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# Crime and Economic Growth: A Case Study of Manaus, Brazil

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**Abstract:**

Due to economic and social advances since the 1990s, Brazil became the 7th largest economy in the world in 2012. However, crime rates have not stopped rising since the beginning of the last decade, with Brazil having the 11th largest homicide rate on the planet in that year (UN). In this paper we estimate how much crime harms economic activity from a case study of the city of Manaus, where in 2007 the organized crime group known as "Família do Norte" was created. We analyzed the effects on Manaus' GDP per capita using the synthetic control method. The comparison between Manaus and its synthetic control in the period after the creation of the criminal group showed that the presence of the criminal faction diminished the city's GDP by 3% per year. Robustness checks confirmed this result, showing how organized crime can disrupt the country's economic advances.

**Keywords:** Crime and economic activity; Organized crime; Synthetic control method.

**JEL Codes:** K32; O47; Z18.

# Crime and Economic Growth: A Case Study of Manaus, Brazil


## ABSTRACT

*Due to economic and social advances since the 1990s, Brazil became the 7th largest economy in the world in 2012. However, crime rates have not stopped rising since the beginning of the last decade, with Brazil having the 11th largest homicide rate on the planet in that year[1]. In this paper we estimate how much crime harms economic activity from a case study of the city of Manaus, where in 2007 the organized crime group known as "Família do Norte" was created. We analyzed the effects on Manaus' GDP per capita using the synthetic control method. The comparison between Manaus and its synthetic control in the period after the creation of the criminal group showed that the presence of the criminal faction diminished the city's GDP by 3% per year. Robustness checks confirmed this result, showing how organized crime can disrupt the country's economic advances.*


## 1. INTRODUCTION

"Any government is better than the absence of government. Despotism, however bad, is preferable to the greater evil of anarchy, widespread civil violence, and the permanent fear of violent death." Almost four hundred years after this remark by Hobbes (1968), the problems of despotism has been resolved, but the absence of government still remain, although in the latter case the problem is less one of anarchy and more one of weakened institutions that fail to secure the right to property of citizens - who are at the mercy of civil violence.

In the last five years, Syria - despite its current war-torn status - recorded fewer murders than Brazil[2] (280,000 Brazilian deaths vs. 256,000 war deaths)[3]. The United Nations has estimated that in 2012 Brazil was responsible for 13% of all the murders in the world, putting the country in first place in absolute number of violent deaths. Not by chance, in this same study Brazil was in 11th place as the most violent country, having 11 of the 30 most dangerous cities in the world (Remigio, 2014). As a consequence, three out of four Brazilians are afraid of being murdered (Madeiro, 2016), and this figure is even higher for women (83%).

Concerning the right to private property in Brazil, robbery and theft statistics show similar trajectories to those for homicides: in 2010, around 12 million people were victims

[1] United Nations

[2] Brazilian Yearbook of Public Security (n.d.)

[3] Although the damages (psychological, human and economic) caused by the fighting in Syria to the survivors are immeasurable, Brazilian numbers of murders are still impressive.

of robbery or theft (7.3% of the Brazilian population)[4]. When first measured in 1988, this statistic was 3.9% of the population. According to the Organization for Economic Cooperation and Development (OECD), the rate of assaults[5] in Brazil in 2012 was 7.9%, twice the world average.

Another statistic that draws attention is cargo thefts in the country, which directly affects the private sector. The number of these thefts in Brazil jumped from 12,000 in 2002 to 17,500 in 2014 (NTC & Logistics, 2017). Brazil also occupies the sixth position in the ranking of places with greatest risk to freight transportation, tied with Iraq and Somalia (Bretas, 2016), and second place in the world ranking of shoplifting (Fellet, 2010).

