National Homicide Police Database, Colombia 2010-2020

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Abstract

Security services offer depends on the demand of that services. The changes of homicides across time affects the amount of resources required to offer security services. The planning and control of police services operation can be characterized through fixed and variable components for many geographical areas. In this text, cyclical components are identified since 2010 to 2020 for the criminal murder identification by police force corps. To accomplish that it is used open source or public information from information system SIEDCO offered by the Colombian National Police. Then it is used a regression model with categorical variables for this data base over dates and quantities from a national criminal murder point of view. From these models coefficients are obtained for the year and week of the facts.

Keywords
Criminal Murder, cyclicity, Justice Service, Colombia, Public Policy.

1. Introduction

Manage and analysis of information are fields that have been studied vastly in the XX and XXI centuries**.** It is right that fundamentals of information management can be traced from XVIII and XIX centuries using Fourier Methods but, its diffusion, use and automatization on enterprises, organization and institutes has yet a huge field of usage, implementation and adequation on the provision of justice services related with homicide records. For some periods of the 20th century Colombia has been the country with more homicides of the world. For that reason, identifying the cyclical components of this phenomena at the subnational territorial level can be useful for sourcing assignment, provision, prediction, available personal assignation for dissuasion activities and prevention.

1.1 Objectives

Identifying cyclical components for homicides in Colombia at national level. Estimate the contribution of the administrative records of homicides at a sub national level.

2. Literature Review

The modified ARIMA statistical models and its related with computational learning techniques are used for estimating and forecasting of crime behavior (Boppuru & Ramesha, 2020) presented on aggregate or percentage level (Amin et al., 2014) and, based on that they have been made specific models for homicide forecasting in Colombia for 5 years horizon based on 60 years homicide records from 1960 to 2019 (Ordonez-Eraso et al., 2020). Homicides in Colombia can be found concentrated in specific populations like syndicalist inside the diversity of power relations linked with organized crime (Dombois & Campos, 2018) or political reasons (Brauer et al., 2004), Matorel (2018) has the hypothesis that murders are related with political activity (P et al., 2015) (Romero-Rodríguez et al., 2017).

It is also so useful having models to identify the happening of these events (White et al., 2003), about this it is has appeared an interest of working with (Spelman, 2017) as it has been shown that the activity of the economic cycle causes or is associated cyclily on homicide activity (Carranza Romero et al., 2011) even though with contradictory evidence at municipal level for specific periods where it is found that the more criminal activity the less economic activity. (Rozo, 2018) and it is too probable that with the same cyclical activity related with natural resources extraction (Romero et al., 2020) but that not as a consequence of only that causes and also not just for psychosocial causes as a diferent kinds of violence (Fandiño-Losada, A., Guerrero, 2017), ("La Ley Justicia y Paz, Un Ej. Justicia Transic. En Colombia.," 2014), (Escobar-Echavarría et al., 2017), (Diaz et al., 2018), (Sherman, 2006), (Sandvik & Lemaitre, 2017). However, it has found out cyclical behavior for criminal activity not just in Colombia but in United States and for long periods of time (Esguerra-Umaña & Parra-Ulloa, 2016) from the place that was considered to have the biggest homicide rate of the world (Cardona et al., 2005) with not just local effect but global(Raymond, 2014)(Richard, 1997).

For the above, this models could be potentially used in searching of having better public politics designs. (Correa, 2015), management of public force(Stepanyan (Gevorkyan), 2019) in an environment of frequent violence ("Polit. Violence Lat. Am.," 2019) in or outside reconciliation processes (Seils, 2015), (Muñoz Cardona, 2016), because that needs a change on focus (Sedacca, 2019). From the point of view of the information recording it is neither found in all the territories nor all the times correct information, complete and without political bias that causes an undercording of criminal events. (Urdinola et al., 2017), both at global and latinamerican level (Le Clercq, 2016), (Le Clercq y Rodriguez, 2020).

3. Methods

From SIEDCO database from 2010 to 2020 managed by Colombian National Police it is made an aggregate database. Then an ANOVA model is used, followed by a group of regressions for temporal series for each of the records of the departments of Colombia.

4. Data Collection

Table 1 shows the number of persons registered as homicide lethal victims taken from SIEDCO managed by National Police Force Institution. The original database is on hour; the grouped database is over a diary base; the Table 1 is on annual base for each territorial main division to Colombia named Department. Table 2 shows some statistics at subnational level over monthly aggregated database by departments from 2010 to 2020. The great total is 123.457

homicides; greater numbers are to departments: Antioquia, Valle y Cundinamarca with 21.502; 21.309 and 12.723 homicides respectively.

