \beta_5 inf_{il} + \beta_6 lnppi + \beta_7 lnea_{ij} + \beta_8 lnpob_{ij} +_{ij} \mu_{il}$ (2)

l = 11 al 18 (In the case of Latin America it depends on the decentralization process of each country).

Mientras que el modelo sin restricciones se especifica cómo sigue [3 y 4]:

$lnpibp_{il} = \propto + \beta_9 lnip_{il} + \beta_{11} lncp_{il} + \beta_3 \, lncpcd_{il} + \beta_4 lnce_{il} + \beta_5 inf_{il} + \beta_6 lnppi + \beta_7 lnea_{ij} + \beta_8 lnpob_{ij} +_{ij} \mu_{il}$ (3)

l = 1 al 10 (In the case of Latin America it depends on the decentralization process of each country).

$$lnpibp_{il} = \propto + \beta_{10} lnip_{il} + \beta_{12} lncp_{il} + \beta_3\ lncpcd_{il} + \beta_4 lnce_{il} + \beta_5 inf_{il} + \beta_6 lnppi + \beta_7 lnea_{ij} + \beta_8 lnpob_{ij} +_{ij} \mu_{il} \ (4)$$

l = 11 al 18 (In the case of Latin America it depends on the decentralization process of each country).

As can be seen, only the betas of the lnip and lncp variables change. Therefore, the hypotheses for the test are as follows:

Ho: B1 = B1
B2 = B2
(α= α)
(B3 = B3)
(B4 = B4)
(B5= B5)
(B6 = B6)
(B7= B7)
(B8= B8)

HA: B9 ≠B10
B11 ≠B12
(α= α)
(B3 = B3)
(B4 = B4)
(B5= B5)
(B6 = B6)
(B7= B7)
(B8= B8)

The statistical calculations for the model are as follows:

Latin American Model

$$Fexp = \frac{\frac{0.62753685-0.60986794}{2}}{\frac{0.60986794}{252-11}} = 3.49$$

Prob = 0.06

Therefore, for the Latin American model, the null hypothesis that there is no structural change in the slopes of per capita income and consumption of governments is rejected, that is, a partial rupture caused by a structural change after the internal decentralization processes of each country.

5. Conclusion

Fiscal decentralization in the public sector must be understood from two perspectives: income and expenses to include the transfer of authority and management mechanisms from the central level to local governments. However, there are two justifications for the concept of decentralization: a) Economic justification and b) Non-economic justification. The first has to do with the social welfare economy and the institutional economy, while the second justification is decentralization from the grassroots perspective.

The theoretical discussion in economics on fiscal decentralization and growth focuses on the efficiency aspects of a decentralized provision and the financing of public services. While the empirical discussion analyzes fiscal decentralization tied to spending on public investment, governance, taxes, health, inequality, and even economic policy. Furthermore, it should be mentioned that there are theoretical studies of the relationship between fiscal decentralization and economic growth at the country level. There are also regional studies in countries.

The quantification of the impact of fiscal decentralization on macroeconomic behavior, it is economic growth, the size of the public sector, budgetary stability or inflation, has considered the use of the expense ratio indicator (or income) of sub-national governments. or the self-sufficiency ratio of sub-national governments - their own resources over their total resources. Fiscal decentralization - which includes sources of revenue from local governments - has become the main theme in the decentralization process in many developing countries, being crucial to the effectiveness of decentralized institutions, without which local governments cannot achieve the desired development objectives at the local level.

Theoretical interest on the problem of how economic growth can be affected by fiscal decentralization has led to the development of several studies at the international level. All theoretical studies have shown that efficiency is a factor in decentralization that would affect economic growth. Therefore, transfers from the central government to the local government are not always directed to economic growth, with incentives becoming elements that are contrary to the promotion of production, thus, fiscal decentralization would not affect economic growth.

The relationship between fiscal decentralization and economic growth is defined by public policies that promote a more effective local policy than that carried out by the central government, since local officials can control the situations of policy promotion from the supply side and the demand. Empirically, the relationship between fiscal decentralization and economic growth has been analyzed in the context of the Ecuadorian economy based on a time series. For this, the decentralization indicators and explanatory variables proposed by various authors have been used. The research has been quantitative, since a relationship is sought between two variables, fiscal decentralization and economic growth by applying a multiple regression model, ordinary least squares.

The Adequacy of Design has been based on what was stated by Xie et al. (1999) for the United States, Zhang and Zou (2001) for China and India, Pérez and Cantarero (2001) for Spain, Akai and Sakata (2002) for the United States, Feld, Kirchhanner and Schalteger (2005) for Switzerland, Martínez Vásquez et al (2016) for Spain, Lorenzo and Julio (2017) for Colombia, and were used to evaluate the presence of a relationship between fiscal decentralization and economic growth for the Ecuadorian case, based on a linear equation for the period 2000-2018. The instrumentation started from the statement that marks the relationship between fiscal decentralization and economic growth circumscribed in the correction of specification errors, the specification of the growth equation. For this reason, the sensitivity analysis was essential, allowing us to assess the consistency and robustness of the relationship between fiscal decentralization and economic growth, as suggested by Levine (1998). Thus, the important need to incorporate the appropriate control variables to avoid disguised correlations is highlighted.

The methodology proposed by Cameron and Trivedi (2009) and Álvarez, Perdomo, Morales and Urrego (2013), among other authors, was followed to select the most appropriate estimators. Thus, it allowed performing the Breusch and Pagan test where it was identified if there was a component that generates heteroscedasticity in the model. Next, the Hausman test was calculated to select between fixed and random effects. The commands described by Hoechle (2007) were taken into account to deal with heteroscedasticity, autocorrelation, serial correlation, among other problems that the model may present. Finally, several tests were carried out to validate the classic assumptions in the model.

In all models, GDP pc presented a directly proportional relationship with investment and public consumption, and this trend was extended in processes of fiscal decentralization. In any measurement that was made, the effects of decentralization were greater. This evidenced that a greater process of fiscal decentralization generates greater economic growth.

The results obtained from the econometric panel data model applied to the first differences in the period 2000-2018, evidenced that, in all models, there is a positive and significant impact on GDP per capita, generated by public investment, which it becomes steeper after the application of COOTAD, demonstrating the positive benefits of decentralization. The tests applied for the selection of the most appropriate estimators have determined that the null hypothesis that the model did not present omitted variables with the Ramsey Test is accepted. The model presented heteroscedasticity problems, therefore, to have a correct inference, cluster or robust errors were used. With this correction, the model did not present first order autocorrelation, so the Wooldridge Test was accepted. With the Breusch and Pagan Test, the OLS estimators prevailed before EF or EA. This was corroborated with the acceptance of the null hypothesis of the Hausman test.

In the interpretation of the betas for the grouped OLS model, as a summary, the investment of the GAD's after the application of decentralization has allowed its impact on GDP per capita provincial to be stronger, going from 0.018 % to 0.026%. Additionally, it was observed how the control variables used in the model negatively affect GDP, that is, both national poverty, national inflation, population growth, and the foreign trade ratio, decreased the per capita GDP.

Finally, for the decentralization model of Latin America, the null hypothesis that there is no structural change in the slopes of per capita income and consumption of governments was rejected, that is, a partial rupture caused by a structural change after the internal decentralization processes of each country.

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