Paradoxically, in recent years, and especially in the last decade, Brazil underwent a major transformation[6]. Backed by the commodity boom of the 2000s, economic growth was among the best in the world (Brainard & Martinez-Diaz, 2009). During this period, several socioeconomic indicators also improved – unemployment dropped, the minimum wage rose in real terms, and the creation of social programs such as the conditional income-transfer program *Bolsa Família* reduced socioeconomic inequality as measured by the Gini Index. Latin America in general experienced considerable economic growth during the period, but this was accompanied by an increase in crime indicators (Alvarado, 2015). Among the potential explanations for this conundrum are the poor quality of institutions and the presence of organized crime related to drug trafficking. The latter explanation certainly fits Brazil, where violence has increased in the last few years, particularly in the North and Northeast regions[7] of the country, where the homicide rate has doubled since the beginning of the last decade, vis-à-vis stagnation in the rest of the country[8]. These two regions are also the weakest economically in the country[9], and both have witnessed a spread of organized crime in the past decade.

The first organized crime factions created in Brazil came from the Southeast region. More precisely, the first major criminal faction was created in Rio de Janeiro in

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[4] National Household Survey (PNAD).

[5] "Assault" means physical attack on another person's body, resulting in serious bodily injury, excluding sexual assault.

[6] All data presented in the above paragraphs predate the recent economic crisis of 2015-2017. Also, the true numbers are certainly higher due to underreporting (although this is also true of other countries and is difficult to estimate).

[7] Brazil is divided officially into five regions: North, Northeast, Midwest, Southeast and South.

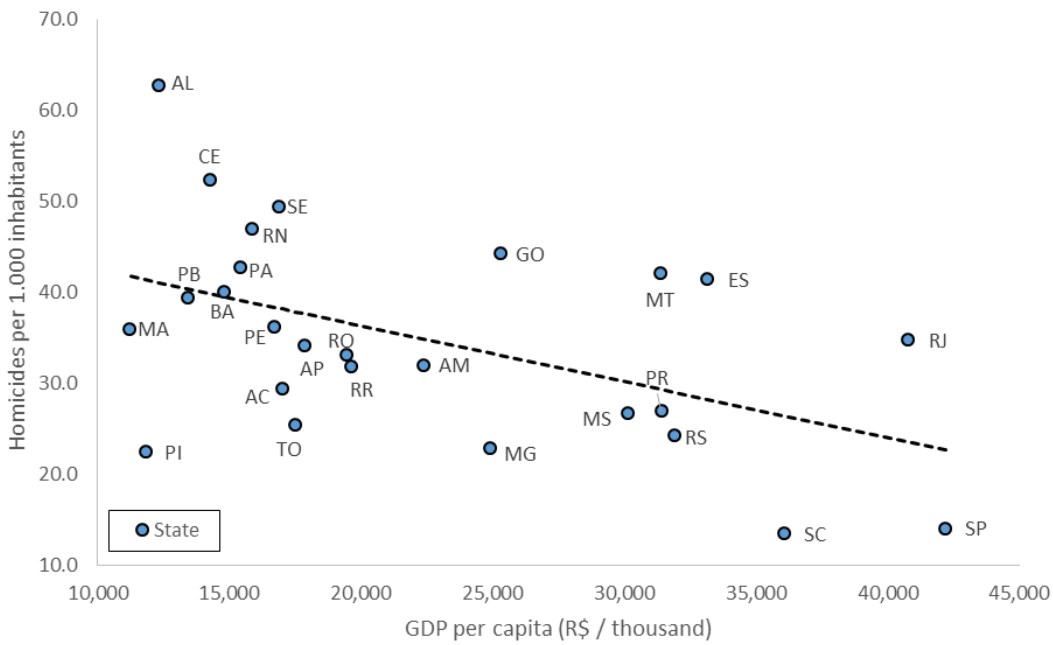
[8] Atlas of Violence - Ipea (s.d)

[9] Some articles show a high correlation between institutions and economic development (Acemoglu et al., 2001)

the 1970s, called *Comando Vermelho* (Red Command – CV) (Martín, 2017). Some years later, in the 1990s, the other large Brazilian criminal group was created in the state of São Paulo: *Primeiro Comando da Capital* (First Command of the Capital – PCC). At first, these two factions were rivals and focused their actions in their respective states, but throughout the 2000s, organized crime gradually migrated from the Southeast to the Northeast (Zaverucha and Junior, 2010).