Table 1 Number of homicides per year for each department of Colombia.

División Sub Nacion	2.010	2.011	2.012	2.013	2.014	2.015	2.016	2.017	2.018	2.019	2.020
Amazonas	10	10	9	11	15	9	18	5	7	6	6
Antioquia	1.784	1.933	2.289	2.006	1.718	1.718	1.675	1.720	2.107	2.357	2.002
Arauca	141	97	128	79	122	77	75	78	117	160	95
Atlántico	437	426	457	430	422	458	456	474	455	515	528
Bolívar	309	304	336	364	343	335	336	359	342	382	415
Boyacá	110	104	124	112	111	99	103	75	85	91	76
Caldas	341	307	302	287	258	211	206	188	188	162	148
Caquetá	228	206	235	240	203	164	137	164	161	157	137
Casanare	65	53	83	74	90	71	81	68	49	61	83
Cauca	487	500	560	470	477	524	497	524	617	772	792
Cesar	233	203	210	241	185	201	172	194	216	229	210
Chocó	103	140	190	181	157	152	188	211	197	220	273
Córdoba	481	483	333	331	297	256	311	245	347	402	300
C marca	1.031	1.182	1.072	1.187	1.126	1.158	1.100	1.082	1.021	1.417	1.347
Guainía	1	-	-	4	3	2	2	3	3	3	4
Guajira	223	203	194	161	139	163	173	194	206	215	185
Guaviare	43	41	45	48	38	33	22	38	18	32	24
Huila	302	301	304	314	224	195	242	191	226	260	232
Magdalena	272	307	315	288	201	183	184	189	208	260	291
Meta	331	338	357	288	289	282	277	260	252	220	273
Nariño	532	510	570	513	446	404	398	456	536	571	551
Norte de S.	363	451	499	430	366	317	423	430	438	512	556
Putumayo	145	139	156	194	198	138	99	128	143	169	157
Quindío	217	191	224	234	222	252	240	182	206	193	177
Risaralda	436	362	350	323	300	283	269	258	205	225	200
San Andrés	22	21	15	18	22	17	12	22	21	25	38
Santander	346	305	299	319	289	259	266	234	232	302	281
Sucre	119	116	140	150	144	127	109	114	136	160	140
Tolima	314	309	363	324	332	310	300	304	260	266	228
Valle	1.908	2.203	2.225	2.086	1.793	1.817	1.660	1.749	1.619	2.244	2.198
Vaupés	-	1	1	2	3	6	2	1	3	3	4
Vichada	21	14	23	14	15	15	13	21	21	19	17

Table 2 exposes the total sum since 2010 to 2020; over a monthly database descriptive statistics are showed: maximum, mean, minimum standard deviation; association with time is showed using Pearson correlation coefficient between time in months and quantity of criminal murders; finally probabilistic statistic are used to explore the tendencies around monthly grouped data from 132 monthly records: Curtosis coefficient, Asymmetry coefficient and Near to normality classification.

Table 2 displays Pearson correlation coefficient; values less than -0,30 are for the departments: Boyacá, Caldas, Caquetá, Córdoba, Guaviare, Huila Magdalena, Meta, Quindío, Risaralda, Santander and Tolima. It means that for that departments in different proportion and quantity the more the time the less the homicides. In the other hand and opposite departments with a correlation more than 0,3 are: Atlántico, Bolívar, Cauca, Chocó, Cundinamarca, Guainía, Norte de Santander, San Andrés, Sucre and Vaupés. It means that the more the time the more the homicides. Departments that present a random behavior and no tendency in homicides are: Antioquia, Atlántico, Casanare, Cesar, Guajira, Nariño, Putumayo, Valle, Vichada and national total criminal murder record. Also this table shows curtosis

and asymmetry coefficients for identifying normal distribution presence: absolute values to both standardized curtosis and asymmetry less to 0, 60 are classified near to normality.

