The Great Paulista♣ Crime Decline Puzzle

Eduardo Simões de Almeida: Professor do Departamento de Economia, Universidade Federal de Juiz de Fora (UFJF), Juiz de Fora, MG, Brasil. E-mail: edualmei@gmail.com

Lucas Siqueira de Castro: Professor do Departamento de Economia, Universidade Federal Rural do Rio de Janeiro (UFRRJ), Seropédica, RJ, Brasil. E-mail: lucancastro@hotmail.com

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Abstract

The reversal of the increasing trend of crime in the state of São Paulo has raised interest to determine its possible causes. Several factors have been suggested by literature to explain this great crime decline. Our hypothesis is that the police productivity shock generated by INFOCRIM was the crucial factor for explaining the decline. Thus, this work aims to evaluate the impact of INFOCRIM on crime in the state of São Paulo. We adopted the synthetic control method to perform a case study of the impact of INFOCRIM on homicide rates in the state of São Paulo. We compare outcomes under INFOCRIM against a counterfactual of "state of São Paulo without INFOCRIM". We estimated that the homicide rate with INFOCRIM decreased 37 per cent in comparison to the homicide rate in the synthetic São Paulo scenario without INFOCRIM.

Key words: Police productivity shock; synthetic control; INFOCRIM; homicide rate.

Resumo

A inversão da tendência crescente do crime no estado de São Paulo despertou interesse em determinar suas possíveis causas. Diversos fatores têm sido sugeridos pela literatura para explicar esse grande declínio do crime. A hipótese adotada é a de que o choque de produtividade da polícia gerado pelo INFOCRIM foi o fator crucial para explicar o declínio. Assim, este trabalho tem como objetivo avaliar o impacto do INFOCRIM no crime no estado de São Paulo. Para tanto, adotou-se o método de controle sintético para realizar um estudo de caso do impacto do INFOCRIM nas taxas de homicídio no estado de São Paulo. Comparou-se os resultados no INFOCRIM com um contrafactual do "estado de São Paulo sem o INFOCRIM". Estimou-se que a taxa de homicídios com INFOCRIM diminuiu 37% em comparação com a taxa de homicídios no cenário sintético de São Paulo sem o INFOCRIM.

Palavras-chave: Choque de produtividade da polícia; controle sintético; INFOCRIM; taxa de homicídio.

JEL: C15, R10.

♣ "Paulista" is the person who was born in the State of São Paulo (Brazil).

1. Introduction

Crime imposes immense social costs and negative externalities, representing the pernicious effects on economic activity and the quality of people's life (Lochner and Moretti, 2004). For instance, the cost of violence in Brazil was estimated to be 5.9% of 2016 GDP (Anuário Brasileiro da Segurança Pública, 2017). Obviously, the violence cost is high because the criminality rates are high in Brazil, which concentrates 14% of all homicides in the world, thus being part of the top ten of the violence ranking, according to Health World Organization (Waiselfsz, 2015).

As reported in table 1, there is a clear uptrend in Brazil's homicide rate over the years. In 1980, there were 10.8 homicides per one hundred thousand people in Brazil, whereas in 2014 the homicide rate was already of 34.6. Over this period, crime in Brazil increased more than 220%.

The regional distribution reveals that crime has spread out to all Brazilian macro-regions. In the period of 1980 to 1999, all macro-regions faced an increase in homicide rates (table 1). Some regions are above the Brazilian average, such as the Southeast (149%), the North (135%) and the Central-West (151%), while other regions are below the Brazilian average, namely, the Northeast (94%) and the South (60%). The leading Brazilian state in crime growth during this period was São Paulo (220%), with a homicide rate of 44.1, higher than the Brazilian average (24.1). From 1999 to 2014, Brazil had a slowdown in crime growth, but even so, it faced an increase of 43%. In this period, all regions, except the Southeast, showed an increase in their homicide rates. The negative highlight was the crime growth in the Northeast region (160%).

Table 1. Regional Distribution of Homicide Rates in Brazil

Regions	1980	1999	2014	Variation 1980-1999 (%)	Variation 1999-2014 (%)
South	8.5	13.6	21.2	59.9	55.9
North	11.5	27.0	32.6	134.8	20.7
Northeast	8.5	16.4	42.7	94.1	160.2
Central-West	11.6	29.0	37.7	150.8	29.7
Southeast	15.9	39.5	27.6	148.5	-30.1
São Paulo	13.8	44.1	13.5	220.2	-69.4
Brazil	10.8	24.1	34.6	123.7	43.3

Source: authors' own elaboration, using crime data from the Ministry of Health.

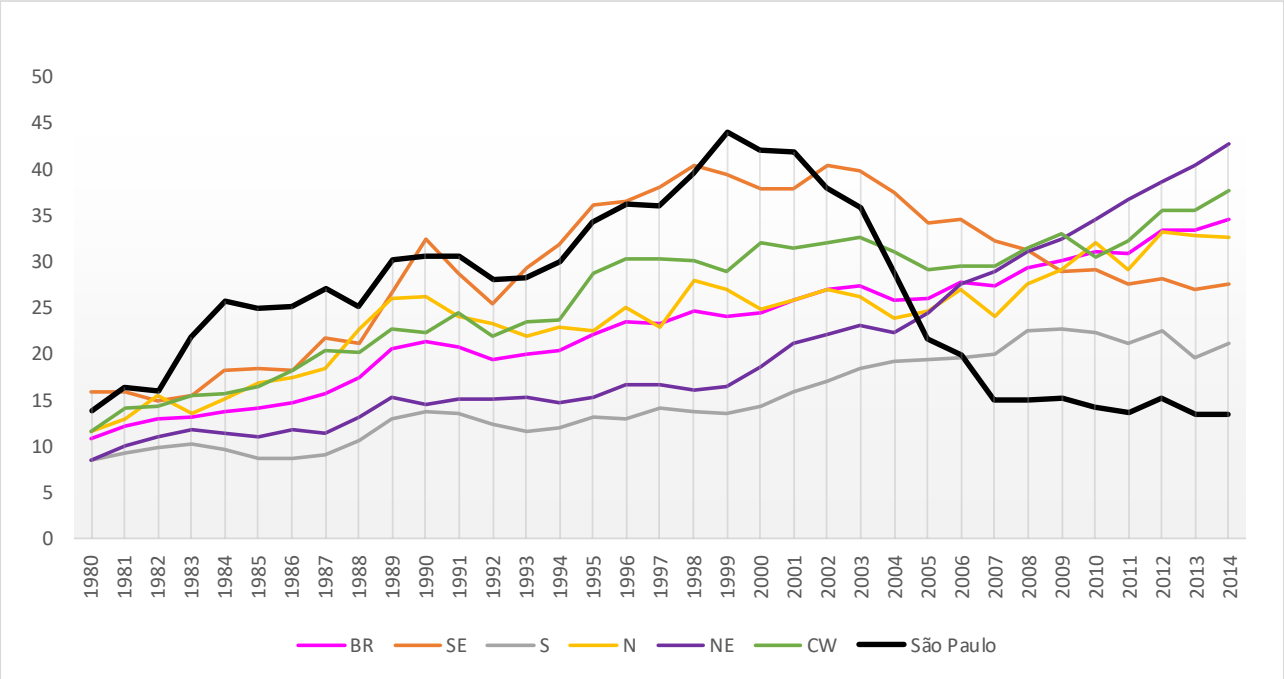
In contrast to this crime surge in Brazil, the homicide rate in the state of São Paulo,[1] after a skyrocketing trend, reversed this trend in 2000 by showing a sharp drop in incidence, returning to the crime level of the early eighties, as in figure 1. There was a decline of almost 70% in the homicide rate in the state of São Paulo, making it one of the three states with the lowest crime levels in the country.[2] This is the "Great Paulista Crime Decline Puzzle". The reversal of criminality in São Paulo was celebrated by the United Nations as a successful case, along with New York and Bogota.

