

Determinants Of GDP Per Capita: A Review Of Disparities In The Caribbean Region And The Andean Triangle 2009 – 2022

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The present research studies the causal relationships between GDP per capita and productive, labor and training variables, for the departments of the continental Caribbean region and the Andean triangle. The descriptive development of the model shows the differences in the fluctuations of per capita income for each of the study units, compared to various elements that are related and condition its evolution. A panel data model is approached through the fixed effects approach, with GDP per capita being the dependent variable and as independent variables the growth of the industrial, agricultural, public administration, financial sectors and the general participation rate. The results show the relevance of the productive sectors and the general participation rate in the first instance, however, it is the productive activity that has the greatest significance.

Keywords: Productive sectors, Caribbean region, GDP per capita, panel data, disparities.

Introduction

Colombia is a country of regions and contrasts, an X-ray of the country shows the particularities of each region, resulting in a tendency of the peripheral regions (Caribbean, Choco, Orinoquia and Amazonia) to focus the productive apparatus mainly on primary sectors such as hydrocarbons and agriculture, for its part, in the center of the country, the Andean region presents a diversified productive structure in sectors such as industry, professional activities, construction, commerce, together with the agricultural sector and hydrocarbons, although to a lesser extent (DANE, 2024).

These differences lead to glimpse social and economic problems, the concentration and diversification of productive activity with greater added value in one region tends to lag behind the other surrounding regions, leading to scenarios of poverty, low level of productivity and competitiveness, limiting in the long term a possible regional convergence (Barro & Sala-i-Martin, 1992), representing not only an inefficient use of productive factors, but also an

inefficient use of productive factors. but also, limiting the country's overall growth, as it is necessary to allocate resources to less developed areas.

The growth trend in the center of the country is a case of special attention, the concentration of economic activity has revealed that the productive sectors have a focus on the Andean triangle, particularly in Bogotá, in addition to this, all productive chain activities have been focused on this region, considerably limiting national growth (Galvis et al, 2007). All this presents an anomaly in terms of production, because the trend shows that countries with proximity to coasts tend to develop all their economic and productive focus in the vicinity of them, given the natural advantages that are presented for international trade and the ease of mobilization of goods (Krugman, 1997), the foregoing also tends to favor the growth of the regions and departments in these coastal zones.

The growth and political development of Colombia has presented since the colony traits of leadership and control by the Andean region, this pattern has been perpetuated since then and it is possible to see it in the political participation that people from this region have in the various cabinets. In this sense, it can be seen that the diversity of positions that have been executed mostly by members of the Andean region, who do not necessarily have an inherited political life, but who are people versed in different areas, but their geographical proximity to the political nuclei allows them to access the political leadership (Meisel, 2012). This behavior has led all political initiatives and financial support to focus on the Andean triangle, without a doubt this has become a catalyst for the disparity in growth and economic contributions of the rest of the regions to the Andean triangle.

All of the above has led to clear disparities in the level of income between regions, the Andean triangle and the capital of the Colombian state, have the highest levels of GDP per capita, showing significant differences with the departments of the Caribbean region, where in the best of cases it doubles them (Bonet & Meisel, 2009), the behavior has been presented historically and is supported not only by factors and productive conditions, but also by labor and technological elements, which have gradually led to the concentration of GDP growth and GDP per capita in specific regions, conditioning the quality of life and generating rigidities in national growth and reduction of disparities (Solow, 1956).

In relation to quality of life, per capita income is of special importance, especially in a country of social contrasts such as Colombia, where the population presents categorizations that show many qualities, in this case 36.6% are identified as poor, 30.7% as vulnerable, 29.9% as middle class and 2.8% are classified as upper class (DANE, 2023); This population division shows a very important aspect at the socioeconomic level, more than 60% of the population has difficulties in satisfying their basic needs, in addition to the above, the highest levels of presence of the population classified as poor is concentrated in the regional peripheries of the country, generating a process of greater backwardness.

The relevance of the study of GDP per capita makes it necessary to carry out research that allows analyzing how its evolution has been and the possible determinants that condition its behavior, based on methodologies that allow capturing unobserved differences between departments, the objective of the research is to approach the factors that condition the behavior of GDP per capita through the understanding of causal relationships in the productive field, work and social of each of the study units.

The theoretical component of the research work addresses various references, which propose factors or varied elements that tend to condition the behavior of the GDP, although in practice it is not possible to contemplate all the factors, the elements that contain the greatest significance for the units of study will be modeled and established. The framework of studies carried out reveals the heterogeneity in the determinants of GDP per capita, this is due to the differences in the places of study and conjunctural factors to which they are linked.

The research development of the determinants is aligned with the theoretical approaches of Solow (1956) and Barro (1991), which state that improvements at the level of professionalization and human capital tend to promote the conditions to achieve higher levels of economic growth, as well as elements such as purchasing power in the face of the cost of living generate mismatches between the supply and demand of goods and services. The implementation of the proposed approaches seeks to identify key elements for GDP per capita growth, without the need to reach spaces for comparison between models or express which is more useful than another.

Within the empirical component of the research, the behavior of GDP per capita for the departments of the continental Caribbean region and the Andean triangle is studied, with the study units being the departments of Atlántico, Bolívar, Magdalena, La Guajira, Córdoba, Sucre and Cesar for the Caribbean region, while the departments of Cundinamarca, Antioquia and Valle del Cauca for the Andean triangle. The research support information is obtained from the components of the labor market and departmental national accounts of the National Administrative Departments of Statistics (DANE), for the years 2009 – 2022.

The research work is structured as follows: the first section addresses the productive structure of the departments under study for the period 2009 – 2022; the second section shows the behavior of the labor market; in the third section it addresses a review of higher education; in the fourth section, a panel data model is addressed to analyze the causal relationships that determine the disparities in GDP per capita, finally the fifth section presents the conclusions of the study.

1 Structure and participation of the productive sectors in the Caribbean region and the Andean triangle, 2009 – 2022

The diversification and participation of the productive sectors in the economy of Colombia has been a topic of continuous discussion, especially since the opening of the economy in the 1990s, regarding this, there were changes in the participation that productive sectors contributed significantly to the economy of the country as is the case of the industrial sector, where a good part of its participation was reduced, this due to the participation of the service sector, which absorbed to a large extent of the jobs generated by other sectors (Carranza & Moreno, 2013), in this way, new economic sectors began to take a greater share in the contribution of GDP, however, the opening also gave way to the intensification of other sectors, in the case of the Caribbean region, the mining and quarrying sector saw vertiginous growth.