Table 2 Descriptive statistics for the number of homicides for each department of Colombia

División Sub Nacional	Sum	Max	Mean	Min	Std. .Dev.	Pears. Corr. C. (t)	Curt C.	Asym. C.	Near Norm.
Amazonas	106	18	10	5	3,96	-0,389	0,76	1,04	
Antioquia	21.309	2.357	1.937	1.675	239,43	0,205	(0,85)	0,62	
Arauca	1.169	160	106	75	29,19	-0,062	(0,88)	0,55	
Atlántico	5.058	528	460	422	34,54	0,809	0,39	1,06	
Bolívar	3.825	415	348	304	31,62	0,804	0,96	0,79	
Boyacá	1.090	124	99	75	15,70	-0,809	(0,81)	(0,28)	
Caldas	2.598	341	236	148	65,47	-0,984	(1,43)	0,25	
Caquetá	2.032	240	185	137	38,71	-0,850	(1,62)	0,26	
Casanare	778	90	71	49	13,08	-0,002	(0,87)	(0,27)	
Cauca	6.220	792	565	470	114,96	0,764	0,75	1,43	
Cesar	2.294	241	209	172	20,78	-0,145	(0,45)	(0,11)	Yes
Chocó	2.012	273	183	103	45,18	0,856	0,85	0,23	
Córdoba	3.786	483	344	245	80,33	-0,505	(0,20)	0,83	
Cundinamarca	12.723	1.417	1.157	1.021	125,16	0,513	0,76	1,18	
Guainía	25	4	2	-	1,42	0,700	(0,79)	(0,59)	
Guajira	2.056	223	187	139	25,59	-0,007	(0,49)	(0,46)	Yes
Guaviare	382	48	35	18	9,89	-0,756	(0,98)	(0,47)	
Huila	2.791	314	254	191	45,18	-0,651	(1,57)	0,07	
Magdalena	2.698	315	245	183	52,60	-0,361	(1,98)	(0,02)	
Meta	3.167	357	288	220	40,25	-0,858	(0,24)	0,28	Yes
Nariño	5.487	571	499	398	62,92	0,036	(1,14)	(0,56)	
Norte de S.	4.785	556	435	317	70,00	0,467	(0,27)	0,05	Yes
Putumayo	1.666	198	151	99	28,44	-0,095	0,32	0,11	Yes
Quindío	2.338	252	213	177	24,69	-0,405	(1,18)	0,03	
Risaralda	3.211	436	292	200	72,33	-0,969	(0,03)	0,57	
Sanandrés	233	38	21	12	6,71	0,504	3,92	1,50	
Santander	3.132	346	285	232	34,99	-0,630	(0,41)	(0,04)	Yes
Sucre	1.455	160	132	109	16,43	0,297	(1,09)	0,11	
Tolima	3.310	363	301	228	37,27	-0,795	0,46	(0,50)	
Valle	21.502	2.244	1.955	1.619	241,66	-0,126	(1,85)	(0,03)	
Vaupés	26	6	2	-	1,69	0,553	0,88	0,82	
Vichada	193	23	18	13	3,56	0,051	(1,72)	0,20	
Total	123.457	12.610	11.223	10.046	933,77	-0,079	(1,61)	0,11	

5. Results and Discussion

5.1 Numerical Results

In order to decompose the modeled information using categorical linear regression by ordinary least squares, OLS, we use variables for each kind of date component: year, Month, week of year, day of month and day of week. The main reason the independence, recurrence and repetition of these categorical variables year by year. Table 3 shows coefficient for the week of the year and every one are significant, that means, each week has a different behave and the difference is statistically significant.

Table 3 Least squares estimators for the categorical variable week of the year.

Week of Year	Value	Std. error	t	Pr > |t|	Lower L.	Upper L.
2	-29,026	8,888	-3,266	**0,001**	-46,453	-11,600
3	-29,080	8,894	-3,269	**0,001**	-46,518	-11,642