In a context of the spread of organized crime groups to the North and Northeast, we see the emergence of a new criminal organization in 2007, called *Família do Norte* (Northern Family - FDN). Since then, the homicide rate per thousand inhabitants of the city of Manaus (capital of Amazonas state), for example, rose by 55% in less than 10 years (from 35.6 in 2006 to 54.9 in 2015). As a result, Manaus was ranked 23rd on the list of the world's most violent cities in 2016 (Barbosa, 2017). Data from 2014 on Brazilian states points to a negative relationship between crime and economic growth, as shown in Figure 1.

**Figure 1: Homicide rate vs. GDP per capita (2014)**




Source: IPEA

In this paper we intend to explore the causality between these two variables, i.e., does violence, identified by the level of criminal activity in a place, influence economic activity? We discuss some channels by which we believe there is such an effect. In terms of identifying this effect, the literature already indicates that regions with high crime rates

tend to have worse economic development, and that economic decay leads to an increasing rate of violence, thus the direction of causality is not obvious. Therefore, the strategy to identify the effect of crime on economic growth used here is examine the sudden creation of a new criminal group in the city of Manaus using the synthetic control method to evaluate its effect on economic activity.

## 2. CRIME AND ECONOMIC ACTIVITY

The potential output of an economy comes from its production function and criminal activity negatively affects the main production factors in this function. First, there is a disincentive for companies to invest in regions where legal security and physical safety are poor. Danielli and Marani (2008) show a negative relationship between foreign direct investment in Italy and organized crime. According to the authors, more unsafe places are unlikely to have good teaching centers or to attract skilled labor, hampering the accumulation of human capital. For the number of effective workers, there also appears to be a reflection of the homicide rate on the labor force (economically active population). By comparison, in 2014 in Brazil, more than 30 thousand young people (between 15 and 29 years old) were murdered. That means a potential workforce that could have contributed to Brazilian GDP growth over the next 20-30 years ended up being wasted – and this is only for 2014. In addition, total factor productivity is typically undermined by increasing violence. Pinotti (2012) showed that the entry of the Italian mafia in the regions of Apulia and Basilicata contributed to the drop in labor productivity in those regions.

Besides the possible decrease of inputs, another reflection of criminality is in the misallocation of resources. In 2014, the revenue of private security companies was US$ 21,3 billion[10]. That amount could have been allocated for training people and productive capital expenditures instead to assure a right that the State did not guarantee: private property.

If long-term potential GDP can be reduced, the same movement can be found in actual GDP, but by different transmission channels. When looking at the product from the perspective of domestic demand, it can be divided into consumption, investment and government spending. Consumption can be reduced through two channels: theft of goods

[10] The average exchange rate with the dollar in 2014 was 2,16 Brazilian reais per dollar.

and the closure of stores, or a decrease in the number of working hours due to lack of security. However, the most important channel is that of investment, because investors, fearing greater risks, end up delaying or even canceling new projects, preferring to reallocate their capital to other regions that they think are safer. Abadie and Gardeazabal (2003) and Pinotti (2012) both found a transfer of investment to less dangerous regions and the existence of a crowding-out[11] effect of the private sector.

