Colombia: Sub National Murder Cyclicity. 2010- 2020

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Abstract

This text describes the evolution of the crime of homicide at the sub-national level, departmental level, for Colombia from years 2010 to 2020 based on open data from Statistics System of the Colombian National Police, SIEDCO, characterizing the behavior and cyclicality within each of the sub-national territories over time considering the differentiated temporal evolution in each of the territorial units. For this, linear regressions are used with categorical variables for time for each year. There it is found the simultaneity or similarity between the behavior of the 32 territories and time. Subsequently, the statistically significant correlation coefficients between the territories are obtained. The differences and similarities between the territories are found, with this coefficient the direction or type of evolution is identified and through this the similarity in the evolution trend is identified. Since the coefficients discriminate the effect and correlation between these coefficients identifies the projection between each pair of territorial data series and its evolution over time.

Keywords

Justice Service, Criminal Murder, Public Policy, Time Series Cyclicity and Colombia.

1. Introduction

The crimes could or could not be the same across time and space. Here we find this communalities and differences between: year, weeks, and days, for each of 32 subnational divisions to criminal murder in Colombia since 2010 to 2020. For it first use departmental murder crime diary time series; aftermath over general lineal model regression we find statistical coefficients, after this we use correlation and regression between annual, monthly, and diary coefficients

1.1 Objectives

Identify the evolution in crime of homicide for each territory with respect to time or date and with respect to the evolution of the other territorial units or departments based on the aggregation of homicide records as a source of open data.

2. Literature Review

De la Hoz studies the homicide reports of the Institute of Legal Medicine in 14.294 cases, a different number from the one obtained by the National Police report with 11.732, that is 30% less, and details it by department for that year and identifies a significant decrease regarding to the year 2003 (De La hoz 2013) and details its characteristics and conditions for that year, as well as identifying temporary common components for better management of the public resources allocation.

Mancera identifies the differentiated factors for 5 regions of Colombia for the years 2001 to 2006 associated with the development of social activity and the process of internal conflict (Mancera 2008). On the other hand, at the municipal level, homicide in Colombia is studied for the period 2000 to 2014, finding that "The results show that indicators of crime deterrence, such as police force and arrests, are negatively affected by the presence of the armed conflict" (Patiio 2018) identifying the institutional bases and historical presence of the state as relevant to affect the homicide rate.

Specific studies are also available to estimate the climate effect on the consolidation of crimes, especially homicide and interpersonal violence and its link with 4 climatic variables: temperature, relative humidity, precipitation and wind speed. (Trujillo & Howley 2021) finding no relationships between crime and climate for the city of Barranquilla. Therefore, it is possible to hypothesize or try to estimate the effect on crimes of periodic components of different cyclicality associated with climate, sociocultural factors (Goyeneche & Muñoz Guerrero 2018) differentiated by country, territory or culture (Hollis 2019); (Torrente et al. 2017); for regions specific populations and behaviors (Arias Pérez et al. 2021); ("Mortalidad Por Homicidio En Medellín, 1980-2007 Deaths by Homicide in Medellin, 1980-2007," 2012) or demographic or political and social (Bonilla 2010); (De los Ángeles Rodríguez 2008); (Bello Montes 2009) and also biological (Delgado et al. 2020). Even for homicide, the underreporting of this activity is presumed and identified in rural areas and in times of exacerbated violence, for which methods are proposed to estimate number effectively (Urdinola et al. 2017) and its differentiation from suicide (Campo-Arias et al. 2020), (Segura-Cardona & Cardona-Arango 2018).

3. Methods

Public information is available at the level of daily records, it is consolidated for the reference period 2010 to 2020. Then a database with daily records is constructed. Subsequently, dichotomous variables are constructed for each of the years and week. of the year.

4. Data Collection

Table 1 contains the inferential descriptive statistics for the ANOVA linear regression models for each of the 32 territorial subdivisions of Colombia and for the national total for homicides registered by the Colombian National Police between 2010 and 2021 for daily records , this with the purpose of identifying the effect of the year, the week of the year, day of the month and day of the week. For each of the departments, the total homicides in the period are identified, the descriptive statistics for the day: maximum, average, standard deviation, kurtosis coefficient, asymmetry coefficient. In any case, all the data do not behave as a normal probability distribution function using the skewness and kurtosis coefficients as a reference. The inferential statistics are the coefficient of determination, adjusted coefficient of determination, mean square error, Durbin Watson (DW) statistic and mean square error, MEC. Here it is identified that the model with the highest level of explanation is for the total number of murders at the national level with 52% and in any case the DW statistic indicates serial correlation between the data, all of them close to 2.00 (Table 1).