4	-29,245	8,889	-3,290	**0,001**	-46,672	-11,818
5	-29,374	8,866	-3,313	**0,001**	-46,756	-11,992
6	-29,823	8,880	-3,359	**0,001**	-47,232	-12,415
7	-30,224	8,893	-3,399	**0,001**	-47,660	-12,788
8	-29,900	8,893	-3,362	**0,001**	-47,334	-12,466
9	-28,712	8,882	-3,233	**0,001**	-46,124	-11,299
10	-28,996	8,883	-3,264	**0,001**	-46,411	-11,580
11	-29,191	8,893	-3,283	**0,001**	-46,625	-11,756
12	-29,470	8,893	-3,314	**0,001**	-46,905	-12,036
13	-31,862	8,878	-3,589	**0,000**	-49,268	-14,457
14	-30,777	8,867	-3,471	**0,001**	-48,161	-13,393
15	-30,219	8,889	-3,400	**0,001**	-47,647	-12,791
16	-31,492	8,894	-3,541	**0,000**	-48,929	-14,055
17	-30,159	8,887	-3,394	**0,001**	-47,583	-12,735
18	-28,919	8,879	-3,257	**0,001**	-46,327	-11,511
19	-28,066	8,891	-3,157	**0,002**	-45,497	-10,636
20	-28,879	8,898	-3,245	**0,001**	-46,324	-11,433
21	-28,328	8,894	-3,185	**0,001**	-45,766	-10,891
22	-29,222	8,874	-3,293	**0,001**	-46,621	-11,824
23	-27,365	8,878	-3,082	**0,002**	-44,771	-9,958
24	-28,657	8,896	-3,221	**0,001**	-46,098	-11,216
25	-27,738	8,897	-3,117	**0,002**	-45,182	-10,294
26	-29,203	8,888	-3,286	**0,001**	-46,628	-11,778
27	-26,867	8,883	-3,024	**0,003**	-44,283	-9,451
28	-27,554	8,894	-3,098	**0,002**	-44,990	-10,117
29	-29,898	8,898	-3,360	**0,001**	-47,344	-12,452
30	-29,604	8,891	-3,330	**0,001**	-47,036	-12,172
31	-28,889	8,869	-3,257	**0,001**	-46,277	-11,501
32	-29,069	8,886	-3,271	**0,001**	-46,490	-11,647
33	-28,500	8,898	-3,203	**0,001**	-45,944	-11,056
34	-28,890	8,896	-3,248	**0,001**	-46,330	-11,450
35	-28,628	8,879	-3,224	**0,001**	-46,035	-11,221
36	-27,673	8,874	-3,118	**0,002**	-45,071	-10,274
37	-29,069	8,895	-3,268	**0,001**	-46,508	-11,630
38	-27,292	8,898	-3,067	**0,002**	-44,737	-9,847
39	-29,559	8,890	-3,325	**0,001**	-46,988	-12,131
40	-29,800	8,883	-3,355	**0,001**	-47,215	-12,385
41	-29,746	8,892	-3,345	**0,001**	-47,180	-12,313
42	-30,014	8,898	-3,373	**0,001**	-47,459	-12,568
43	-29,927	8,893	-3,365	**0,001**	-47,362	-12,492
44	-29,785	8,872	-3,357	**0,001**	-47,179	-12,391
45	-25,766	8,881	-2,901	**0,004**	-43,179	-8,354
46	-28,399	8,897	-3,192	**0,001**	-45,842	-10,956
47	-29,031	8,897	-3,263	**0,001**	-46,474	-11,589
48	-27,888	8,886	-3,138	**0,002**	-45,309	-10,466
49	-25,824	8,884	-2,907	**0,004**	-43,242	-8,406

Table 4 displays the least squares estimations coefcients for each year coefficient for national criminal murder in: Non standardized coefficient, standardized coefficient, standard error of each coefficient, t value statistic, p-value from the t statistic, and the lower and upper coefficient limit. Table 5 shows the analysis of variance decomposition to the estimates of the coefficients for the linear model by ordinary less squares for each year. Values are significant to all

variables: Year, week of year, Day of month, Day of week using the p-values less than 0,05. Each variable are significant, the sum of squares modeled by all variables is 339.311 units, of this 241.044 units of information are loaded by Day of week variables.

Table 5 resume the model of categorical variables for number of homicides by year, week of the year, day of the month and day of the week. From whole information, 648k units, the modeled fraction is 339k that is a 52% from the total. 71% of the information is captured by the day of the week and year captures 20%.

Table 4 Least squares estimators for the categorical variable year.

Year	N. Coefficient.	S. Coefficient	Std. error	t	Pr > |t|	Lower L.	Upper L.
Interception	81,45		8,81	9,24	0,00	64,17	98,72
2010	6,27	0,14	0,94	6,66	0,00	4,43	8,11
2011	8,43	0,19	0,94	8,96	0,00	6,59	10,28
2012	8,84	0,20	0,94	9,39	0,00	7,00	10,69
2013	6,11	0,14	0,94	6,50	0,00	4,27	7,96
2014	0,61	0,01	0,94	0,65	0,51	-1,23	2,46
2015	-0,74	-0,02	0,94	-0,78	0,43	-2,58	1,11
2016	-1,65	-0,04	0,94	-1,75	0,08	-3,49	0,19
2017	-1,79	-0,04	0,94	-1,90	0,06	-3,64	0,05
2018	-0,23	-0,01	0,94	-0,25	0,81	-2,07	1,61
2019	-0,23	-0,01	0,94	-0,24	0,81	-2,07	1,61
2020	-2,05	-0,05	0,94	-2,18	0,03	-3,89	-0,21

Table 5 OLS for the number of homicides as a function of category variables year, week of the year, day of the month and day of the week.

