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Short-term effects of marijuana legalization in Uruguay on homicides: an analysis using synthetic control

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Abstract

The purpose of this paper is to analyze the short-term impacts of Uruguayan policy legalizing marijuana on homicides rate in that country, seeking to contribute to the literature by presenting the first results of this unique situation in the world. To do so, the paper employs the synthetic control methodology whose objective is to create a linear combination of the units of the donor pool, in this case the other countries of South America. The results show that Uruguay witnessed a resurgence in homicidal violence in 2018. It remains to be seen whether this is an occasional movement or a trend caused by the worsening dispute over the illegal drug market, made more restricted after the change in Uruguayan law.

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1. Introduction

It is estimated that 269 million people, or 5.3% of the 15 to 64 year old age group, used at least one illicit drug in 2018. Marijuana is the most consumed drug, by about 192 million individuals (World Drug Report, 2020).

As an alternative strategy to combat drugs, eleven North American states, in addition to Washington, D.C., legalized recreational marijuana consumption. Uruguay – a unique case in the world - adhered to legalization of the entire marijuana production chain (import, production, acquisition, storage, commercialization and distribution), and allowed planting for own consumption, as well as the formation of culture clubs (Uruguay, 2013).

While such measures have been widely studied in North American (Addiction, 2016; Dragone, et al., 2017; Hall and Weir, 2015), to the best of author´s knowledge there is no study dealing with the Uruguayan case. The present study therefore aims to analyze the short-term impacts of the Uruguayan policy on marijuana regulation on homicide rates in the country, seeking to contribute to the literature by presenting the first results of this unique case in the world.

The study makes use of the synthetic control method, using a donor pool made up of other countries in South America to portray the situation in Uruguay after legalization, in the absence of approved legislation.

The work is organized into four sections besides to the present introduction. First, a brief theoretical framework is presented emphasizing the consequences of criminalizing drug use. The second section describes the empirical strategy used, the data and sources, while the third presents the results and discussion. Finally, concluding remarks are made.

2. Theoretical Reference

Goldstein (1985) lists three links between drugs and violence: the psychopharmacological effect, where the consumption (or withdrawal crisis) of the drug can lead to violent behavior on the part of the user; the committing of crimes against property to defray addiction and, finally, the most important nexus, systemic violence, intrinsic to the functioning of illicit markets, where violent behavior assumes multiple roles, from a dispute over territories to an instrument of debt collection.

Analyzing crime in the state of São Paulo, Mello (2015) finds a strong relationship between crack-cocaine trafficking and the homicide rate. Shepard and Blackley (2010) enumerate another two channels of connection between the prohibition of trafficking and the increase in criminality: the greater allocation of resources in the fight against drugs reduces the inputs available to fight other types of crime, which may lead to an increase in the latter; as well as reducing the availability of slots in the prison system for other types of criminals.

Thus, the legalization of the production and consumption of soft drugs, implying the consequent regulation of the market, could be an interesting strategy to reduce violence. Law 19,172 was passed on December 20, 2013 by the Uruguayan Senate allowing the planting, storage and distribution of psychoactive cannabis, including domestic cultivation, cultivation and consumption in clubs and sale in pharmacies.

Law 19,172-2013 is still being regulated and the sale in pharmacies started only in July 2017. The palpable effects of this will perhaps only be felt after a few years. IRCCA data for August 2018 show 6,735 people registered as self-cultivators, 99 consumer clubs and 25,865 consumers across the country.

Table I illustrates the use of various drugs, legal and illegal, based on the latest household surveys (*Encuesta Nacional sobre Consumo de Drogas en Población General*) carried out by the National Drug Board (Junta Nacional de Drogas).

Table I: Evolution of Drug Use in Uruguay (%) – 2001/2018
Prevalence in the last 30 days

DRUG	2001	2006	2011	2014	2018
Alcohol	53.2	52.4	55.3	52.1	59.4
Tobacco	34.5	34.0	31.0	29.5	27.9
Tranquilizers	(-)	(-)	(-)	8.9	9.7
Marijuana	0.5	3.5	4.9	6.5	8.9
Cocaine	0.1	0.8	0.9	0.6	0.6

Source: JND; Observatorio Uruguayo de Drogas (2019)
Obs: (-) Information not available

Observing the prevalence of consumption in the last thirty days of the population aged 15 to 65 years old, after the enactment of Law 19,172-2013, it can be seen that consumption of alcohol, marijuana and tranquilizers has increased over the period, while the smoking of cigarettes remains in decline. In 2018, 8.9% of the age group surveyed had used marijuana in the month prior to the interview. It is interesting to note that since 2001 there has been an increase in the consumption of marijuana.