Table 1. Descriptive statistics for murders and models statistics for each territorial unit

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Sub national division / day	Sum	Max	Mean	Std. .Dev.	Curt C.	Asym. C.	R^2	R^2 adj.	MEC	DW	RMSE
Amazonas	119	4	0,03	0,19	88,97	8,02	0,03	0,00	0,03	1,99	0,19
Antioquia	26.494	28	6,40	3,17	1,06	0,75	0,20	0,18	8,23	1,85	2,87
Arauca	1.425	16	0,34	0,82	86,11	6,61	0,04	0,02	0,66	1,98	0,81
Atlántico	6.110	10	1,48	1,37	2,64	1,31	0,11	0,09	1,72	1,93	1,31
Bolívar	4.411	10	1,07	1,18	4,19	1,57	0,10	0,08	1,28	1,88	1,13
Boyacá	1.154	12	0,28	0,59	43,60	3,97	0,10	0,08	1,28	1,88	1,13
Caldas	2.783	6	0,67	0,90	2,99	1,57	0,13	0,11	0,72	2,01	0,85
Caquetá	2.338	14	0,57	0,95	19,57	3,08	0,06	0,04	0,88	2,00	0,94
Casanare	853	5	0,21	0,51	11,31	2,97	0,04	0,01	0,25	2,01	0,50
Cauca	7.026	15	1,70	1,64	4,46	1,61	0,13	0,11	2,38	1,99	1,54
Cesar	2.504	9	0,61	0,84	5,15	1,73	0,06	0,03	0,68	1,99	0,83
Chocó	2.281	8	0,55	0,84	5,98	1,99	0,06	0,04	0,68	1,93	0,82
Córdoba	4.188	11	1,01	1,09	4,62	1,56	0,08	0,06	1,12	1,83	1,06
Cundinamarca	18.717	27	4,52	3,06	4,90	1,61	0,34	0,32	6,33	1,95	2,52
Guainía	27	2	0,01	0,09	232,42	14,44	0,03	0,00	0,01	2,04	0,09
Guajira	2.337	13	0,56	0,85	16,60	2,52	0,04	0,02	0,70	1,97	0,84
Guaviare	429	6	0,10	0,38	46,91	5,42	0,03	0,01	0,14	2,03	0,38
Huila	3.004	9	0,73	0,98	4,99	1,81	0,15	0,13	0,84	2,05	0,92
Magdalena	3.040	6	0,73	0,93	2,54	1,45	0,08	0,06	0,82	1,95	0,91
Meta	3.570	11	0,86	1,04	4,77	1,66	0,06	0,04	1,04	2,02	1,02
Nariño	6.387	11	1,54	1,54	3,43	1,49	0,13	0,10	2,12	2,01	1,46
Norte de S-	5.772	11	1,39	1,39	2,78	1,33	0,07	0,04	1,84	1,92	1,36
Putumayo	1.887	8	0,46	0,80	8,98	2,43	0,04	0,02	0,62	2,05	0,79
Quindío	2.528	5	0,61	0,82	2,14	1,45	0,04	0,02	0,66	1,97	0,81
Risaralda	3.516	7	0,85	0,97	1,80	1,26	0,09	0,07	0,87	1,97	0,94
San andrés	260	4	0,06	0,27	31,84	5,03	0,03	0,01	0,07	1,95	0,27
Santander	3.363	12	0,81	1,03	6,60	1,84	0,11	0,09	0,97	1,95	0,98
Sucre	1.593	7	0,38	0,67	6,81	2,14	0,04	0,01	0,45	1,99	0,67
Tolima	3.606	8	0,87	1,08	2,99	1,51	0,12	0,10	1,05	2,02	1,02
Valle	30.920	30	7,47	3,69	1,80	0,92	0,31	0,30	9,60	1,91	3,10
Vaupés	27	2	0,01	0,08	197,19	13,49	0,02	(0,00)	0,01	2,03	0,08
Vichada	220	5	0,05	0,28	67,94	7,01	0,02	(0,00)	0,08	2,05	0,28
Total	152.88	126	36,95	12,52	3,56	1,27	0,52	0,51	76,48	1,84	8,75

5. Results and Discussion

5.1 Numerical Results

Table 2 contains the summaries of the models for each department and the decomposition of the sum of squares for the model of each of the territorial divisions. Thus, for example, the model of the department of Antioquia explains 19.84% of all the information and in this one, the year component explains 12.79% of all the information of the department; for Cundinamarca 33.87% is explained, where the day of the week explains 26.80% of the total information of the department. The models are all significant and the amount of information modeled varies between 2% to 52%. From this table it is clear that day of the week is the statistic that most explain in the models (Table 2).