The participation of the mining and quarrying sector in Colombia has generated a large part of the income to the country's national accounts, also in the Caribbean region, the departments of Cesar and La Guajira have presented the highest levels of participation in this sector, however, this does not coincide with a positive relationship of GDP per capita. in the departments and much less in the region (Benavides et al, 2015), on the contrary, there have been lags in other productive areas that historically captured other regional productive factors, such as agriculture and livestock. This has led to problems such as the imbalance in the labor market by not being able to capture all the labor force in the mining sector, which became the labor objective of the majority of the population, all of the above, leads to the inability to obtain a basic basket of food as an effect of the increase in the CPI.

On the other hand, the abundance of natural resources or, in other words, the existence of factors that promote the development of the primary sector, is not necessarily a trigger for growth in GDP per capita, cases such as Canada, Finland and others, have reported benefits in economic growth, however, in southern African countries, have not benefited from this behavior (Sánchez, 2011), this disparity in GDP per capita is due to two factors, firstly, constitutional and governmental stability, and secondly, the development of an industrial sector that generates a productive value chain, leading to improvements in the level of income.

The evidence for the cases of the departments of the Caribbean region and the Andean triangle is shown in Graph 1, where the GDP per capita, in this case, the Andean triangle, shows a level of income that turns out to be double that of the departments of Atlántico and Bolívar, which are the ones with the highest economic growth in the region. but it is three times greater than the rest of the departments, this reveals approximations relationships not only between the intensity of a productive sector, but also the diversification of these in their relationship with GDP per capita.

Graphic 1.
GDP per capita growth by region



Source: Own based on DANE data

In contrast to the above, the breakdown of departmental productive activity (Annex 1) shows the distinction of three groups in the Caribbean region according to their productive apparatus, the first group is made up of the departments of Atlántico, Bolívar and Magdalena, where the participation of two relevant productive sectors, commerce and industry, is observed. which tend to promote labor improvements and increases in per capita income due to the formality of work, for its part Magdalena replaces the industrial sector with the agricultural sector, in this group the participation of the public administration sector (represents the departmental payroll) is also noticeable, which competes in participation with the initial sectors.

The second group is made up of the departments of Cesar and La Guajira, this group is characterized by a predominance of the primary sector, in this case mining and quarrying, leaving aside sectors such as agriculture, which represents a historical activity in these departments lagging behind, centralizing, together with this sector, is the public administration sector that participates to a large extent, this is configured as a bureaucratic expense, the productive structure leads to establish the presence of Dutch disease in these departments, in this case there is evidence of a continuous increase in mining activity that contrasts with the increasingly lower participation of the industrial sector (Vallejo, 2014), configuring a panorama of inefficiency in the use of productive factors.

Finally, the third group is made up of the departments of Sucre and Córdoba, in this case, a total predominance of the public administration sector is observed over the others, the situation is worrying because there is no significant participation of the primary sectors, the condition in which bureaucratic spending has a high participation distorts the labor market, Because the State participates in the role corresponding to the private sector in terms of labor recruitment, this leads to the conclusion that there are no minimum conditions for the

development of productive sectors, even on a small scale. The problem of bureaucratic spending lies in the effects on the labor market, where the growth of informality is favored, preventing improvements in the quality of life due to incomes below the minimum wage (García, 2008).

2 Characterization of the labor market

The Colombian labor market has presented relevant dynamics throughout its history, in part, some conditioned by market expectations and conditions, others by the possibility of finding a space to exercise the chosen profession and others by the remuneration received in the spatial location of the company or organization where one works. The income levels present great differences, from the economic opening four strategic regions for productive development were consolidated, Bogotá, Cali, Medellín and Barranquilla, this was due to the progress presented so far in the industrial sector of the first three, for its part Barranquilla entered the group due to its port capacity (Galvis & Meisel, 2000). Although exponential growth was expected in these municipalities, the behavior was only evident in what is now known as the Andean triangle (Bogotá, Medellín and Cali), leading to a behavior of labor and human capital lag in the rest of the regions.

Table 1 reveals how the behavior has been for GDP per capita in 2005 and 2023, it is shown for 2005, Bogotá is seen at the head, followed by the departments of the Andean triangle, in distant places are Cesar and La Guajira also participating with mines and quarries, followed lately by Atlántico and Bolívar, finally, the departments of Magdalena, Córdoba and Sucre occupy the last places in the income level.

On the other hand, in the 2023 review, the Andean triangle continues to be the region that maintains the highest income levels, followed this time, but by a long way, by the departments of Atlántico and Bolívar, while Cesar maintains its position, and being at the bottom of income levels the department of La Guajira enters the list. The differences in per capita income are even more pronounced when looking at the national total, bringing four of the departments of the Caribbean region to the bottom of the rankings (Annex 2).

Board 1.
Departmental GDP per capita comparison 2005-2023

Department	2005	Department	2023
Bogota	13.385.931	Bogota	49.730.969
Cundinamarca	10.268.544	Santander	42.893.136
Santander	9.951.651	San Andrés and Prov.	36.188.950
Antioquia	9.340.469	Antioquia	33.738.353
San Andrés and Prov.	7.876.466	Boyacá	32.177.791
Boyacá	7.211.579	Cundinamarca	28.847.163
Cease	6.810.781	Risaralda	26.939.277
La Guajira	6.503.249	Bolívar	25.197.612

Huila	6.451.275	Atlantic	25.039.898
Atlantic	6.388.791	Caldas	24.943.015
Risaralda	6.277.539	Tolima	24.308.336
Bolívar	6.205.737	Cease	23.932.464
Caldas	6.036.872	Quindío	23.365.783
Tolima	5.905.371	Huila	22.376.653
Quindío	5.378.939	La Guajira	18.870.184
Cupcake	3.938.108	Norte de Santander	14.714.945
Norte de Santander	3.928.796	Córdoba	14.614.790
Córdoba	3.912.903	Cupcake	14.564.364
Sucre	3.045.612	Sucre	12.642.903