A peculiar characteristic of drug legalization processes is the delay in manifesting significant changes: fifteen years after legalization for medical use in California, only 60 of its 336 districts had formally regulated marijuana dispensaries (Van Ours, 2012). According to Hall and Weir (2015), a period of 5 to 10 years, starting from the date of legalization, would be necessary to evaluate a possible effect of increasing drug dependence.

3. Empirical Strategy

To analyze the effects of the Uruguayan policy, this study adopts the synthetic control method (Abadie et al., 2010; Conley and Taber, 2010), which consists of creating a linear combination of the donor pool made up of the other South American countries - except Guyana, Suriname and Venezuela due to excessive missing values -, to portray the possible situation prevailing in Uruguay in the absence of the drug policy expressed in the Law change.

Denoting the value of the homicide rate of the location "i" with and without treatment, respectively $YitI$ and $YitN$, the method aims to obtain estimates for:

$$\tau it = YitI - YitN = Yit - YitN \text{ for } t > T0 \quad (1)$$

Where $YitI = Yit$, since this value is observable.

Estimates are then sought for $YitN$ based on data from the other J locations. It is worth noting an important characteristic of the synthetic control method: the interaction of the fixed effects of the states with temporal effects, which allows them to vary in time and contributes to the control of unobserved effects.

The technique then looks for among the vectors of weights W (Jx1), (w_1, w_2, ..., w_j), subject to the constraints that the weights must be positive and whose sum must equal the unit, such that $w_j \geq 0$ and $\Sigma_{j=1}^{J} w_j = 1$, a vector w * that involves the minimization between

the values of the variables of the locality that suffered the intervention - in this case, Uruguay -, and the same set of variables for the South American countries that did not undergo intervention in the same period, weighted by the vector of weights, $X0W$ (vector of weighted variables) in the pre-intervention period.

In summary, the technique seeks to identify a linear combination that presents the maximum similarity with the Uruguayan homicide rate, between the years 2008 and 2013, the period prior to the implementation of the policy.

Thereunto it uses urbanization rate, literacy rate, GDP per capita, Gini index, percentage of poor, unemployment rate, population density and a proxy for the supply of drugs as controls. To avoid endogeneity problems, deterrence variables were not included, such as police force or public security expenses. 2014 was considered as a baseline.

Table II presents descriptive statistics for Uruguay and the donor pool from 2008 to 2018.

Table II: Descriptive Statistics of Covariates and Crime Indicators
– South America vs Uruguay – 2008/2018

VARIABLE	Minimum		Maximum		Mean		Standard Error	
	AS - U	Uruguay	AS - U	Uruguay	AS - U	Uruguay	AS - U	Uruguay
HomRt	2.47	5.91	36.47	12.06	13.52	7.78	10.11	1.67
GDPpc	4,868.44	14,764.19	24,765.23	21,324.85	13,364.72	18,797.91	4,913.44	2,385.51
UrbRt	58.61	94.00	95.33	95.33	76.32	94.77	10.94	0.43
LiterRt	90.04	98.07	99.18	98.70	94.36	98.40	2.59	0.19
Gini	0.395	0.395	0.555	0.455	0.477	0.415	0.396	0.238
%Poor	0.1	0.1	11.0	0.2	4.22	0.13	2.52	0.05
Unemp	2.01	6.31	12.82	8.34	6.07	7.29	2.77	0.74
Dens	8.97	19.08	68.79	19.71	27.28	19.38	16.47	0.21
Drugs	30.66	30.66	15,661.84	135.45	1,238.41	80.69	2,717.48	32.24

Sources: UNODC, World Bank
Obs: AS – U = South America except Uruguay

4. Results and Discussion

Six models were tested for homicide rates. The first two use the time frame from 2008 to 2018, differing in relation to the donor pool: model 1 excludes Bolivia and Peru, countries for which the dependent variable was not available for all years, while model 2 includes these countries, interpolating the missing data through the *mipolate* command in STATA 14.0. The following models, on the other hand, use data from 2010 to 2018, a period for which information about the seizure of drugs was available. Model 3 again removes Bolivia and Peru from the control group and includes the drug-related variable, while model 4, in addition to including this variable, reinserts the two countries with the help of *mipolate* command. Finally, models 5 and 6 reproduce models 3 and 4, but without drug seizures. The equations below show the synthetic controls obtained from these procedures:

$$Uruguay = 0.957\,ARG + 0.043\,EQU \quad (2)$$

$$Uruguay = 0.856\,ARG + 0.042\,BOL + 0.048\,PAR + 0.054\,PER \quad (3)$$

$$Uruguay = 0.821\,ARG + 0.042\,EQU + 0.137\,PER \quad (4)$$

Equation (2) depicts the synthetic controls obtained by models 1, 3, 4 and 5. Equations (3) and (4) illustrate the results of models 2 and 6, respectively. Argentina was the

country that had the greatest weight (82.1% to 95.7%) in the construction of synthetic controls.