One of the main papers estimating the economic impacts is Abadie and Gardeazabal (2003), who analyzed the effect of terrorism in the Basque Country. The authors proposed the method of synthetic control, comparing the Basque Country with the other regions of Spain, and found that the *per capita* GDP of the Basque region, affected by the terrorist activity of the ETA[12] group, was 10% lower than what would have been observed in the region in the absence of the terrorist group. Sandler and Gaibulloev (2008) also found a negative relationship between terrorism and economic activity from panel data analysis across Western Europe. The authors reported that one terrorist act per 1 million inhabitants reduced a country's growth by 0.4%.[13]

Italy has been well studied due to the existence of the Mafia in the country. Pinotti (2015) assessed the economic damage caused by organized crime in this country using two states (Apulia and Basilicata), where the mafia settled in the 1970s. The author concluded that the *per capita* GDP of these regions was 15% lower due to the presence of the criminal organization. Otranto and Dettoto (2010) calculated the economic costs of crime using time series analysis for Italy. They estimated that an increase in the crime rate of 1% decreases, on average, real growth by 0.0004% in the month for the whole country.

Despite the recent international literature on the subject, we found no studies focusing on underdeveloped and developing countries. In this sense, this paper fills a gap in the literature, by investigating the effects of criminal activities on economic activity in Brazil. We use the same identification strategy proposed by Abadie and Gardeazabal (2003) for the Manaus case, in which we observe the effects of the sudden rise of the criminal faction FDN.

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[11] Swelling in the public sector that generates a decrease in private sector participation.

[12] Group founded in 1959 aiming to fight for the independence of the Basque region of Spain. However, they became famous because of his terrorist practices.

[13] For a country like Spain with 40 million inhabitants, 10 terrorist acts would reduce the country's growth by 0.1 percentage point on average.

## 3. THE NORTHERN FAMILY

In order to understand the introduction of the FDN criminal group in the Manaus city, we first present the origins of the group and its growth in the state of Amazonas, and show that FDN consolidated itself as the third largest Brazilian criminal faction using information provided by reports from the Brazilian Federal Police (Polícia Federal, 2015).

Prior to the birth of the FDN, the city of Manaus had been occupied by some drug dealers who acted in a decentralized manner. The lack of unity between them became explicit with the massacre in the Anísio Jobim Penitentiary Complex in Manaus in 2002. According to an investigation by the Federal Prosecution Service (*Ministério Público*), the massacre was a payback between enemy inmate factions. There was no monopoly (or a cooperative structure, such as a cartel) among drug dealers, with profits from criminal activity being divided among rival drug dealers.

However, this situation began to change in 2006, according to the report of the Federal Police (2015). That year marked the start of the establishment of the FDN in the city of Manaus. The following excerpt describes the establishment of the criminal organization according to the cited report:

> The Northern Family - FDN was born from the union of Gelson Lima Carnaúba, a.k.a. "G", and José Roberto Fernandes Barbosa, a.k.a. "Z", "Messi" or "Pertuba", known criminals in the state of Amazonas, who after serving sentences in federal prisons, came back to Manaus determined (or guided) to structure a criminal faction, in the same way as the First Command of the Capital - PCC and Red Command - CV. (Polícia Federal, 2015, p. 19)

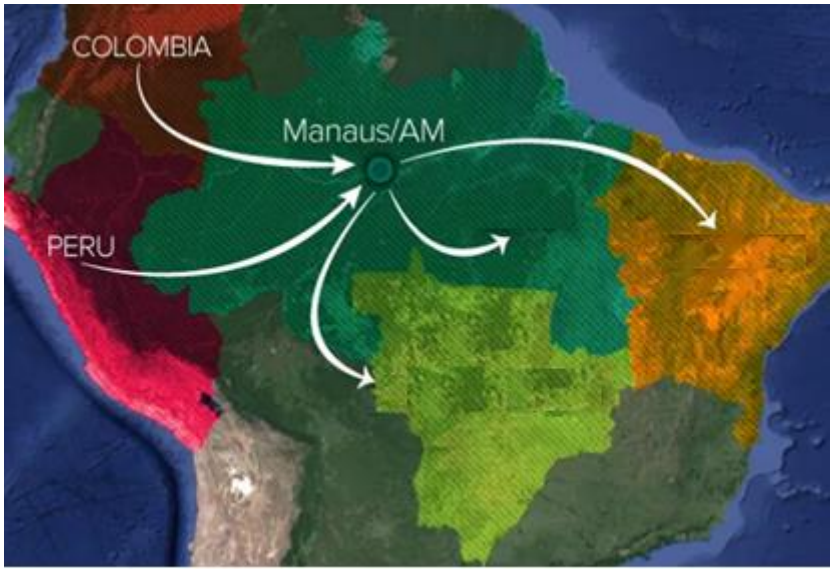
The way in which the faction was created and grew in Manaus is important for the identification of the effects of this study. The entrance of FDN in the city happened exogenously to local economic activity. The reason is that the drug dealers of the North, who previously acted in a decentralized manner, were put in contact with the more articulated members of the First Command of the Capital (PCC) and Red Command (CV). This contact, according to the police, happened because of the transfer of two local dealers to federal prisons. After release, they came back to Manaus with the intention of starting a similar criminal organization.