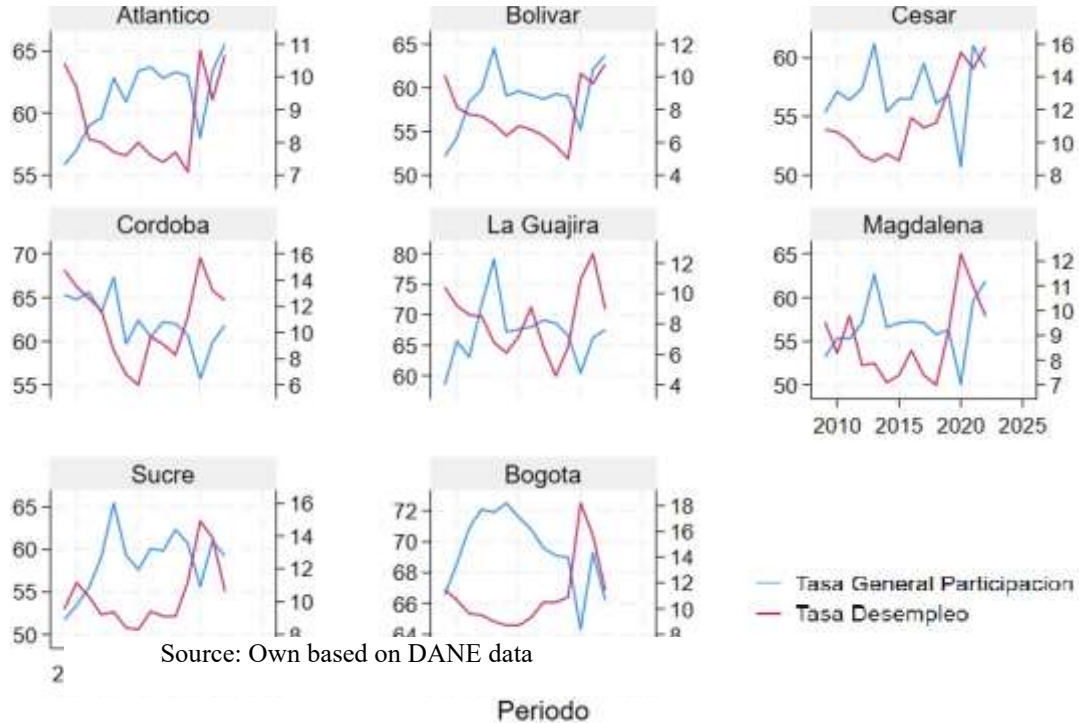
Source: Own based on DANE data

This behavior has led to certain conditions in the labor market, one of which is the flight of human capital, Cepeda (2023) conducted a study where postgraduate professional level students were asked what were the conditions for which they changed cities and what would be the main destination for mobilization, mostly professionals and some with postgraduate degrees responded that the reason for moving was a higher salary, on the other hand, a low percentage of professionals with express postgraduate degrees who were mobilized by the need to be in a place with greater job opportunities and with a better salary according to their profession and not dedicating themselves to something completely different from their profile. According to the above, departments with conditions with a poorly developed and diversified productive apparatus are not attractive for those who invest in training and therefore improving human capital, which leads to brain drain and, therefore, lower levels of productivity.

The disparities in opportunities and work spaces together with the poorly diversified productive sectors, have led to increases in the unemployment rate, due to the fact that to a certain extent, there are no trained professionals for the new productive markets, thus generating a spiral of mismatches between labor supply and demand, the results of this condition are observed in graph 2, where Bogota presents an inverse behavior between the general participation rate and the unemployment rate, resulting in a higher rate of labor absorption of the population than in the other departments, which shows that even the flight of talent and human capital from the Caribbean region is captured by the labor market in Bogota, a similar case is presented by the departments of Atlántico and Bolívar, which have developed industrial sectors capable of absorbing the labor supply, while the departments of

Cesar, Córdoba, La Guajira and Magdalena present increases in participation rates along with increases in the unemployment rate, adapting both to the conditions of the productive structure and the impossibility of attracting labor force. finally, Sucre presents an inverse relationship, which may be due to a large informal market that is assumed by the population as formal employment at the time of the survey.

Graphic 2.
Overall participation rate and unemployment rate by region



3 Higher education and per capita income

Personal development and growth has become an objective of the general population, during the industrial revolution it was common to apply the term proletarian to the worker with certain skills that allowed him to perform basic tasks in mines, industries, the countryside and other sectors; currently, technological progress, greater productive diversification and the need for increasingly specialized skills, has led to the condition of university or postgraduate professional, which is increasingly needed in the labor market (Granovsky & Pérez, 2021), so training is necessary not only for work, but also as a means to improve and optimize processes. reinforcing the technological apparatus.

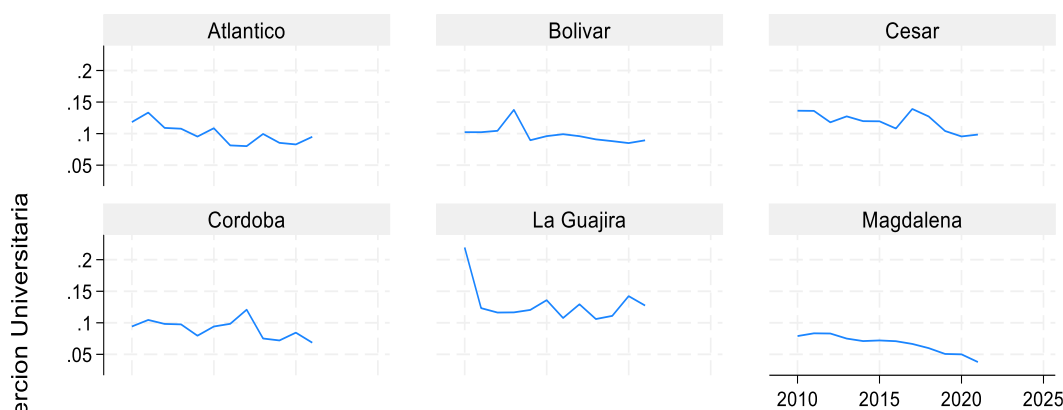
In this sense, higher levels of education tend to offer a higher income margin, in this regard, Ramos et al (2016) addressed a research in which the level of academic training was related to the income received by the population, taking as a reference group the population without any type of training, the results showed that the population with completed primary education earns 14.4% than the reference group, the group with basic and secondary

education earns 74.5% more and finally the population with vocational training or higher earns an average of 108.1% more. The results show an important element, the preparation or professional training will seek to a certain extent to achieve higher levels of income that compensate for the investment made.