Table III shows the square root of the average forecast error (RMSPE), the value of covariates for Uruguay and its synthetic controls, as well as the homicide rate for each of the models tested. As models 3, 4 and 5 produced identical synthetic controls, only model 3 is shown in the table.

Table III: RMSPE, Covariates – Uruguay vs Synthetic Control – and T-Test for Homicide Rate

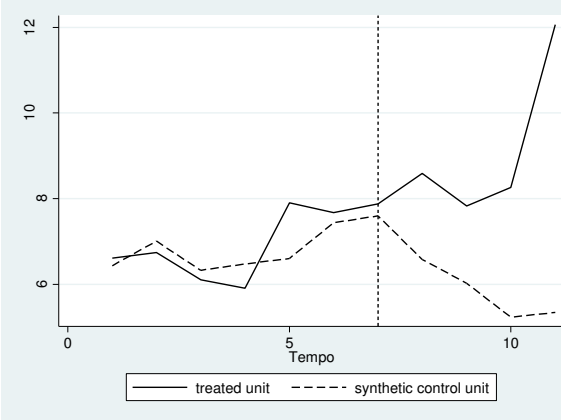
		Model 1	Model 2		Model 3	Model 6
VARIABLE	TREATED	CONTROL	CONTROL	TREATED	CONTROL	CONTROL
GDPpc	17,061.79	18,104.13	17,070.58	18,447.19	18,983.65	17,812.75
LiterRt	98. 27	98.76	98.24	98.32	98.78	98.06
Gini	0.429	0.434	0.438	0.414	0.424	0.427
%Poor	0.15	1.78	2.28	0.12	1.19	1.68
Unemp	7.02	7.45	7.03	6.58	7.13	6.58
Dens	19.22	16.99	15.24	19.31	17.27	18.30
Drugs		-	-	73.06	243.63	-
HomRt	6.82	6.72	6.74	6.82	6.72	6.70
t-test		0.4071	0.3399		0.4071	0.4922
RMSPE		0.608104	0.558639		0.608104	0.582393

Source: Author´s estimates on STATA 14.0 software.

In the case of the first two models, the homicide rate for the synthetic control is very close to the Uruguayan rate, so much that the t-test of means equality does not reject the null hypothesis at the level of 5% error.

With regard to additional models, there is a change in the averages of the treated unit due to the change in the time frame. For this reason, data for Uruguay appears in the fifth column of the table again. Once more the homicide rate for both, treated and control, is very similar and it is not possible to reject the null hypothesis in the test of equality of means. Thus, the technique was able to produce good counterfactuals for the performance of the homicide rate in Uruguay.

FIGURE 1: Homicide Rate Uruguay vs Synthetic Control – Models 1, 3, 4 and 5.



Source: Authors' own

Figure 1 shows the performance of the homicide rate for the treated and control units for models 1, 3, 4 and 5. Models 2 and 6 behave very similarly (see supplementary material).

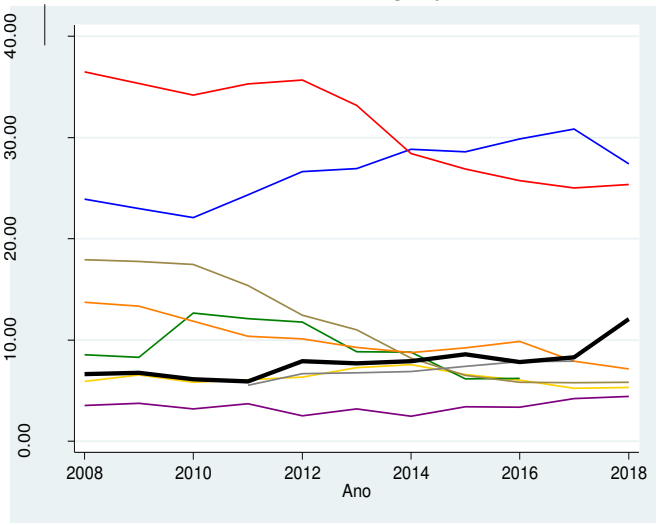
These first results seem to indicate a detachment between the Uruguayan homicide rate compared to its counterfactual: while in the latter there is a fall between 2014 (baseline) and 2017 with stabilization in 2018, the treated unit shows a strong increase in 2018, after a volatile behavior in the three years after legalization.