The fundamental question that arises is the following: while Brazil and the other states are facing increasing criminality, what is the cause of this great crime decline in the state of São Paulo? Such a great crime decline in the 2000s has motivated intense debate in the literature to try to address this question. There are several competing hypotheses to explain it. Some hypotheses involve nationally scoped policies and, while others involve policies that occurred only in São Paulo.

[1]The state of São Paulo is Brazil's second richest state in terms of GDP per capita and the country's most populous state with more than 45 million inhabitants in 2017.

[2] The macro-region Southeast had a drop in crime due to the state of São Paulo's crime decline.

Figure 1. Trajectory of Homicide Rates for Selected Regions (1980-2014)



Source: authors' own elaboration.

As to national scoped events, there is a suggested hypothesis about the impact of Brazil's gun control laws on the crime decline in the state of São Paulo (Hartung, 2009; Cerqueira, 2010; Cerqueira and Mello, 2012; Souza et al. 2007).[3] This hypothesis hinges on the argument of "less weapons, less crimes". In Brazil, 88% of all homicides involve firearms. In this context, the argument is that fewer circulating weapons would reduce crimes motivated by interpersonal conflict. Gun control laws have increased the cost of carrying firearms, reducing their demand, alongside with the voluntary devolution of firearms in exchange for money (buy-back). The hypothesis is that such a policy has reduced the stock of firearms.[4]

From an empirical approach, Cerqueira and Mello (2012) adopt a panel data model to estimate the effect of guns on violent crimes and on property crime, using a proxy for the prevalence of firearms (suicides committed with firearms divided by total of suicides) and using also an instrumental variable for this proxy to correct endogeneity. The authors presented evidence that gun control measures, operated in the state of São Paulo between 2001 and 2007, decreased violent crimes. The problem with this explanation is that gun control laws were implemented throughout Brazil after June 2004, but the study used only information from the state of São Paulo. If gun control laws reduce crime, it must be valid for the entire national territory. The authors did not validate the gun control laws hypothesis by expanding the study area for Brazil as a whole. In the guise of partial validation, using information from all Brazilian federative units,[5] we ran the first differences in homicide rates between 2000 and 2010 (DHOMRATE) on the same proxy variable for prevalence of firearms used by the authors, also in first differences (DSAF), in the same period. There is no correlation between these variables.

The soundest evidence on the impact of the buy-back program on crime is from Scorzafave *et al*. (2015). The authors analyzed its impact on deaths, using a quasi-experimental study based on matched difference-in-differences. The treatment group was composed by Paraná's municipalities,

[3] Justus and Kassouf (2012; 2013) seek to investigate the impact of gun laws, but only for the city of São Paulo.
[4] According to Scorzafave et al (2015), only 3% of the stock of firearms in Brazil was withdrawn from circulation by the buy-back campaign.
[5] Brazil is divided into 27 federative units, being 26 states and one federal district. The map with the Brazilian states and federal district is in figure A.1 in the appendix. The list with names and initials of the Brazilian states and macro-regions is in table A.1 in the appendix as well.

whereas the control group was composed by municipalities of other Brazilian states. No impact of the buy-back program was found out at all.

Another explanation given for the great crime decline is the demographic transition experimented by Brazilian society (Mello and Schneider, 2010). The basic idea behind this hypothesis is that young males aged fifteen to twenty-four are prone to commit offenses, representing a high-risk age group in terms of involvement with offenses. Consequently, this demographic transition has provoked the decline of the percentage of males between fifteen and twenty- four years old in the population, which caused the reduction of crime. Once again, the validation test of this hypothesis was not done using information from all levels of Brazilian society.

By ways of partial validation, using information from all Brazilian federative units, we ran the differences between homicide rates over the period of 2000-2010 (*dhomrate*) regarding the differences of the group of young men aged 15-24 years for the same period (*dcrimeage*). The correlation between these variables was not significant at the 10% level, casting doubt on the possible causal link.

Sixty-seven municipal police forces were created over the period of 1999-2014 in São Paulo (Kahn and Zanetic, 2005). One might therefore conjecture that security policies at the municipal level may have been responsible for reducing crime in São Paulo. However, there was also the creation of municipal police forces throughout the country. Analyzing the implementation of municipal guards only for the state of São Paulo, and using a fixed-effect model for the period 2004-2009, Ferreira et al. (2016) found evidence of a drop in both the homicide rate and the robbery and theft rates due to the impact of the implementation of municipal police forces. The problem is that the study did not control for the regression of INFOCRIM, which is a technological information system similar to COMPSTAT. In this sense, INFOCRIM is a confounding factor because it is correlated with the implementation of municipal police forces and, at the same time, related to crime, thus overshadowing the causal effect.

In turn, Vital (2018) assessed the impact of this kind of policy on both homicide and vehicle theft rates, but now controlling for INFOCRIM. The author did not find evidences that the creation of municipal police forces had an impact on crime rates (homicide rates and vehicle theft rates) in São Paulo or Brazil, ruling out that this hypothesis is valid to explain the "great Paulista crime decline". The absence of statistical significance lies in the fact that the assignment of municipal police forces is intended by law to protect public property and not to fight crime. In fact, what causes the decline of crime in São Paulo must be another factor that is missing in the estimation of the model, operating exclusively in this state.