Although higher education institutions tend to offer programs in accordance with the needs of the departmental and regional labor market, the conditions are not always conducive to finding spaces to practice, for this reason it is always necessary to update academic programs to the new labor dynamics and maintain a synergy that enriches the productive sector through the human capital from universities (Mungaray, 2001). The productive scenario of the departments of the Caribbean region presents serious rigidities to diversification, as well as a productive bias to the primary sectors, this has conditioned the space for there to be a mismatch between vocational training and insertion in the labor market, so that many students choose to drop out of higher education. seeking refuge in technical or technological areas that are more accepted in the workplace.

Graph 3 shows that for most departments of the Caribbean region there are high dropout rates, with only the department of Magdalena having relatively low dropout levels, next to it, Bogotá shows lower results, although there are factors that determine school dropout, it is clear that there are stimuli that lead the population to complete a professional cycle. such as the stability of the labor market and the possibility of obtaining salaries in line with their expectations.

Graphic 3.
College dropout rate



Source: Own based on data from the SNIES

4 Determinants of GDP per capita in the Caribbean region and the Andean triangle: implementation of panel data

Graph 1 shows certain characteristics related to the per capita CIP in relation to each of the study units, the departments in which higher levels of growth and economic diversification are observed present positive relationships with respect to per capita income, industrial growth tends to put pressure on planned and unplanned urban growth, this being the result of migratory flows due to the advantages and labor facilities offered by certain departments (Mertins, 2007), likewise, not only economic growth and diversification are elements that promote the growth of GDP per capita, it is necessary to generate productive chain processes that connect the primary sectors with industry and even with transport, thus generating greater added value, which is reflected in advantages that differentiate per capita income between regions (Mejía, 2015). Although the above are relevant factors, there are other significant elements that impact the differences in GDP per capita, especially in the framework of the heterogeneities of the study units.

In order to capture the determinants in GDP per capita, it is proposed to analyze based on variables that represent three elements of economic growth, the first being the productive sectors with the greatest participation in the study units, the second elements of the labor market, and finally, academic factors.

For the implementation of the panel data methodology, ten study units are taken made up of the departments of the Caribbean region and the Andean triangle ($i=10$), the temporality is between the period 2009 to 2022 ($t=14$). The GDP per capita variable takes the definition proposed by DANE where it is expressed as the variation of real GDP per person based on chained series of 2015. The determining factors are the variables that represent the growth of the industrial, agricultural, public administration, trade and mining sectors; to capture the situation of the labor market, the unemployment rate is used, finally, to measure the social factor and cost of living, the variation of the CPI is taken. To this end, two models relevant to each region are addressed:

The model to be developed is the following for the Caribbean region is:

$$pibp_{it} = \beta_0 + \beta_1 agropec_{it} + \beta_3 indust_{it} + \beta_4 admonp_{it} + \beta_5 minas_{it} + \beta_6 var_ipc_{it} + \beta_7 desem_{it} + \beta_8 comercio_{it} + e_{it}$$

$$i = 1,2, \dots, 7$$

$$t = 1,2, \dots, 14$$

For its part, the model for the Andean triangle is:

$$pibp_{it} = \beta_0 + \beta_1 agropec_{it} + \beta_3 indust_{it} + \beta_4 admonp_{it} + \beta_5 minas_{it} + \beta_6 var_ipc_{it} + \beta_7 desem_{it} + \beta_8 comercio_{it} + \beta_9 construccion_{it} + \beta_{10} energia_{it} + \beta_8 inmobiliarias_{it} + e_{it}$$

$$i = 1,2, \dots, 3$$

$$t = 1,2, \dots, 14$$

Regarding the model, it is expected that there will be a positive relationship of GDP per capita with the agricultural and industry variables, this hypothesis is due to the capacity of the industrial sector to offer to attract more labor to the extent that its participation increases, resulting in higher levels of income, likewise, compared to the agricultural sector it is expected that to the extent that there is a growth of this, hand in hand with an industrial sector, productive chains are generated that should promote greater growth.

A second hypothesis leads to establish that the relationship between public administration and GDP per capita must be inverse, this because this productive sector represents an expense for the state, which can generate rigidities in the labor market compared to the private sector, therefore, lower incomes tend to persist.

Finally, for the unemployment rate, an inverse relationship is expected, especially for the study units with higher levels of industrialization.

The reason for implementing panel or longitudinal data models is the possibility of capturing elements that are not observable between the study units (Wooldridge, 2010; Stock & Watson, 2012), own elements such as idiosyncrasies, labor productivity, geographical factors, among others, heterogeneities are captured are perceived by fixed effects, where the constant () represents the baseline of differences and the perturbations are captured by the error ($\beta_0 e_{it}$).

Two models are made, the first under the fixed-effect approach, which assumes that the unobserved heterogeneities are relevant because there is evidence of correlation between these heterogeneities and the variables, so these must be taken into account and not be contained in the term error, on the other hand, the random-effects model. which is based on the assumption that there is no evidence of correlation between the unobserved heterogeneities and the variables (Rosales et al, 2010). The results express statistical significance under the

fixed-effect and random-effects approaches for all variables. The results are shown in Table 1:

Picture 1: GDP per capita dashboard data model

	Caribbean Region		Andean Triangle	
	Fixed Effects	Random Effects	Fixed Effects	Random Effects
Mines	645.97**(329.68)	1528.263*(185.68)	1622.43(548.53)	- 6878.82(1730.77)
Construct ion	1308.97*(437.85)	1035.82**(459.20)	552.79(127.37)	- 550.02*** (477.18)
admin	3186.11*(278.03)	2435.13*(270.75)	- 584.01*** (695.47)	3457.1*** (1432.94)
desem	208296*(80368.32)	218849.6*(88183.11)	263735.5(51498.03)	441766.9(170233.7)
var_ipc	339323.4*(45584.41)	422644*(49405.39)	450547.6(49966.41)	971703(130569.5)
industry	- 128.83*** (624.77)	- 80.14*** (221.52)	527.86(198.76)	81.44*** (817.69)
Agropec	3129.72*** (2523.32)	- 2607.79*** (486.78)	292.15*** (377.67)	4319.43*** (521.22)
commerc e	635.60*** (934.32)	673.91*** (349.88)	114.47*** (225.05)	1266.95*** (859.89)
Energy	-----	-----	2896.84(857.05)	- 1447.02*** (1463.08)
Financial	-----	-----	- 2347.78(410.84)	4740.07(752.93)
Real estate	-----	-----	3543.19(264.28)	- 1678.24(287.91)
Joint testing	F(5, 86) = 96.26 Prob > F = 0.0000	Wald chi2(5) = 403.93 Prob > chi2 = 0.0000	F(8, 31) = 504.03 Prob > F = 0.0000	Wald chi2(5) = 156.74 Prob > chi2 = 0.0000
corr(u_1) xb	-0.6059	0 (assumed)	-0.9553	0 (assumed)