4.1 Robustness Check and Discussion

Two exercises were carried out to verify the internal validity of the results found above. Given the impossibility of replicating the procedure adopted by Abadie et al (2010), which consists of the use of a space placebo[1], it was decided to plot the real behavior of the homicide rate in all South American countries (except Guyana, Suriname and Venezuela) over the entire period.

As shown in Figure 2, the only country that has strong growth in the homicide rate in 2018 is Uruguay, which seems to confirm the detachment of this country in relation to the behavior of its synthetic control.

FIGURE 2: Homicide Rate - Uruguay vs Donor Pool



Source: Authors' own

Table IV: RMSPE and Synthetic Control - Homicide Rate – 2013 as a *Baseline*

Model / Variable	RMSPE Original	RMSPE Placebo	Original Synthetic Control	Placebo Synthetic Control
Model 1	0.608104	0.657877	UR = 0.957Arg + 0.043Equa	UR = 0.958Arg + 0.042Equa
Model 2	0.558639	0.542283	UR = 0.856Arg + 0.042Bol + 0.048 Par + 0.054Per	UR = 0.824Arg + 0.018Col + 0.159Per
Model 3	0.608104	0.657877	UR = 0.957 Arg + 0.043Equa	UR = 0.958Arg + 0.042Equa
Model 6	0.582393	0.626335	UR = 0.821Arg + 0.042Equ + 0.137Per	UR = 0.836Arg + 0.038Equa + 0.127Per

Source: Author´s estimates on STATA 14.0 software.

[1] The supplementary material explains why it was impossible to adopt the space placebo as in Abadie et al. (2010).

Finally, we sought to verify whether the expectation of the change in the law induced changes in the agents' behavior even before its enactment, using a temporal placebo and re-estimating the models using 2013 as a baseline. Table IV above presents the results.

Columns 2 and 3 show the square root of the average forecast error (RMSPE) for each of the models originally estimated and their version with the placebo of the date of the legalization, respectively. Columns 4 and 5 in turn show the synthetic control originally produced by each model and that obtained with the placebo. It can be seen that in general the results are quite similar, indicating that there seems to have been no change in the behavior of the agents prior to the change in the law.

Our results are in line with the findings of authors who point out that the delay in significant changes is a characteristic of marijuana legalization processes due to the slow implementation (Dragone et al., 2017; Hall and Weir, 2015; Van Ours, 2012). However, in the case of homicidal violence, such changes may have started to manifest themselves in 2018.

Table I shows that the increase in Uruguayan marijuana consumption precedes legalization. This could impact violence through three channels: psychopharmacological, economic-compulsive and systemic violence, according to Goldstein (1985). For the author, the third channel is the most relevant. Thus, with regard to systemic violence, the removal of part of the drug market from illegality should lead to a reduction because commercial relations and market competition would be controlled by the law. Therefore, the rise in homicide rates in 2018 is intriguing. For now, three hypotheses for this can be suggested:

i. It is a temporary movement and not a trend. Future data will allow us to check the plausibility of this idea;
ii. Legalization restricted but did not extinguish marijuana trafficking, as 24.4% of Uruguayan consumers acquired it through drug trafficking in 2019 (JND; OUD, 2019, p. 125). As a result, competition has become more acute in the illegal market, which is now more restricted, exacerbating the violence practiced in it;
iii. There may have been some substitution of heavier drugs for marijuana, contributing to the restriction of the market for the trafficking of other drugs, reinforcing the practice of violence for the reason explained in the previous hypothesis. For González (2018), “Cocaine use seems to have reached a stable level. Without being able to expand the market for the sale of dust, traffickers started to dispute territory”. It is worth noting that Mello (2015) found a strong relationship between crack-cocaine trafficking and the homicide rate in the state of São Paulo.

5. Concluding Remarks

This work aimed to analyze the short-term impacts of the legalization of marijuana production and consumption on homicide rates in Uruguay, contributing to the literature by presenting the first results of a unique case in the world.

The study made use of the synthetic control method, using the other South American countries, except Guyana, Suriname and Venezuela, as a control group. The results indicate a detachment between the behavior of the Uruguayan homicide rate compared to the performance of its counterfactual, showing a strong increase in 2018, after volatile behavior in the three-year period after legalization.

Nevertheless, the present study has some limitations. First, given the specificity of the Uruguayan case, the results found here cannot be extrapolated to other situations. Second, the control group made up of the other South American countries, for which data were

available is limited (eight countries). Finding ways to refine synthetic control, as well as monitoring the impacts on drug use and trafficking in Uruguay as new data becomes available, should present useful paths for future studies.

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