Table 2. R2 decomposed by factor Daily Colombian Sub National Murder 2010- 2020. Open Data by SIEDCO.

Sub national division / day **a**	**Year**	**Week of Year**	**Day of Month**	**Day of Week**	**Model**
Amazonas	0,45	1,40	0,56	0,24	2,59
Antioquia	12,76	1,63	0,62	4,67	19,84
Arauca	1,30	1,64	0,47	0,77	4,24
Atlántico	0,15	1,54	0,85	8,27	10,84
Bolivar	0,33	2,21	1,04	6,74	10,31
Boyacá	0,65	1,57	0,75	1,69	4,77
Caldas	4,82	1,55	1,40	4,98	12,91
Caquetá	2,46	1,19	0,81	1,42	5,85
Casanare	0,63	1,50	0,49	1,12	3,78
Cauca	2,54	2,08	0,80	7,61	13,21
Cesar	0,47	1,55	1,10	2,48	5,60
Chocó	2,23	1,86	0,45	1,27	5,85
Córdoba	5,68	1,31	0,68	0,37	8,04
Cundinamarca	3,01	2,63	1,33	26,80	33,87
Guainía	0,23	1,39	0,95	0,18	2,62
Guaviare	0,94	1,66	0,46	0,38	3,43
Huila	1,60	2,44	0,77	9,90	14,80
Magdalena	3,31	1,59	0,65	2,20	7,80
Meta	1,83	1,32	0,76	2,12	6,04
Nariño	1,69	1,98	1,07	7,78	12,59
Norte d S.	1,74	1,62	0,86	2,23	6,55
Putumayo	1,09	1,46	0,69	1,13	4,42
Quindío	0,93	1,10	1,12	0,78	3,92
Risaralda	5,80	1,76	0,82	0,65	8,94
San andrés	0,64	1,58	0,61	0,61	3,45
Santander	1,06	1,35	1,38	7,06	11,03
Sucre	1,05	1,20	0,48	1,10	3,85
Tolima	1,26	2,01	0,61	8,04	12,23
Valle	14,12	3,03	0,74	13,10	31,38
Vaupés	0,29	1,02	0,91	0,20	2,38
Vichada	0,20	1,11	0,49	0,28	2,10
Total general	10,58	2,84	1,15	37,19	52,36

Table 3. Descriptive statistics across years for murders to 34 sub national unit level in Colombia.

Sub National Division / Year	Sum	Max	Mean	Min	Std. .Dev.	Curt C.	Asym. C.
2.010	11.355	1.908	354,84	-	444,10	7,06	2,61
2.011	11.760	2.203	367,50	-	502,82	7,67	2,75
2.012	12.408	2.289	387,75	-	536,14	8,45	2,90
2.013	11.723	2.086	366,34	2	493,84	7,58	2,77
2.014	10.548	1.793	329,63	3	428,52	6,88	2,65
2.015	10.236	1.817	319,88	2	437,09	6,78	2,65
2.016	10.046	1.675	313,94	2	412,73	6,35	2,55
2.017	10.161	1.749	317,53	1	427,28	6,65	2,61
2.018	10.642	2.107	332,56	3	457,36	8,29	2,80
2.019	12.610	2.357	394,06	3	571,13	6,93	2,68
2.020	11.968	2.198	374,00	4	527,80	6,35	2,57

Table 3 contains the descriptive statistics for the behavior of the years with the detail of the subnational territorial level. There the statistics of dispersion between departments and the coefficients of asymmetry and kurtosis are reported, found that in no case do the records behave according to normal probability distribution functions The descriptive statistics refer to the value for the departments, with what in 2010 the maximum per department is 1908 and the minimum zero with an average of 354.84 for each of the 32 territorial units, the standard deviation between them is 444.10, the kurtosis coefficient is 7.06 and the asymmetry coefficient between departments 2.61 (Figure 1).