Source	DoF	Sum of Squares	Mean Squares	F	Pr > F	% to model	% to total
Year	11	68.586	6.235	81,521	0,000	20	11
Week of Year	53	18.383	347	4,535	0,000	5	3
Day of Month	30	7.469	249	3,255	0,000	2	1
Day of Week	6	241.044	40.174	525,258	0,000	71	37
Model	100	339.311	3.393	44,363	0	100	52
Error	4.037	308.767	76				

Table 6 shows coefficients for every day of week 1 to Sunday, 6 to Friday. In all cases each day is statistically significative and different to the mean using a p value less than 0,05. Table 7 shows the Analysis Of Variance, ANOVA to general linear model for the homicides in function of each administrative political region in the country: each department. Independent variable is the number of administrative registers of homicides, dependent variable is each department. Departments explain the 555k/648k units of variance or 85% of the total information, that is, the model is significant with a p-value under 0,0001; that is some departments have a different murder rate. Data is used at daily level.

Table 8 shows the coefficients for each day of the month. Significant coefficients are the first 3 days of the month and 10 th day. That means, day of the month doesn't have an incidence on homicides. Bolded figures are Table 6 shows coefficients for every day of week

Table 6 Least squares estimators for the categorical variable day of the week.

Day Of Week	Value	Std. error	t	Pr > |t|	Lower L.	Upper L.
1	-17,291	0,510	-33,890	**<0,0001**	-18,291	-16,290
2	-22,632	0,510	-44,412	**<0,0001**	-23,631	-21,633
3	-22,843	0,509	-44,853	**<0,0001**	-23,841	-21,844
4	-22,421	0,509	-44,038	**<0,0001**	-23,419	-21,423
5	-20,601	0,509	-40,495	**<0,0001**	-21,599	-19,604
6	-13,560	0,509	-26,645	**<0,0001**	-14,558	-12,563

Table 7 ANOVA for the number of homicides by department.

Source	DoF	Sum of Squares	Mean Squares	F	P(F)
Model	32	555.116,61	17.347,39	766,031	**<0,0001**
Error	4.105	92.961,01	22,65		
Total	4.137	648.077,62			

Table 8 Least squares estimators for the categorical variable day of the month.

Day Of Month	Value	Std. error	t	Pr > |t|	Lower L.	Upper L.
1	3,852	1,280	3,010	**0,003**	1,343	6,361
2	-3,403	1,285	-2,648	**0,008**	-5,922	-0,884
3	-2,801	1,293	-2,166	**0,030**	-5,337	-0,265
4	-1,196	1,305	-0,917	0,359	-3,754	1,362
5	-1,751	1,317	-1,329	0,184	-4,333	0,831
6	-2,089	1,328	-1,573	0,116	-4,692	0,514
7	-1,025	1,339	-0,766	0,444	-3,651	1,601
8	0,076	1,354	0,056	0,955	-2,577	2,730
9	-1,474	1,365	-1,080	0,280	-4,150	1,202
10	-2,798	1,374	-2,037	**0,042**	-5,491	-0,105
11	-0,942	1,382	-0,682	0,496	-3,652	1,768
12	-0,755	1,388	-0,544	0,586	-3,476	1,965
13	-0,804	1,390	-0,579	0,563	-3,529	1,920
14	-0,763	1,392	-0,548	0,584	-3,493	1,967
15	0,017	1,395	0,012	0,990	-2,718	2,752
16	0,061	1,394	0,044	0,965	-2,672	2,795
17	-0,576	1,392	-0,414	0,679	-3,305	2,153
18	-0,786	1,388	-0,566	0,571	-3,508	1,936
19	-0,306	1,383	-0,221	0,825	-3,016	2,405
20	-1,114	1,374	-0,811	0,417	-3,808	1,580
21	-0,994	1,366	-0,728	0,467	-3,672	1,683
22	-1,094	1,356	-0,807	0,420	-3,753	1,565
23	-1,076	1,343	-0,801	0,423	-3,709	1,557
24	-2,349	1,330	-1,767	0,077	-4,956	0,257
25	1,985	1,313	1,512	0,131	-0,590	4,560
26	-2,269	1,298	-1,747	0,081	-4,814	0,277
27	-0,748	1,284	-0,582	0,560	-3,265	1,770
28	-1,859	1,272	-1,462	0,144	-4,353	0,634
29	-0,626	1,278	-0,490	0,624	-3,131	1,880
30	-1,978	1,280	-1,546	0,122	-4,487	0,530