As to policies that were just implemented in the state of São Paulo, dry law hypothesis is regarded as a potential reason to explain the crime decline (Biderman et al, 2010; Kahn and Zanetic, 2005; Dualibi et al, 2007). Sixteen municipalities in São Paulo enacted dry laws that impose compulsory closing hours for bars and restaurants from 11pm to 6am all week long (Biderman et al, 2010). The idea behind this hypothesis lies in the fact that dry laws restrain recreational alcohol consumption and sales by imposing compulsory closing hours. The restriction of alcohol consumption avoids the interpersonal confrontation that might lead to murders. There are two caveats with this explanation, acknowledged by the authors themselves (Biderman et al, 2010). First, it is not a general explanation since only 2.5% of the municipalities of the state adopted dry laws, therefore, insufficient to have an impact on the whole state. Second, the timing of implementation of the dry law does not match the onset of crime decline. All these cities implemented the dry law after 2001, except one, while the criminal drop started in the state of São Paulo in 2000.

Another explanation claims that there was a monopolization of crime in the prison system by the PCC[6] gang. The PCC Hypothesis would explain the reduction of crime by means of administering justice and of the meditation of personal conflicts and the monopolization of drug trade (Biderman et

[6] The acronym PCC means "Primeiro Comando da Capital", that is, "First Command of State's Capital".

al, 2014). [7] Working with data from January 2005 to October 2009, Biderman et al (2014) found a negative effect on crime in some slums in the metropolitan area of São Paulo. Once again, it is noteworthy that the crime decline happened earlier. In addition, Justus et al (2016) dismantle this hypothesis, arguing that there was a crime decline in most of the municipalities of the state of São Paulo where there were no attacks by the PCC gang. Using a proxy for presence of the PCC gang, the authors did not find out any effect of PCC on crime.

The bottom line is that we are skeptical about the identification of the causal effect of these hypotheses suggested by the literature to explain the great crime decline in São Paulo. The aforementioned explanations suffer from three potential shortcomings. First, the timing of the implementation of these policies (gun control laws, dry laws and the PCC hypothesis) does not match the onset of the crime decline in São Paulo. Second, nationally scoped factors should be tested not only for São Paulo, but also for Brazil as a whole in order to validate their causal link (gun control laws, demographic transition and municipal police forces). Third, the majority of the studies did not control for the INFOCRIM, the technology oriented to the public security, being this one kind of confounding factor.

Our alternative hypothesis is that the police productivity shock experienced in the State of São Paulo, generated by INFOCRIM, was the crucial factor to explain its great crime decline. The causal channel that explains the crime reduction is as follows: the adoption of INFOCRIM in 1999/2000 represented a police productivity shock, thereby increasing the probability of a criminal being arrested. Consequently, there was a change in the behavior of potential criminals that reduced their chance of committing offenses. We consider this hypothesis more plausible than the others because the date of implementation of INFOCRIM matches the onset of the crime decline. In addition to, our hypothesis involves a distinctive factor that only happened in São Paulo.

In our empirical strategy, we investigate the hypothesis of a police productivity shock as the main factor responsible for the great crime decline, using a synthetic control method. Our findings indicate that the police productivity shock caused a drop in the homicide rate of around 37% in comparison to what would have happened with the crime rates in São Paulo, if it had not experimented this police productivity shock generated by the adoption of INFOCRIM.

The organization of the paper is as follows. Next section describes the public security oriented policy, INFOCRIM. The third section explains the empirical strategy adopted and the data set compiled. The fourth section discusses the results, whereas the final part concludes.

2. Police Productivity Shock in the state of São Paulo

We claim that the "great Paulista crime decline puzzle" is caused by the police productivity shock in São Paulo. The policy that had the greatest impact on the increase of police efficiency in São Paulo was the integrated technological information system, INFOCRIM, implemented when crime in São Paulo reached its peak.

From 1999 onward, the state of São Paulo began to invest heavily in technological systems dedicated to fighting crime. This investment in technology at the service of public security has intensified the efficiency of police operations, increasing the likelihood of potential criminals to be arrested. This moment coincides with the onset of the reversal in the trajectory of the homicide rate for the state of São Paulo in 2000.

INFOCRIM is a technological crime tracking system, which is able to compile in online databases the entire information about criminality in the state of São Paulo. This information system is similar to COMPSTAT and includes the type of crime and the location of its occurrence on map. This unified criminal data and intelligence system geocodes police reports, detecting crime spots and allocating police forces to fight crime where and when it occurs.[8] Besides, by transmitting crime information in real-time and online, INFOCRIM allows coordinating police activities.

[7] Some studies use ethnographic evidence in favor of the crime reduction in geographic areas dominated by PCC gangs (Dias, 2011; Willis, 2013 and 2015).

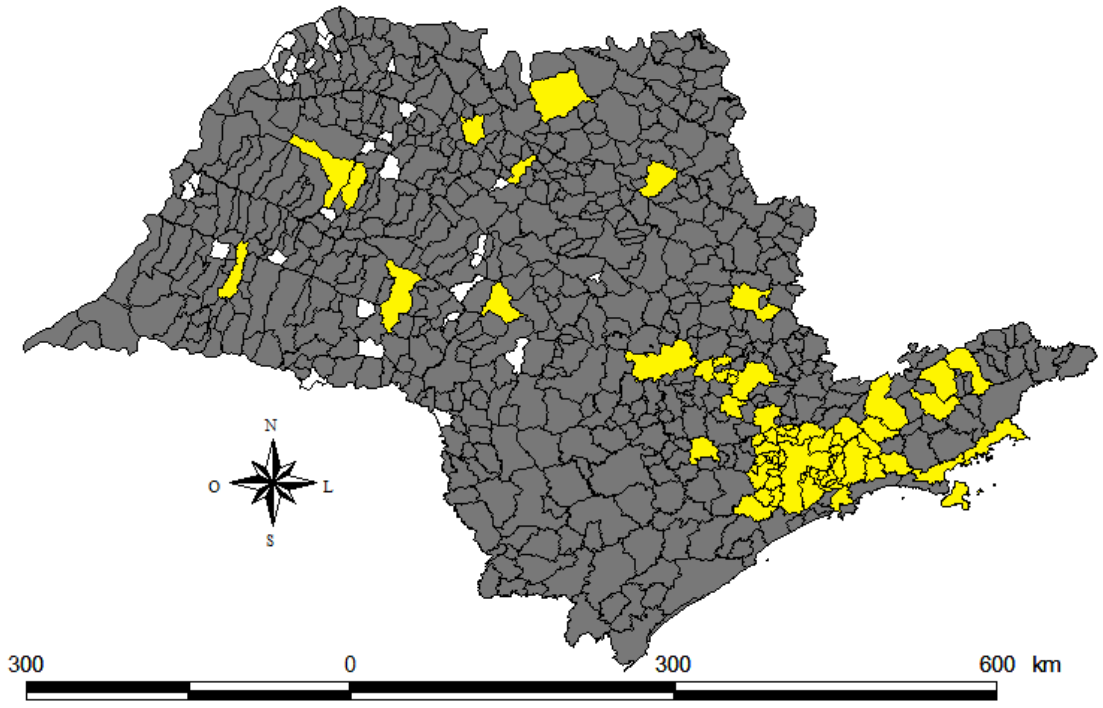
[8] Besides, INFOCRIM now includes FOTOCRIM, which is a photo database that contains prisoners' photos.