5.2 Graphical Results

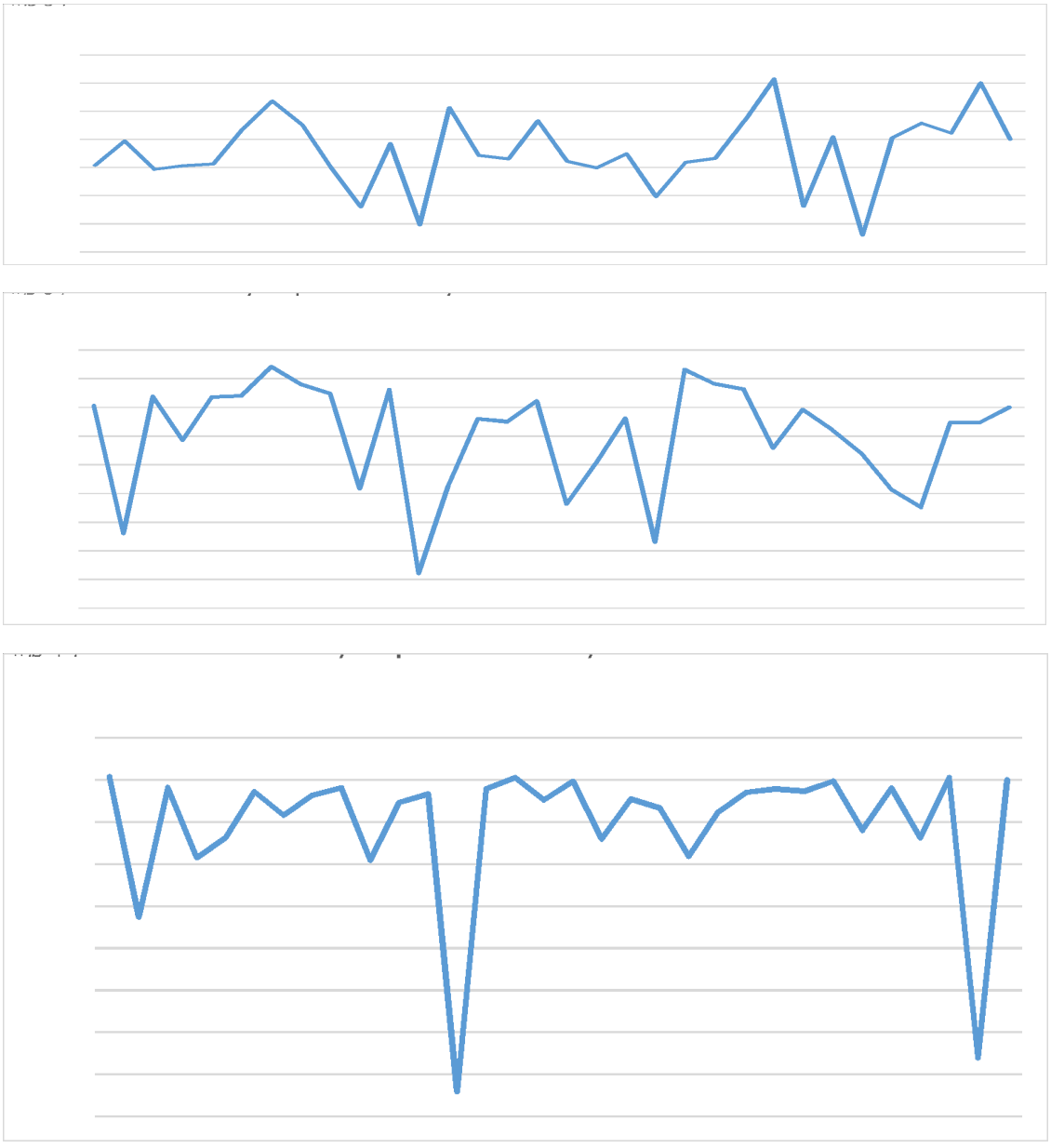

Figure 1. Graphical Results

5.3 Proposed Improvements

This methods could be used to other illegal activities, crimes or fraudulent non-criminal behavior in order to forecast local, regional, subnational behavior, in order to plan, assign and control this situations (Figure 1).

5.4 Validation

Therefore, models are built to obtain Beta coefficients of the day of the week, without standardizing and standardizing in table 4 for each department and each day of the week starting on Monday with the number 1. In this way, the effect of the day is identified. for each territorial unit so that territorial differentiation is provided as a mechanism for the allocation of resources within the management of the public force for the attention of this type of activities .

Table 4. Beta Standard coefficient and Normal By day of week Colombian Sub national Murder 2010- 2020. Open Data by SIEDCO.