Source: Own calculations

* $p > 0.01$; ** $P > 0.05$; *** $P > 0.1$

() standard errors

The results coincide with some of the hypotheses raised, in the first instance in the industrial, energy, mining sectors for the Andean triangle, a positive relationship is observed, in which to the extent that a greater development of these sectors is generated, the increase of GDP per capita is favored, clearly leads to propose that the synergy between primary and secondary sectors, apart from generating added value, it fosters the conditions to require more qualified jobs and therefore with higher per capita income. For the Caribbean region, relevance is not observed in the industrial sector as expected, this is due to the low presence in most departments, on the other hand, relevance is observed in the mining and quarrying sector, representing the weight of its contribution in the region, despite the fact that its participation is limited to two departments.

On the other hand, the public administration sector, which represents state spending, presents a positive relationship contrary to what is expected in the Caribbean region, instead of being seen as a positive result for the CPI per capita, at a general level it presents room for uncertainty in the face of the continued growth of this sector, due to the fact that it enters the labor market occupying to a certain extent the role of the private sector. clearly the result is due to the relevance of state spending in the Caribbean region. On the other hand, in the Andean triangle, their participation is not significant, resulting in a strong and consolidated private sector, together with a public sector that does not participate as a relevant agent in the labor market.

According to the financial sector, the result is also contrary to expectations, observing an inverse relationship, this may be due to two factors that have gained weight in the last five years, the increase in the cost of credit and the increasing conditions to access it, this leads to a condition in which both private investment and for household consumption is depressed.

The construction and real estate activities sector expresses precisely the dynamics resulting from economic activity, the continuous migration to sectors with a higher level of income and job opportunities, these variables not being the cause of the increase in per capita income, but rather, they are the result of the effects on the increases in GDP per capita.

Finally, the unemployment rate and the variation of the CPI express a positive result, as observed, the departments with developed industrial sectors tend to have a higher participation rate together with low unemployment rates, which results in a greater capacity to absorb the available labor force than the departments that do not have diversified productive sectors.

In order to establish whether there is evidence of correlation between the unobserved heterogeneities and the variables under study (), that is, that there are factors specific to each unit of study that are significant to explain their behavior (Greene, 1998), it is necessary to

apply Hausman's test, the results are evaluated with respect to the planning of the hypotheses: $Cov(a_i, x_i) \neq 0$

$$H_0: B_1 = B_2 = B_n ; \text{ No hay diferencia sistematica entre los coeficientes}$$
$$H_1: B_1 = B_2 \neq B_n ; \text{ Hay diferencia sistematica por lo menos en un coeficiente}$$

The results of the test are observed in Table 2, where the null hypothesis is rejected, so there is evidence of correlation between the unobserved heterogeneities and the variables, for which it is necessary to apply fixed effects.

Picture 2:
Test de Hausman

Caribbean Region		Andean Triangle	
chi2(5)	= 26.54	chi2(5)	= 34.54
Prob > chi2 = 0.0001		Prob > chi2 = 0.0000	

Source: Own calculations

The development of the research makes it necessary to validate three common problems in panel data by fixed effects, the cross-skedasticity between the units of study, a problem that poses unequal variances of the errors (Greene, 1998), then, cross-section correlation validation is required, for this and I take into account that a t greater than n is presented, intraunit autocorrelation validates the relationship of errors within each unit of study (Cameron & Trivedi, 2005), finally in order to solve the present problems, the Discroll-Kraay variance estimator (1998) is implemented in the fixed-effect panel and is supported by recommendations from Hoechle (2007).

To validate the presence of heteroskedasticity in cross-section, for this purpose the modified Wald test for fixed effects is applied, the test is based on the assumption of homoskedasticity or egalitarian variance between the errors:

$$H_0: \sigma_{i1}^2 = \sigma_{i2}^2 = \sigma_{in}^2 ; \text{homocedasticidad}$$
$$H_1: \sigma_{i1}^2 = \sigma_{i2}^2 \neq \sigma_{in}^2 ; \text{heterocedasticidad}$$

The results of the test express the rejection of the null hypothesis for the case of the Caribbean region, while for the Andean triangle it is not rejected (Table 3), so we have the presence of heteroskedasticity in cross-section for the Caribbean region, this is due to the fact that there are factors of the cross-sectional component that lead to the presence of unequal variances in the residuals of each study unit.

Picture 3:
Wald's test for cross-section heteroskedasticity

Source: Own calculations

In order to validate the cross-section correlation, the Breusch-Pagan Lagrange Multiplier test is implemented, taking into account that we are in the presence of a long panel ($t > n$) adapted to the needs, this test hypothesizes that there are no problems of transversal dependence in the model, this is due in the case of the departments, to political, environmental, and conjunctural factors, among others, which affect everyone equally, as is the case of COVID-19 and

behaviors generated general results of show the presence of this problem for the Caribbean region, but not for the Andean triangle (Table 4).

Caribbean Region	Andean Triangle
chi2 (7) = 127.91 Prob>chi2 = 0.0000	chi2 (3) = 0.46 Prob>chi2 = 0.9280

Picture 4:
Cross-Section Correlation Test

Source: Own calculations

Finally, for the validation of the intraunit autocorrelation, the Wooldridge test is implemented, which expresses the absence of first-order autocorrelation, based on the hypotheses:

Caribbean Region	Andean Triangle
chi2(21) = 76.362Pr = 0.0000	chi2(3) = 4.292Pr = 0.2316

$$H_0: \text{Cov}(u_{it}, u_{jt}) = 0, \text{ siendo } i \neq j$$
$$H_1: \text{Cov}(u_{it}, u_{jt}) \neq 0, \text{ siendo } i \neq j$$

The results of the test show the presence of a relationship between the errors within the departments for the two regions under study (Table 5).