All police departments have online access to INFOCRIM and police officers on streets can consult the system by means of computers installed on the vehicles. INFOCRIM has affected all stages of fighting crime, whether at the stage of prevention, repression or further investigation of crimes.

An important step towards the implementation of INFOCRIM was the geocoding of police reports, which started in the biennium of 1999-2000 in the city of São Paulo, since it had one of highest crime rates in the state of São Paulo.[9] From 2001 to 2003, INFOCRIM was taken to 38 municipalities that make up the metropolitan region of the city of São Paulo. These 39 cities concentrate 54% of all homicides in the state. Over the period of 2003-2005, INFOCRIM was implemented in five big cities in the countryside of São Paulo. In 2008, INFOCRIM was taken to eighteen other cities. The spatial distribution of municipalities with INFOCRIM in 2008 is shown in figure 2.

Cabral (2016) carried out the only work in the literature that investigated the impact of INFOCRIM on crime in São Paulo. By means of the variation of the data within the state of São Paulo in a difference-in-differences approach, the main finding indicates that the municipalities that received INFOCRIM had a lower homicide rate than the municipalities that were not contemplated with the program.

Figure 2. Spatial Distribution of Cities with INFOCRIM in São Paulo in 2008



Subtitle:

Cities with INFOCRIM (67)
Cities without INFOCRIM (548)
Not sampled (30)

Source: adapted from Cabral (2016).

The increase in police productivity coming from the adoption of INFOCRIM is observed in table 2. As can be observed, over the period of 2002-2014, seizures of drug trafficking per police officer increased by 218%, whereas arrests per police officer and people caught in the act per police officer rose, respectively, 55% and 50%.

[9] The state of São Paulo is divided into 645 municipalities. In turn, the city of São Paulo is the capital of the state of São Paulo.

Table 2. Occurrences and Police Productivity Indicators in the State of São Paulo

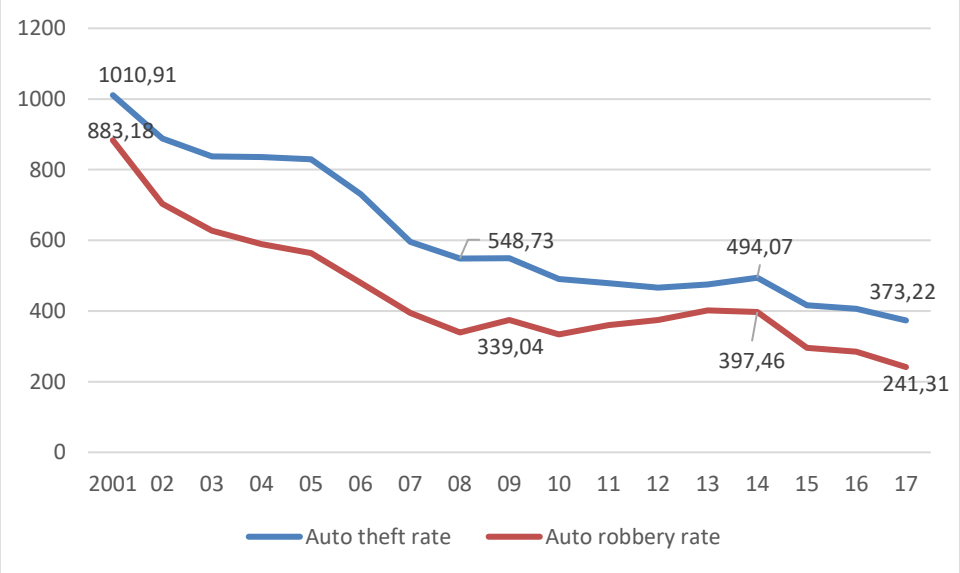
Occurrences	**2002**	**2014**	**Variation (%) 2014/2002**
Drug trafficking (1)	12,104	41,563	243
Arrests (2)	90,319	151,044	67
People caught in the act (3)	65,583	106,498	62
Number of police officers♦ (4)	112,659	121,756	8
Police productivity indicators			
Drug trafficking per police officer: (1)/(4)	0.11	0.34	218
Arrests per police officer: (2)/(4)	0.80	1.24	55
People caught in the act per police officer: (3)/(4)	0.58	0.87	50

Source: Secretary of Public Security.
Note: ♦sums civil police officers and military police officers.

The result of this increase in police productivity in São Paulo is the crucial factor explaining the large decline of approximately 70% in the homicide rate between 2000 and 2014. In addition, the increase in police productivity also explains the reduction of crimes against property. Figure 3 shows the downward trajectory of vehicle theft and vehicle robbery rates.[10] In the period 2001-2014, the vehicle theft and robbery rate fell, respectively, 51% and 55%. Extending the time interval to 2017, the vehicle theft and robbery rate decreased, respectively, 63% and 73%.

Therefore, our hypothesis is that INFOCRIM, a technological system at the service of public security, has increased police productivity, raising the likelihood of criminals being arrested and thereby reducing crime. Such an increase in police productivity was the distinguishing factor in relation to the situation of the other states, which did not have this technological shock. Moreover, the starting date of INFOCRIM (1999/2000) coincides with the beginning of the reversal of the crime trend in São Paulo (2000).

Figure 3. Annual Evolution of Vehicle Theft and Robbery Rates (2001-2017)



[10] These crime rates were compiled from São Paulo's Secretary of Public Security.

3. Empirical Strategy

3.1. Construction of Synthetic Control

In order to evaluate the impact on crime generated by the police productivity shock generated by the adoption of INFOCRIM in São Paulo, it is necessary to compare the situation of this state after the occurrence of the productivity shock with the situation that would prevail in the same state if there had not been a productivity shock. Clearly, the last outcome is not observed. Therefore, such outcome should be conjectured by building up a counterfactual for São Paulo in such a way that the only difference between São Paulo and the control group would be the police productivity shock generated by INFOCRIM.

A way to build up a counterfactual is to make an experiment by randomly choosing a treatment group and a control group. However, the difficulty for building up a controlled experiment in economics is widely known. Most frequently, economists and social scientists have to use observational data instead of sampling data, in order to assess a policy impact. Therefore, economists endeavor to find some options in order to build up a quasi-experiment, which attempts to mimic a random experiment (Cameron and Trivedi, 2005).