Day of Week	**Mean of Beta Coef,**						**Mean of Std. Coef.**					
Sub national division / day	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
Amazonas	0,02	0,00	-0,01	0,00	0,01	-0,01	0,03	0,00	-0,01	0,01	0,02	-0,02
Antioquia	-1,60	-2,05	-2,10	-1,97	-1,85	-1,29	-0,23	-0,23	-0,22	-0,20	-0,14	0,00
Arauca	-0,15	-0,11	-0,19	-0,16	-0,19	-0,02	-0,07	-0,05	-0,08	-0,07	-0,08	-0,01
Atlántico	-0,95	-1,18	-1,18	-1,14	-1,08	-0,72	-0,24	-0,30	-0,30	-0,29	-0,28	-0,18
Bolívar	-0,50	-0,88	-0,84	-0,84	-0,95	-0,70	-0,15	-0,26	-0,25	-0,25	-0,28	-0,21
Boyacá	-0,20	-0,23	-0,21	-0,22	-0,17	-0,10	-0,12	-0,14	-0,12	-0,13	-0,10	-0,06
Caldas	-0,31	-0,59	-0,56	-0,60	-0,52	-0,38	-0,12	-0,23	-0,22	-0,23	-0,20	-0,15
Caquetá	-0,14	-0,26	-0,32	-0,34	-0,25	-0,11	-0,05	-0,09	-0,12	-0,12	-0,09	-0,04
Casanare	-0,12	-0,15	-0,18	-0,16	-0,13	-0,12	-0,08	-0,10	-0,12	-0,11	-0,09	-0,09
Cauca	-0,55	-1,21	-1,33	-1,26	-1,20	-0,91	-0,12	-0,26	-0,29	-0,27	-0,26	-0,19
Cesar	-0,28	-0,32	-0,42	-0,40	-0,35	-0,21	-0,12	-0,14	-0,17	-0,17	-0,14	-0,09
Chocó	-0,12	-0,26	-0,22	-0,28	-0,26	-0,17	-0,05	-0,11	-0,09	-0,12	-0,11	-0,07
Córdoba	-0,19	-0,20	-0,14	-0,17	-0,14	-0,07	-0,06	-0,06	-0,04	-0,06	-0,04	-0,02
Cundinamarca	-4,30	-4,64	-4,55	-4,41	-4,07	-2,42	-0,49	-0,53	-0,52	-0,50	-0,47	-0,28
Guainia	-0,01	-0,01	-0,01	-0,01	-0,01	-0,01	-0,02	-0,04	-0,03	-0,05	-0,03	-0,03
Guajira	-0,23	-0,39	-0,36	-0,32	-0,31	-0,18	-0,10	-0,16	-0,15	-0,13	-0,13	-0,07
Guaviare	-0,04	-0,06	-0,07	-0,06	-0,07	-0,04	-0,04	-0,06	-0,06	-0,06	-0,07	-0,04
Huila	-0,67	-0,90	-0,92	-0,89	-0,88	-0,55	-0,24	-0,32	-0,33	-0,32	-0,32	-0,20
Magdalena	-0,24	-0,33	-0,39	-0,34	-0,33	-0,08	-0,09	-0,12	-0,15	-0,13	-0,13	-0,03
Meta	-0,40	-0,44	-0,45	-0,48	-0,35	-0,29	-0,14	-0,15	-0,15	-0,16	-0,12	-0,10
Nariño	-0,59	-1,24	-1,25	-1,23	-1,05	-0,78	-0,13	-0,28	-0,28	-0,28	-0,24	-0,18
Norte de S.	-0,58	-0,56	-0,51	-0,51	-0,43	-0,16	-0,15	-0,14	-0,13	-0,13	-0,11	-0,04
Putumayo	-0,14	-0,22	-0,28	-0,24	-0,18	-0,13	-0,06	-0,10	-0,12	-0,11	-0,08	-0,06
Quindio	-0,14	-0,19	-0,23	-0,18	-0,13	-0,06	-0,06	-0,08	-0,10	-0,08	-0,06	-0,03
Risaralda	-0,17	-0,21	-0,23	-0,21	-0,22	-0,09	-0,06	-0,08	-0,08	-0,07	-0,08	-0,03
San andrés	-0,04	-0,05	-0,06	-0,07	-0,06	-0,05	-0,05	-0,06	-0,08	-0,09	-0,08	-0,07
Santander	-0,68	-0,80	-0,74	-0,80	-0,72	-0,39	-0,23	-0,27	-0,25	-0,27	-0,25	-0,13
Sucre	-0,15	-0,22	-0,14	-0,14	-0,18	-0,04	-0,08	-0,11	-0,07	-0,07	-0,09	-0,02
Tolima	-0,70	-0,94	-0,87	-0,90	-0,79	-0,51	-0,23	-0,31	-0,28	-0,29	-0,26	-0,16
Valle	-3,09	-3,97	-4,07	-4,05	-3,68	-2,93	-0,29	-0,38	-0,39	-0,38	-0,35	-0,28
Vaupés	-0,01	-0,01	-0,01	-0,01	-0,01	0,00	-0,03	-0,04	-0,04	-0,03	-0,02	0,00
Vichada	-0,04	-0,03	-0,04	-0,03	-0,05	-0,04	-0,04	-0,03	-0,05	-0,04	-0,06	-0,04