Picture 5:
Wooldridge test for autocorrelation

Caribbean Region	Andean Triangle
F(1, 6) = 38.035	F(1, 2) = 21.893
Prob > F = 0.0008	Prob > F = 0.0428
Source: Own calculations	

The results of the tests show the presence of the three problems, to solve them the fixed-effect model by estimator of variances Discroll – Kraay is implemented, this method allows to reach parameters robust to heteroskedasticity and solves the correlation in any order, the results of the estimation initially give as non-significant the variable general participation rate (Annex 4), A new regression excluding the variable results in statistical significance at 5% for the model at the general level and at the individual level of the variables. The results of the coefficient signs are consistent with the initial results in the fixed-effects panel data model for both the Caribbean region (Table 6) and the Andean triangle (Table 7).

Picture 6:
Fixed Effects Regression with Driscoll-Kraay Standard Errors Caribbean Region

		F(5, 13) = 282.91				
Number of obs	=	98	Prob > F	=	0.0000	
Number of groups	=	7	within R-squared	=	0.8484	
pibp	Coefficient	std. err.	t	P> t	[95% conf. interval]	
minas	645.9783	543.7397	1.19	0.056	-528.6998	1820.656
constr	1308.974	590.7532	2.22	0.045	32.72895	2585.218
admonp	3186.113	488.7587	6.52	0.000	2130.214	4242.012
desem	208296	122866.9	1.70	0.014	-57141.83	473733.8
var_ipc	339323.4	104336.8	3.25	0.006	113917.5	564729.3
_cons	-4436309	677396.2	-6.55	0.000	-5899735	-2972884

Table 7:
Fixed Effects Regression with Standard Errors Driscoll-Kraay Andean Triangle

		F(8, 13) = 9152.77				
Number of obs	=	42	Prob > F	=	0.0000	
Number of groups	=	3	within R-squared	=	0.9924	
pibp	Coefficient	std. err.	t	P> t	[95% conf. interval]	
minas	1622.439	666.2446	2.44	0.030	183.1049	3061.773
indust	527.8662	161.9496	3.26	0.006	177.9954	877.737
energia	2896.849	524.3898	5.52	0.000	1763.974	4029.725
construccion	552.7963	116.7889	4.73	0.000	300.4893	805.1033
financieras	-2347.781	356.7027	-6.58	0.000	-3118.39	-1577.172
inmobiliarias	3543.193	179.2903	19.76	0.000	3155.86	3930.526
desem	263735.5	39484.03	6.68	0.000	178435.4	349035.5
variacion inc	450547.6	72838.38	6.19	0.000	293189.9	607905.4
Source: Own calculations					37	-2.16e+07

5 Conclusions

The results show that the main determinants of per capita income are mostly the existence of productive sectors capable of generating value chains, potentiating the absorption of workers at any level of qualification, which is in line with what Gómez (2012) proposed, the evidence shows a significant positive relationship between the growth of per capita income in the departments of the Andean triangle, the contrasting results are also observed in the Caribbean region. The departments with the lowest levels of per capita income are Cesar, La Guajira, Sucre and Córdoba, which have a common production pattern, a production bias towards a single sector: the primary, or failing that, a spurious participation of these sectors, with bureaucratic spending being the greatest contributor to departmental economic growth.

The departments of Atlántico, Bolívar and Magdalena, although they present moderate growth in GDP per capita, the behavior of bureaucratic spending persists, the economic dynamics tend to favor regions with access to coasts and ports, due to their capacity to generate greater commercial activity (Krugman, 1997), despite this, full economic growth and increase in the level of income has been rigid in these departments. therefore, it can be understood that the existence of heterogeneities at the economic level and even in terms of public policies that promote a better scenario.

The Andean triangle has the best levels of growth in GDP per capita, economic dynamics have led to the proliferation and growth of a diversity of activities from those belonging to the primary sector, through the added value of the industrial sector, to the development of professional activities and with technological value; it is valid to clarify that this behavior has developed historically, centralizing this behavior in the Andean triangle, confirming Meisel's (2012) hypothesis regarding the centralization of productive activity as a result of the national capital effect.

All of the above allows us to establish why there are disparities in the level of per capita income between the departments of the Caribbean region and the Andean triangle, which highlights a scenario of vital importance, the persistence of this behavior (centralization of productive activity in the center of the country and backwardness in the peripheries). will increasingly lead to a process of divergence that will be expressed in living conditions, the peripheries will see the possibility of reaching a basic food basket, acquiring goods of personal satisfaction increasingly reduced, eventually leading to the drain of qualified human capital or brains proposed by Cepeda (2023), intensifying regional disparities.

On the other hand, the positive relationship between GDP per capita evidence supports the results proposed by Campos & Cubillos (2012) and Zamora & Arteaga (2023), it is observed that as the level of income increases, a positive response is generated in the CPI, clearly greater economic dynamics tend to generate price pressures, however, applying a qualification of good or bad to this increase will be due to a certain extent precisely if economic activity provides the conditions for workers to solve the increase in the consumer price index, therefore, in the framework of greater diversification and intensity of productive activity, the Andean triangle will suffer to a lesser extent than the population of the Caribbean region.

Finally, the fixed-effect panel data model allowed the differences between the study units to be captured, evidencing the efficiency of spatial econometric methods, although elements of the approaches of Barro (1991) and Solow (1956) were taken as a reference, for the case of the regions under study during the periods 2009 – 2022. Barro's postulates were more relevant, this does not mean that Solow's postulates are not valid, but rather, for this sample under these conditions there was not enough evidence of relevance in the elements raised by this author.