5.2 Graphical Results

Figure 1 shows homicides by week in Colombia from 2010 to 2021, there it is identified a cyclical behave by weeks. Figure 2 shows the aggregate of homicides by year where it is seen a decreasing tendency on the number of homicides across years, but with values that are significant. Maximus values are finded at 2010, 2011 and 2012 decreasing from

2013. Figure 3 and figure 4, shows standardized regression coefficients obtained for the variable year, followed by coefficients for variable week and for day of the week. It is identified a diminution of the number of homicides from 2012 and a increasing tendency from 2018.Days Saturday, Sunday and Monday has a increasing tendency.

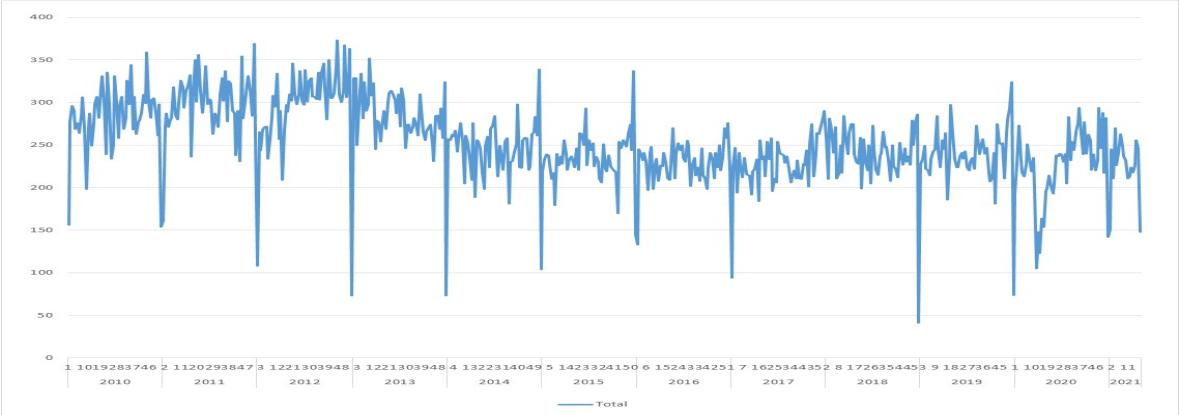

Figure 1 Number of homicides per day for Colombia. Own elaboration.

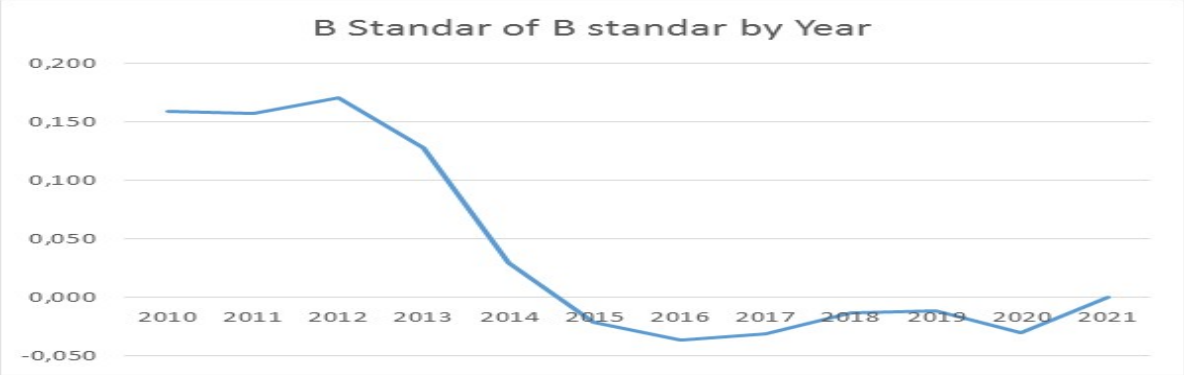

Figure 2 Number of homicides per year for Colombia.