In this case, the ordering of the Durbin Watson coefficients shows serial correlation according to the ordering mode of the data for the year model, but it is not considered with effect for the week of the year or day of the week models. Table 5 includes the statistics of the used models for the effect of the department together with the effect of time. For models of the effect of the year, the week of the year, the day of the week, the normal coefficients and the standardized coefficients are summarized.

Table 5. Summary of model statistics grouped by temporal variable.

	Year		Week of Year		Day of Week	
	B Estándar	B Normal	B Estándar	B Normal	B Estándar	B Normal
DoF	341	341	1581	1581	155	155
R^2	0,63	0,33	0,99	0,99	0,94	0,97
R^2 adj.	0,59	0,25	0,99	0,99	0,93	0,96
MEC	0,00	0,63	0,00	0,19	0,00	0,03
RMSE	0,05	0,79	0,02	0,44	0,03	0,18
MAPE	153,60	800,44	50,68	235,23	127,84	3.501,23
DW	0,996	0,452	1,830	1,521	1,794	1,811

Table 6 .Beta Coeficcient By year Colombian Sub national Murder 2010- 2020. Open Data by SIEDCO.

Sub national division	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Amazonas	-0,01	-0,01	-0,01	-0,01	0,01	-0,02	0,01	-0,03	-0,02	-0,03	-0,02
Antioquia	1,81	2,30	2,64	1,03	-0,33	-0,54	-0,63	-0,46	0,93	0,70	-0,27
Arauca	0,11	-0,08	0,01	-0,09	-0,03	-0,19	-0,18	-0,19	-0,07	0,02	-0,16
Atlántico	-0,05	-0,14	-0,08	-0,18	-0,15	-0,02	-0,07	-0,04	-0,07	-0,15	-0,13
Bolívar	-0,17	-0,22	-0,09	0,03	-0,03	-0,03	-0,08	-0,03	-0,09	-0,09	-0,01
Boyacá	0,11	0,09	0,15	0,12	0,11	0,12	0,09	0,01	0,04	0,05	0,01
Caldas	0,61	0,49	0,46	0,42	0,33	0,19	0,17	0,11	0,14	0,03	-0,01
Caquetá	0,37	0,26	0,33	0,38	0,19	0,08	-0,02	0,08	0,08	0,02	-0,04
Casanare	-0,06	-0,10	0,01	-0,03	0,02	-0,04	-0,01	-0,05	-0,11	-0,08	-0,02
Cauca	-0,64	-0,60	-0,44	-0,76	-0,78	-0,55	-0,73	-0,62	-0,32	-0,07	-0,02
Cesar	0,12	0,06	0,05	0,15	-0,01	0,04	-0,07	0,01	0,08	0,07	0,01
Chocó	-0,57	-0,46	-0,30	-0,32	-0,40	-0,45	-0,30	-0,25	-0,32	-0,28	-0,13
Córdoba	0,50	0,49	-0,05	-0,06	-0,15	-0,30	-0,12	-0,31	-0,03	0,08	-0,21
Cundinamarca	0,82	1,90	0,74	1,14	1,09	1,18	0,93	0,54	0,25	0,18	-0,02
Guainia	-0,01	-0,01	-0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Guajira	0,11	0,04	0,05	-0,08	-0,18	-0,08	-0,06	0,02	0,03	0,01	-0,08
Guaviare	0,14	0,08	0,10	0,11	0,08	0,06	0,02	0,07	0,02	0,05	0,03
Huila	0,09	0,09	0,10	0,15	-0,14	-0,21	-0,08	-0,20	-0,12	-0,06	-0,14
Magdalena	0,02	0,13	0,21	0,11	-0,22	-0,28	-0,26	-0,25	-0,21	-0,10	-0,02
Meta	0,16	0,20	0,23	0,01	0,01	-0,02	-0,05	-0,09	-0,12	-0,26	-0,11
Nariño	-0,23	-0,29	-0,10	-0,28	-0,60	-0,69	-0,68	-0,42	-0,16	-0,35	-0,39
Norte de S.	-0,15	0,09	0,25	-0,05	-0,35	-0,45	-0,06	-0,06	-0,03	-0,05	0,06
Putumayo	-0,01	-0,03	0,03	0,12	0,12	-0,08	-0,18	-0,11	-0,05	-0,02	-0,05
Quindio	0,17	0,11	0,19	0,21	0,17	0,28	0,25	0,09	0,11	0,06	0,02
Risaralda	0,88	0,63	0,60	0,52	0,43	0,41	0,34	0,31	0,14	0,16	0,09
San andrés	-0,08	-0,08	-0,10	-0,09	-0,08	-0,09	-0,11	-0,08	-0,07	-0,07	-0,04
Santander	0,29	0,17	0,13	0,24	0,13	0,04	0,04	-0,06	-0,06	0,11	0,05
Sucre	-0,35	-0,36	-0,29	-0,24	-0,28	-0,33	-0,38	-0,37	-0,30	-0,25	-0,31
Tolima	0,17	0,15	0,29	0,17	0,18	0,13	0,10	0,09	-0,04	-0,05	-0,16
Total general	6,27	8,43	8,84	6,11	0,61	-0,74	-1,65	-1,79	-0,23	-0,23	-2,05
Valle	2,08	3,51	3,69	3,37	1,45	1,09	0,46	0,49	0,09	0,11	-0,03
Vaupés	0,00	0,01	0,01	0,01	0,01	0,02	0,01	0,01	0,01	0,01	0,01
Vichada	0,03	0,01	0,05	0,01	0,01	0,01	0,01	0,03	0,03	0,02	0,01