First of all, one should notice the peculiarities of this particular quasi-experiment. We have only one Brazilian state that has adopted INFOCRIM in our study. In addition, the set of untreated regions that can make up the control group is limited to, at most, the other 26 federative units. Given this quasi-experimental scenario, the lack of observations makes it unfeasible to adopt some of the most popular approaches to implement impact assessment, such as differences-in-differences (DID) and the data-panel approach estimated by the instrumental variables method.

Alternatively, the synthetic control method is adopted in the literature for studying several subjects when geocoded data are used (as for example, regions, census tracts, districts, planning areas, counties, municipalities, states, countries, etc.). Such a method has proved to have several advantages (Abadie and Garzeabadal, 2003; Abadie et al, 2010). For instance, an advantage of synthetic control over differences-in-differences method rests on the fact that synthetic control takes into account non observable idiosyncratic characteristics, both time invariant and time variant (Abadie et al, 2010). It is noteworthy to remember that the differences-in-differences approach considers only these characteristics invariant in time that are removed from the estimation by double differencing.

In view of these advantages, the synthetic control was adopted for the elaboration of the counterfactual by seeking a synthetic trajectory of the homicide rate to the state of São Paulo. The creation of a control group aims to synthesize the trajectory of counterfactual result for this particular region, using information from similar regions. The basic goal is that the synthetic São Paulo should accurately resemble the trajectory of the homicide rate of the actual São Paulo. To do so, we used a data-driven procedure to choose control groups in order to reduce the discretion of this choice.

The synthetic group is formed by a weighted average of potential other states that do not suffer the same treatment. There are two elements in this creation of synthetic control, namely, choice of control states and the choice of weights of the states in the computation of the weighted average. Weights are chosen to minimize the difference between the previous level of the homicide rate for the synthetic São Paulo and the previous level of the homicide rate for the actual São Paulo. Besides, these weights on each state in the control group are constrained to be non-negative and their sum equals one.[11]

For the same reason, the choice of control states was made with the purpose of having similar characteristics to the state of São Paulo. This similarity hinges on the homicide rate and its predictors grounded by theoretical concerns. In our case, the predictors used here are based on crime literature (Becker, 1968; Ehrlicht, 1977; Kelly, 2000).

The basic assumption of identification is that the synthetic São Paulo accurately reproduces what would happen to the actual São Paulo, if that state had not implemented INFOCRIM. Nonetheless, there are other identification challenges. A problem often overlooked is the violation of the assumption of no interference between units (Rosenbaum, 2007). The explicit assumption of

[11] For more details, see Abadie and Gardeazabal (2003) and Abadie et al (2010).

synthetic control is that the assumption of no interference between units is valid. There are two possibilities that may violate this assumption in our study. First, other states may have been influenced by INFOCRIM implemented in São Paulo and may have imitated it. Therefore, we should exclude all those states from the donor pool utilized to construct the synthetic control. Second, this assumption can be violated in the presence of spatial displacement of crime. If this does occur, the police productivity shock in São Paulo will contaminate its contiguous neighbors. The way to handle this kind of contamination within the synthetic control approach is also to eliminate these neighbors from the donor pool.

3.2. Data and Sample

In this study, we adopted annual state-level panel data for the period of 1980-2014 for the state of São Paulo and for other states that belong the donor pool. As INFOCRIM was implemented in 1999, there are 14 years before the intervention under study. Due to the lack of information for our outcome variable (homicide rate) prior to 1988, we removed Tocantins from the donor pool.

In Brazil, no other state had adopted a public security oriented technology quite like INFOCRIM. Notwithstanding, some states adopted other innovative public security policies, such as Rio de Janeiro with Peaceful Police Units , Minas Gerais with “Fica-Vivo” (Stay Alive) and Olho Vivo, Ceará with community policing policy, and, finally, Pernambuco with the "Pact for Life". Including these states in the pool donor could contaminate the synthetic control group, thereby mitigating the effect of police productivity shock in São Paulo. Therefore, as exposed previously, these states were excluded from the donor pool.

One must be aware that Rio de Janeiro, Minas Gerais, Paraná and Mato Grosso do Sul are neighbors to the São Paulo State. If there has been a spatial displacement of crime, such an effect could have contaminated the Synthetic São Paulo, which would attenuate the effect of productivity shock on crime. Thus, we excluded these neighboring states in the donor pool as well.

Consequently, the potential donor pool to elaborate the synthetic São Paulo is composed of 19 states. Since none of these potential control states has been treated, the synthetic control group should be independent of the direct effects of the treatment.

Our outcome variable is homicide rate per 100,000 inhabitants. This proxy for crime was chosen because the under-reporting is low. Besides, this crime information has been available to all Brazilian states for several years since 1980. The homicide data come from DataSus, which is a database of the Brazilian Ministry of Health.

The variables used as predictors for the construction of synthetic control were income per capita, poverty rate, education, population density, income inequality and serially lagged homicide rates (1998, 1990, 1985 and 1980). More information on these variables is reported in table 3.

Table 3. Description of Variables Used

Variable	Description	Source
Homicide rate	Homicide rate per 100,000 inhabitants	Ministry of Health
Income	GDP per capita (in 2010 constant thousand reais)	IBGE
Poverty rate	Ratio of quantity of poor people to population	IBGE
Education	Average years of schooling for people aged 25 and over	IBGE
Population Density	Population divided by area	IBGE
Inequality	Gini coefficient	IBGE
Homicide rate 1998	Homicide rate per 100,000 inhabitants in 1998	Ministry of Health
Homicide rate 1990	Homicide rate per 100,000 inhabitants in 1990	Ministry of Health
Homicide rate 1985	Homicide rate per 100,000 inhabitants in 1985	Ministry of Health