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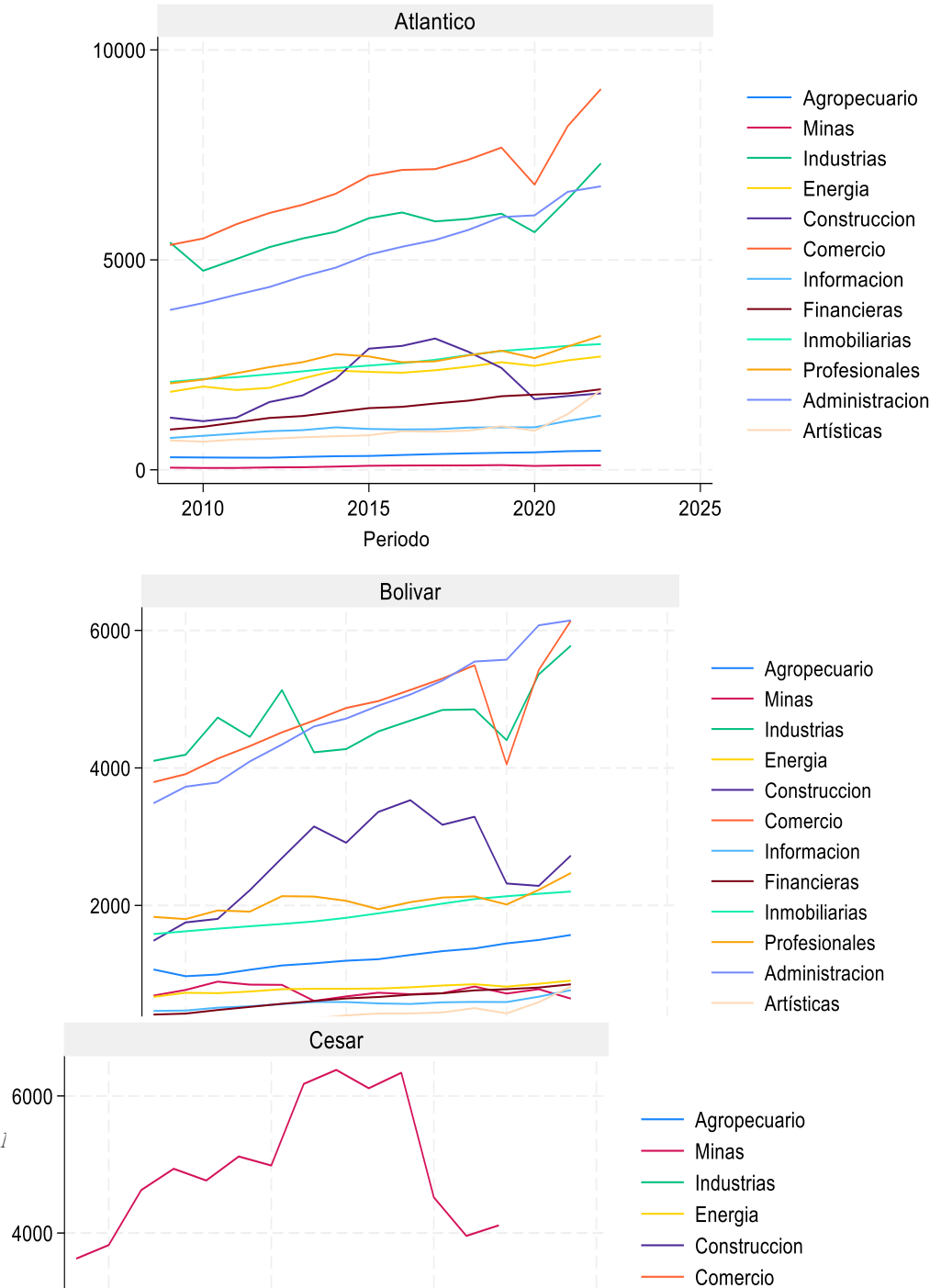
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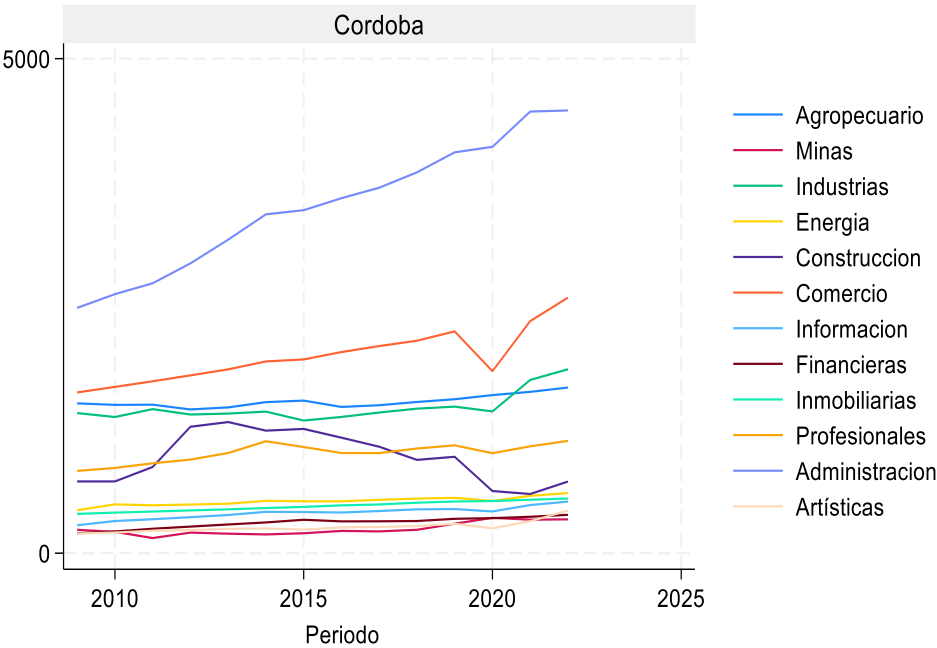
Annexes