Thus, for standardized coefficients for year's model, determination coefficient is 33%, and that adjusted coefficient is 25%. Model for the standardized coefficients explains 63% and with the respective correction the percentage is 59%.

Models of coefficients of the week of the year and the day of the week are 93% or higher. In this case, the ordering of the Durbin Watson coefficients shows serial correlation according to the ordering mode of the data for the year model, but it is not considered with effect for the week of the year or day of the week models. Table 6 contains the non-normalized coefficients of the effect of the years for each territorial unit or department. Table 7 shows Pearson coefficient across subterritorial units. As it can be seen, there are many high coefficients (less than -0,5 or greater than 0,5) meaning that murder in subterritorial departments move over time in some coordinated way. It is very important to highlight that for the most of subeterritorial units the bigger year the less the murders. Also relationships like Guainia and Antioquia are quit interesting, the more murders in Guainia the less in Antioquia. Another example is Meta against Caldas, both increases and decreases at the same time.

Table 7. Correlation Matrix between daily department murders

Cod		100	101	102	103	104	105	106	107	108	109	110	111
100	Year												
101	Amazonas	-0,45											
102	Antioquia	-0,63											
103	Arauca	-0,47		0,68									
104	Atlántico												
105	Bolívar	0,48		-0,63	-0,48								
106	Boyacá	-0,78	0,56	0,43	0,38								
107	Caldas	-0,98	0,43	0,71	0,58		-0,48	0,75					
108	Caquetá	-0,88		0,73	0,59			0,69	0,93				
109	Casanare		0,56				0,52	0,41					
110	Cauca	0,68	-0,63					-0,56	-0,61	-0,51			
111	Cesar	-0,37	-0,38	0,61	0,54				0,47	0,67	-0,45		
112	Chocó	0,78		-0,37	-0,47		0,57	-0,60	-0,75	-0,58		0,55	-0,35
113	Córdoba	-0,61		0,74	0,69		-0,86		0,67	0,53	-0,49		0,48
114	C.marca	-0,77	0,48				-0,36	0,63	0,67	0,53		-0,74	
115	Guainia	0,77		-0,86	-0,59		0,77	-0,47	-0,79	-0,67			-0,32
116	Guajira		-0,42	0,68	0,47	0,37	-0,69		0,34	0,31	-0,58		0,43
117	Guaviare	-0,83		0,57	0,61			0,59	0,85	0,91		-0,46	0,60
118	Huila	-0,70		0,84	0,59	-0,41	-0,40	0,56	0,77	0,81			0,61
119	Magdalena	-0,53		0,85	0,49	-0,44	-0,31	0,39	0,61	0,69			0,55
120	Meta	-0,91	0,43	0,68	0,34		-0,48	0,69	0,89	0,78		-0,50	
121	Nariño		-0,34	0,83	0,59		-0,34		0,37	0,53	-0,38	0,30	0,67
122	Norte de S.			0,61								0,35	
123	Putumayo	-0,39		0,38	0,53	-0,65		0,45	0,47	0,67			0,54
124	Quindio	-0,51	0,54			0,34		0,78	0,41	0,31	0,39	-0,70	