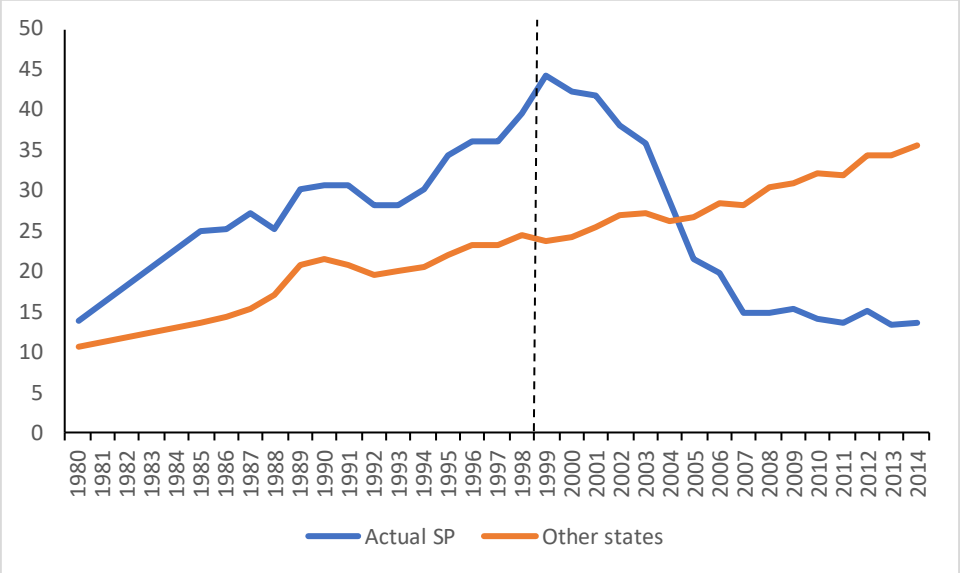
Homicide rate 1980	Homicide rate per 100,000 inhabitants in 1980	Ministry of Health

Source: authors' own elaboration.

4. Results

To evaluate the impact of the police productivity shock on crime, it is necessary to build up a control group to furnish a counterfactual if São Paulo had not had such a shock. Figure 4 shows the increasing temporal trajectory of the homicide rate of the other states in comparison with São Paulo. One perceives that it would not be appropriate to use this control group to do the counterfactual since the parallel-trend assumption is not met.

Figure 4. Annual Trajectories of Homicide Rates: Actual SP and Other States



Source: authors' own elaboration.

In order to be regarded as a good counterfactual, a control group requires that its observable and non-observable characteristics must be similar, on average, to the State of São Paulo. Table 4 reports the means of the predictors used in the implementation of the synthetic control. As can be observed, the synthetic group for the state of São Paulo displays averages for these predictors close in magnitude, except for income and density.

Table 4. Averages of the Predictors of Homicide Rate

Variables	Actual São Paulo	Synthetic São Paulo
Income	23.99	9.77
Poverty rate	12.85	14.05
Education	4.83	4.84
Density	128.63	10.88
Gini coefficient	0.54	0.54
Homicide rate in 1998	39.68	39.49
Homicide rate in 1990	30.69	30.91
Homicide rate in 1985	25.04	24.60
Homicide rate in 1980	13.78	12.10

Source: authors' own elaboration.

Table 5 reports the weights for each donor state in the construction of the synthetic São Paulo, as well as the states that were excluded from the donor pool.

Table 5. Estimated Weights of Synthetic Control for the Homicide Rate

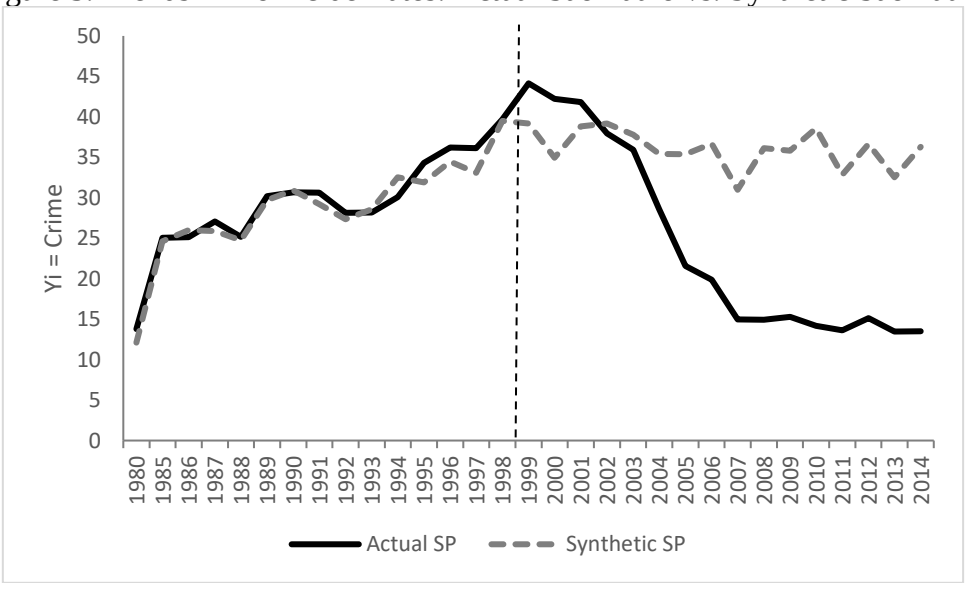
State	Weight	State	Weight
Rondônia	0.340	Sergipe	0
Acre	0	Bahia	0
Amazonas	0	Minas Gerais	-
Roraima	0	Espírito Santo	0.092
Pará	0	Rio de Janeiro	-
Amapá	0.406	Pernambuco	-
Tocantins	-	Paraná	-
Maranhão	0	Santa Catarina	0
Piauí	0	Rio Grande do Sul	0
Ceará	-	Mato Grosso do Sul	-
Rio Grande Norte	0	Mato Grosso	0.129
Paraíba	0	Goiás	0
Alagoas	0.032	Distrito Federal	0

Source: authors' own elaboration.
Observation: the symbol "-" indicates that the State has been excluded from the analysis.

When implementing the synthetic control, five donor states received weights greater than zero to form the control group for the State of São Paulo, namely Rondônia (0.340), Amapá (0.406), Alagoas (0.032), Espírito Santo (0.092) and Mato Grosso (0.129). This weighting structure points out that the homicide rate trend in São Paulo is best represented by a weighted average of these states.

Figure 5 depicts our assumption of identification, tracing the trajectories of the actual São Paulo and the synthetic São Paulo for the homicide rate. Looking at this figure, at first we verify that the synthetic series behaved as a good counterfactual, since it predicted adequately the homicide rate in the absence of INFOCRIM. This is confirmed by the root mean square prediction error (RMSPE) of synthetic series in comparison with the original series. During the pre-treatment period, the RMSPE value was 1.46, considered a very good fit for the homicide rate in São Paulo prior to INFOCRIM.

Figure 5. Trends in Homicide Rates: Actual São Paulo vs. Synthetic São Paulo



Source: authors' own elaboration.