Annex 1. Productive activities by departments

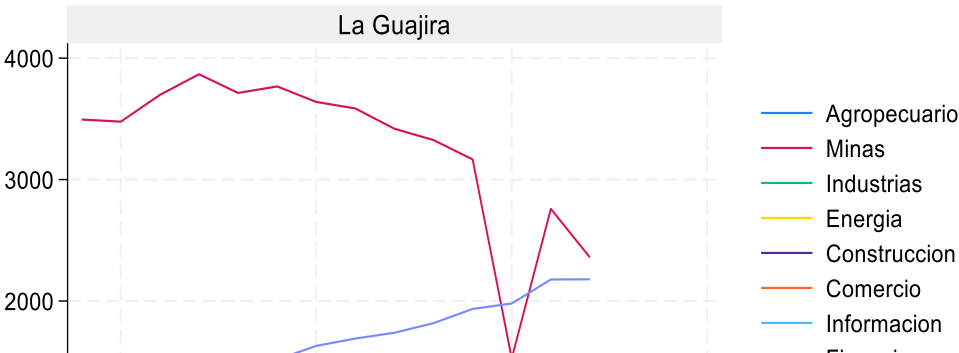
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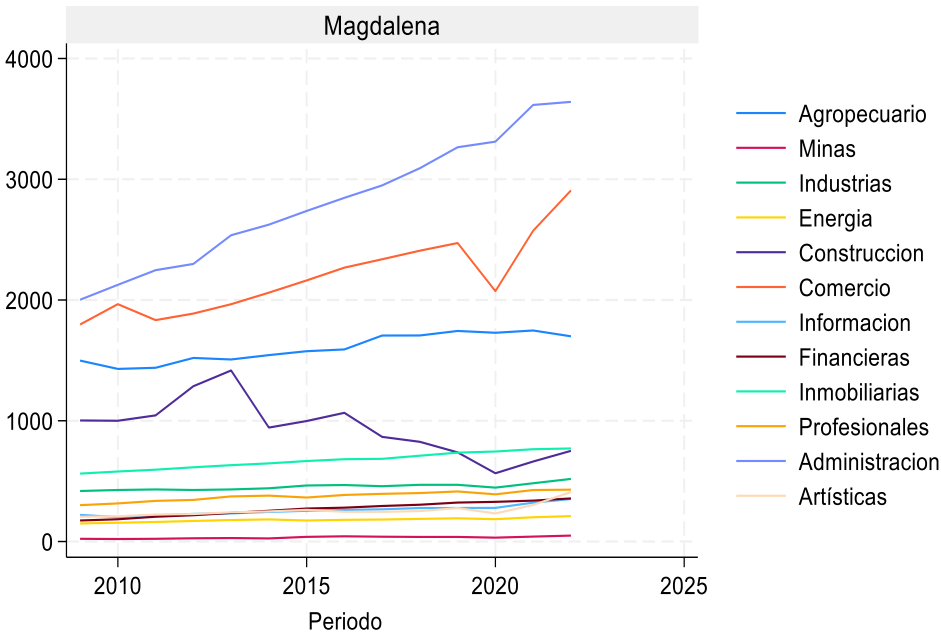
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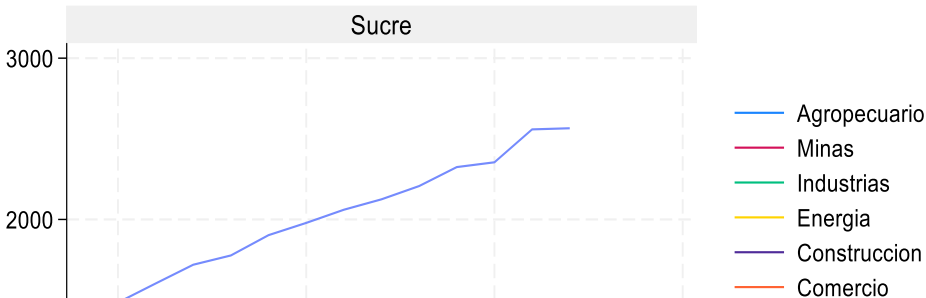
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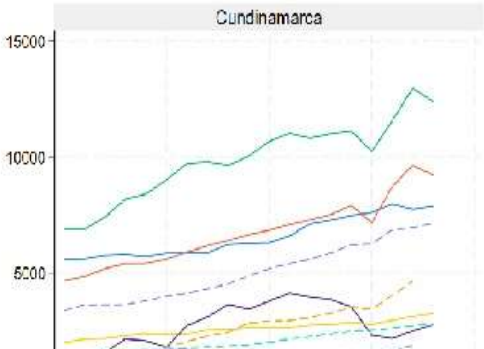
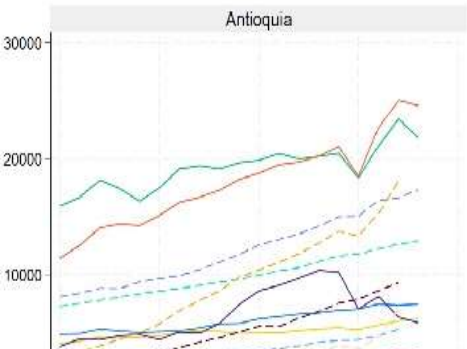
1f.



1g.



1h.



Annex 2. Total departmental GDP per capita

Department	2005		Department	2023
Casanare	24.123.828		Bogota	49.730.969
Arauca	16.097.955		Casanare	48.146.499
Bogota	13.385.931		Goal	47.525.775
Cundinamarca	10.268.544		Santander	42.893.136

Goal	10.016.793		San Andrés and Prov.	36.188.950
Santander	9.951.651		Antioquia	33.738.353
Antioquia	9.340.469		Valle del Cauca	32.875.773
Valle del Cauca	8.233.652		Boyacá	32.177.791
San Andrés and Prov.	7.876.466		Cundinamarca	28.847.163
Boyacá	7.211.579		Arauca	27.403.847
Cease	6.810.781		Risaralda	26.939.277
La Guajira	6.503.249		Bolívar	25.197.612
Huila	6.451.275		Atlantic	25.039.898
Atlantic	6.388.791		Caldas	24.943.015
Risaralda	6.277.539		Tolima	24.308.336
Bolívar	6.205.737		Cease	23.932.464
Caldas	6.036.872		Quindío	23.365.783
Tolima	5.905.371		Huila	22.376.653
Quindío	5.378.939		La Guajira	18.870.184
Guaviare	4.759.905		Cauca	18.172.817
Putumayo	4.190.375		Putumayo	15.128.149
Guainía	4.134.059		Norte de Santander	14.714.945
Cauca	3.948.746		Córdoba	14.614.790
Cupcake	3.938.108		Cupcake	14.564.364
Norte de Santander	3.928.796		Caquetá	14.536.951
Córdoba	3.912.903		Amazon	13.997.736
Vichada	3.887.315		Nariño	13.726.930
Amazon	3.830.908		Guaviare	12.821.768
Nariño	3.422.276		Sucre	12.642.903
Caquetá	3.306.217		Choco	11.420.489
Vaupés	3.133.078		Guainía	9.837.192
Choco	3.060.247		Vaupés	8.984.689
Sucre	3.045.612		Vichada	8.589.754