125	Risaralda	-0,97	0,37	0,60	0,52		-0,49	0,72	0,96	0,86		-0,62	0,39
126	San andrés	0,53	-0,50					-0,70	-0,44	-0,34	-0,30	0,71	
127	Santander	-0,73	0,34	0,56	0,66	-0,43		0,63	0,78	0,77		-0,30	0,56
128	Sucre				0,36	-0,65	0,44						0,49
129	Tolima	-0,86	0,48	0,43				0,85	0,81	0,76	0,39	-0,76	
130	Total general	-0,85		0,91	0,58		-0,50	0,66	0,89	0,90			0,58
131	Valle	-0,86	0,30	0,74	0,36			0,75	0,86	0,89		-0,48	0,46
132	Vaupés	0,34		-0,44	-0,68		0,43		-0,46	-0,42			
133	Vichada			0,54	0,46	0,40				0,32			

Continuation Table 7 Correlation Matrix between daily department murders .

Cod		123	124	125	126	127	128	129	130	131	132	133
123	Putumayo											
124	Quindio											
125	Risaralda	0,32	0,46									
126	San andrés		-0,84	-0,48								

127	Santander	0,60		0,77								
128	Sucre	0,76										
129	Tolima	0,36	0,68	0,81	-0,78	0,48						
130	Total	0,51		0,80	-0,31	0,74		0,68				
131	Valle	0,55	0,35	0,78	-0,44	0,69		0,79	0,94			
132	Vaupés		0,31	-0,44		-0,50			-0,36			
133	Vichada							0,30	0,35		-0,33	

Cod		112	113	114	115	116	117	118	119	120	121	122
112	Chocó											
113	Córdoba	-0,63										
114	C. marca	-0,66	0,38									
115	Guainia	0,54	-0,76	-0,42								
116	Guajira		0,62		-0,67							
117	Guaviare	-0,60	0,49	0,43	-0,63	0,31						
118	Huila	-0,33	0,69	0,39	-0,69	0,42	0,66					
119	Magdalena		0,55		-0,72	0,40	0,58	0,88				
120	Meta	-0,57	0,51	0,66	-0,86	0,32	0,68	0,64	0,63			
121	Nariño		0,49		-0,56	0,69	0,37	0,63	0,72	0,32		
122	Norte de S.	0,44			-0,45	0,52		0,52	0,68		0,71	
123	Putumayo						0,59	0,47	0,49		0,34	
124	Quindio	-0,49		0,55						0,38	-0,41	-0,44
125	Risaralda	-0,79	0,63	0,66	-0,79	0,38	0,88	0,68	0,51	0,87		
126	San andrés	0,37		-0,55						-0,41		
127	Santander	-0,55	0,67	0,44	-0,57		0,80	0,81	0,67	0,56		
128	Sucre					-0,30					0,30	
129	Tolima	-0,58		0,69	-0,55		0,71	0,50	0,33	0,79		
130	Total general	-0,49	0,68	0,56	-0,85	0,45	0,75	0,91	0,87	0,84	0,63	0,44
131	Valle	-0,44	0,46	0,70	-0,71		0,75	0,82	0,79	0,86	0,42	0,31
132	Vaupés		-0,65		0,48	-0,51	-0,47	-0,51	-0,38		-0,51	-0,35
133	Vichada			-0,33	-0,48	0,68			0,31		0,67	0,49

6. Conclusion

Murders can be characterized by temporal variables as year, week of the year and day of the week. All constructed models are significant, and those can be used to improve resources planning of police force. Much of murders at subterritorial unit level are strong correlated and that result can be used also for enhancing the understanding of the homicide phenomena.

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