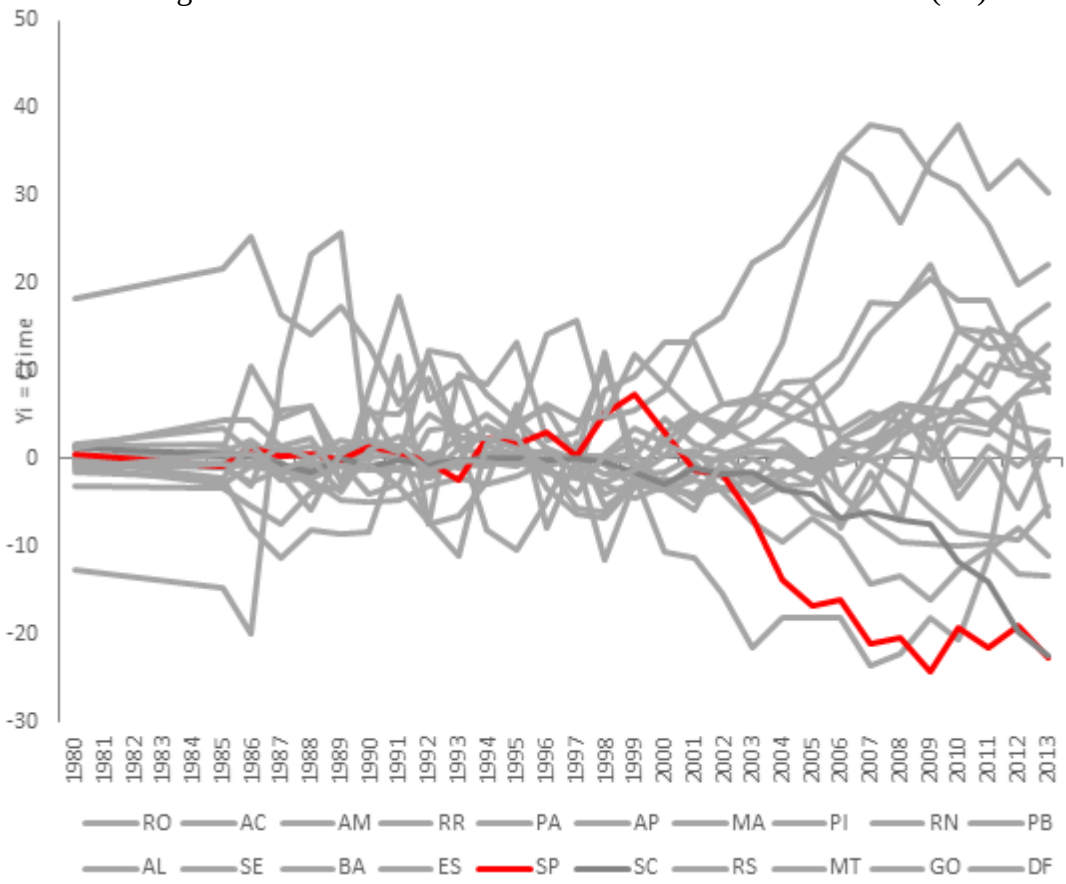
The homicide rate trends for the Synthetic São Paulo and the actual São Paulo are parallel until approximately 1999. During the period of 2000-2003, there is a detachment in this trend. In contrast, after 2003, the synthetic trajectory was above the trajectory of the series for actual São Paulo. Thus, one concludes that the police productivity shock of the state of São Paulo was able to reduce homicide rates considerably.

In addition to the graphical analysis, it is possible to calculate the average effect of the police productivity shock on crime. To do so, one must calculate the ratio between the actual and the synthetic homicide rates. Afterwards, the average is calculated for the periods subsequent to the treatment. Our results indicate that for the entire 2000-2014 period, the homicide rate had a decline of 36.9%.

In order to check the falsification of the results, three placebo tests were performed. In the first placebo test, we applied the synthetic control to estimate the impact of INFOCRIM in São Paulo to every state in the donor pool. In each placebo run one control state is considered as treated in 1999 (that is, adopting INFOCRIM), shifting São Paulo to the donor pool. The idea is to check if the gap in Figure 5 was created by factors other than INFOCRIM (Abadie et al, 2010).

The purpose of the test was to check if the difference for the treated state of São Paulo generates some different behavior when compared to the differences of the other non-treated states. If the effect of São Paulo is located at the extremities of figure 6, there is statistical significance of the police productivity shock generated by INFOCRIM. Figure 6 depicts the results of this placebo test. The gray lines stand for the gap related to each placebo run, displaying the difference in homicide rate between each state in the donor pool and its synthetic control. Similarly, the red line describes the gap in homicide rate estimated for São Paulo. As can be observed in figure 6, the line representing the gap in homicide rate for São Paulo starts to be located at the lower end of the distribution of the gaps for states in the donor pool, denoting the statistical significance of the impact of the police productivity shock.

Figure 6. First Placebo Test for Homicide Rate of São Paulo (SP)

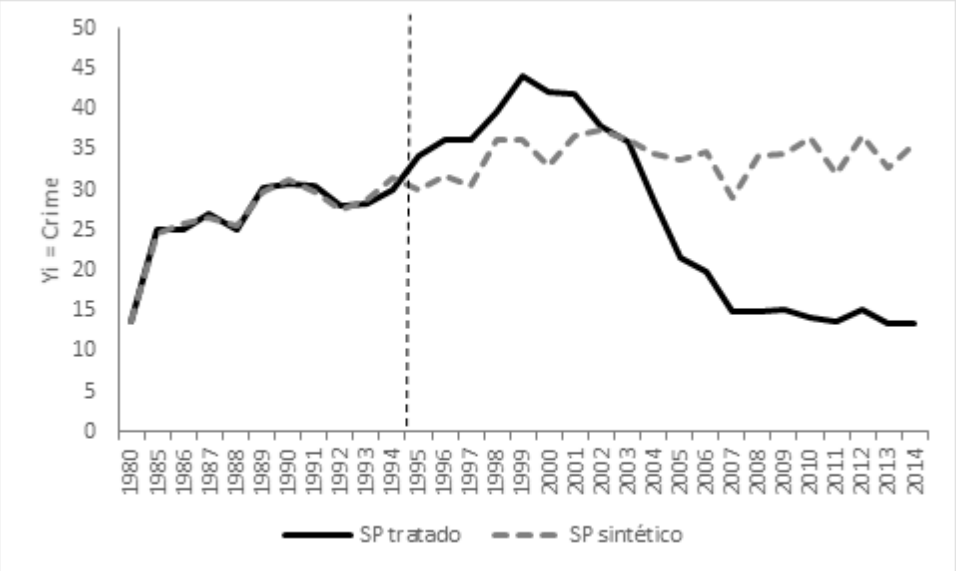


Source: authors' own elaboration.

In turn, the second test stands for a temporal placebo. The intuitive idea behind this test was to check if the effect found in 1999 is not spurious. To do so, new synthetic series was generated with pretreatment periods set back in five years (1994). Even with the new pretreatment period, our expectation was that there would be no changes in the point where the synthetic and treated series

actually separated. The synthetic trajectory constructed by figure 7 followed the trajectory of the treated series, similar to the results of figure 5. This means that the pre-shock period receded in time to 1994 did not alter the previous results.