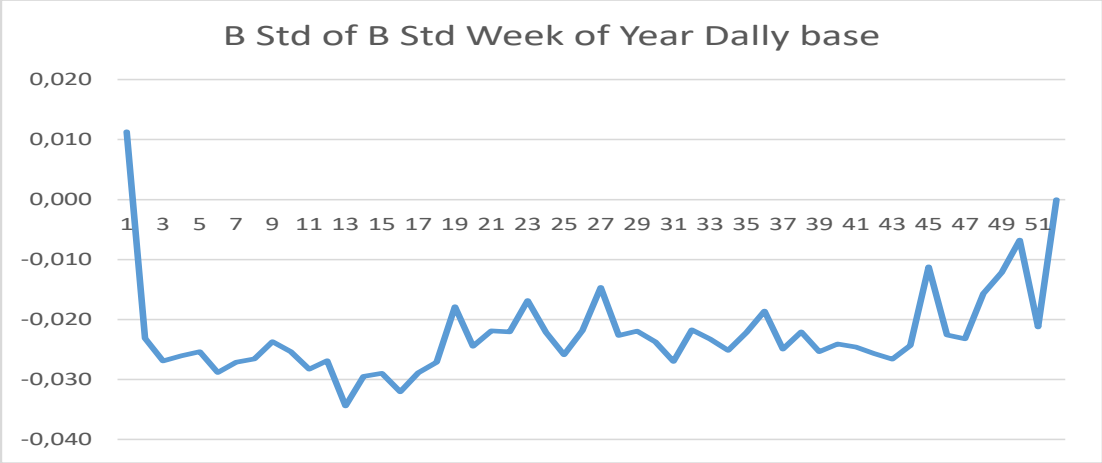

Figure 3 Standard coefficients for the week of the year. Own elaboration

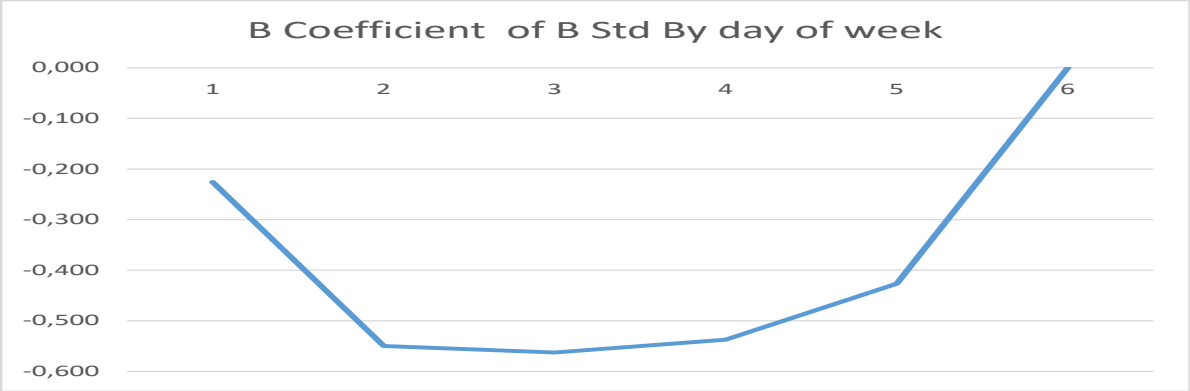

Figure 4 Standard coefficients for the day of the week. Own elaboration

5.3 Proposed Improvements

Its proposed expand this work by subnational data to observe each particular dynamyc link between National Murder Police Database and time dimension. In order to obtain a correlation with economic activity these variables could be linked with others of economic activity. Wavelet coefficients and, and granger causality could also be used for the study of this access as signals and editing with the detail of the daily information that is available.

5.4 Validation

Table 3 to table 8 contains inferential procedures to validate these coefficients for each model, sub dimension about time variable and uses kurtosis and skewness coefficients, in order to decompose the bias or to decompose the variance in their sources

6. Conclusion

It is found out that time factors like year, week or day of the week could explain the variation of the homicides in Colombia. Evidence about incidence of time factors in homicides could be an insight of the presence of cycles on the occurrence of homicides. Spatial variable department showed to be significant in explaining homicides. That means, geography has a major impact in the presence of homicides.

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