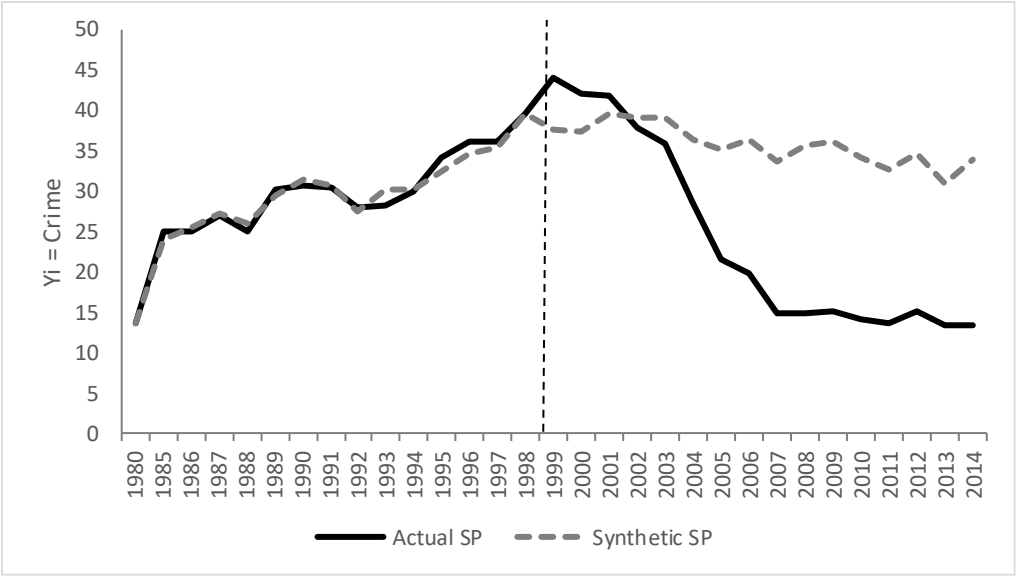
Figure 7. Temporal Placebo Test for the Homicide Rate of São Paulo.



Source: authors' own elaboration.

At last, we checked the robustness when the assumption of no interference between units was relaxed. Therefore, we included the neighbors of São Paulo, as well as the states that implemented innovative security policies in the donor pool. We got then a new synthetic control, which is composed of 21.0% Rondônia (RO), 13.5% Amapá (AP), 14.0% Pernambuco (PE), 2.3% Alagoas (AL), 14.2% Mato Grosso do Sul (MS), 14.9% Mato Grosso (MT) and 20.1% Distrito Federal (DF). It is noteworthy that the synthetic control had then a state that implemented an innovative security policy (PE) and another state (MS), which is neighbor of São Paulo, violating, thereby, the assumption of no interference between units. Figure 8 depicts the homicide rate trajectories for the actual São Paulo and for the synthetic São Paulo, but now allowing an enlarged donor pool with 25 potential control states. Our result indicates a decline in crime of 37.4%, which is very similar to the result obtained with a synthetic control without neighbors and states that adopted innovative security policies. Thus, our results seem to be robust.

Figure 8. Trends in Homicide Rates: Actual São Paulo vs. Synthetic São Paulo with an Enlarged Donor Pool



Source: authors' own elaboration.

5. Final Remarks

The article evaluated the impact on crime of the police productivity shock generated by the adoption of INFOCRIM in the state of São Paulo. Our findings indicate a decline in crime of approximately 37% compared to the state of São Paulo's crime trajectory, had it not had this productivity shock. Therefore, we consider that the police productivity shock was the crucial factor to explain the great Paulista crime decline and to solve the puzzle.

In the end, this article has two messages: one pessimistic and another optimistic. The pessimistic message is that crime in Brazil has spread over the last fifteen years, practically throughout the country, with an increasing trend, except for the state of São Paulo. The optimistic one is that all other Brazilian states may also reduce their crime rates by adopting a public security policy similar to INFOCRIM.

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Appendix

Figure A.1. The Brazilian States

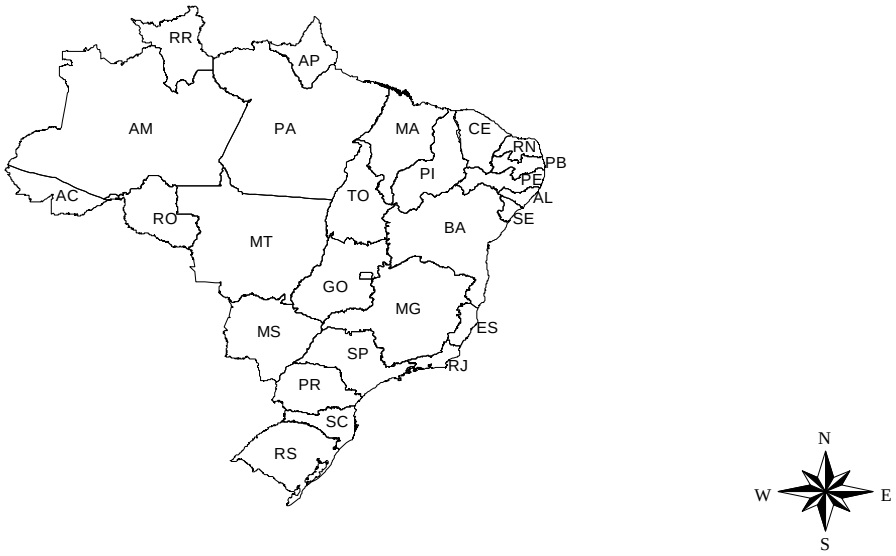

Table A.1. Initials and Names of Brazilian States and Macro-Regions

Macro-Region or State	Initials	**Macro-Region** or State	Initials
North	**N**	**Southeast**	**SE**
Rondônia	RO	Minas Gerais	MG
Acre	AC	Espírito Santo	ES
Amazonas	AM	Rio de Janeiro	RJ
Roraima	RR	São Paulo	SP
Pará	PA		
Amapá	AP		
Tocantins	TO	**South**	**S**
		Paraná	PR
Northeast	**NE**	Santa Catarina	SC
Maranhão	MA	Rio Grande do Sul	RS
Piauí	PI		
Ceará	CE		
Rio Grande Norte	RN		
Paraíba	PB	**Center-West**	**CW**
Sergipe	SE	Mato Grosso do Sul	MS
Bahia	BA	Mato Grosso	MT
Alagoas	AL	Goiás	GO
Pernambuco	PE	Distrito Federal	DF

Source: authors' own elaboration.