Another important point was the speed with which the FDN grew in Manaus. The rapid rise of the criminal faction relied on two primary sources of income: absolute control of trafficking in Manaus; and the dominion over the Solimões Route. The importance of the first aspect is because Manaus is one of the largest cities in Brazil, with

more than two million inhabitants, that is, with a large potential consumer market, besides being the main city in the North region of the country.

The second point is relevant since the Solimões Route (the route on the Solimões River between the city of Tabatinga, in the triple border region of Brazil, Colombia and Peru, and Manaus) is one of the main gateways of drugs into Brazil, especially of narcotics coming from Peru and Colombia. As seen in Figure 2, this route serves as a conduit of the illicit market in the central-northern region of the country.

**Figure 2 – Solimões Route**




Source: Amazonas Public Safety Secretariat

With access to consumer markets and control of significant trafficking routes, FDN rapidly expanded and became one of the main criminal groups in the country. This evolution can be seen in other excerpts from the Federal Police report, where one of the faction's leaders (José Roberto) mentions to another member that the FDN already had more than 200 thousand registered men with passwords in their internal network in 2015. They controlled all the streets and neighborhoods of the capital, as well as the entire prison system in the state of Amazonas.

The faction's force was not only seen in crime. Already in its early years, the FDN financed an amateur soccer team in the region, which won championships in the city[14].

[14] This team went professional in 2009, winning the championship of Amazonas Second Division and qualifying to play the state's first division and the Brazilian forth division in 2010. This development is very similar to others famous drug dealers, such as Pablo Escobar, who financed several soccer teams in Medellin, Colombia, among them Atletico Nacional de Medellín, which won the Libertadores de América championship in 1989 and the world championship a year later.

Another feature common to large criminal factions is their presence in the political and legal sphere. In an audio leaked to the press during the 2014 elections, the undersecretary of justice negotiated with FDN leaders for help in the re-election of the then governor (Leitão, 2014). On the legal front, there is also the involvement of some judges with the leaders of the group[15]. Finally, a final Federal Police report clarifies how structured the FDN is:

> In face of all that has been verified, it has been evidenced that the Northern Family - FDN has all the characteristics traditionally identified as typical of large criminal organizations, such as hierarchical structure, business planning, in-house lawyers, profit goals, use of advanced technological means and anti-intelligence measures, recruitment of people, functional division of activities, structural or functional connections with public and/or political power, provision of social benefits, territorial division of activities, high power of intimidation, local, regional and international connections, among others. (Polícia Federal, 2015, p. 684)

Therefore, given the history of the FDN, there is reason to believe that: i) the creation of FDN occurred exogenously due to the return of local criminals from a period in which they had contact with other organized groups; and ii) from its inception, the criminal organization developed rapidly and consistently, reaching 200,000 members by 2015. In this sense, the rapid organization and size of FDN presents an opportunity to analyze causality between criminal activity and its effects on GDP. Since the city of Manaus was the epicenter of the group (a single unit treated), the method of synthetic control from panel data of Brazilian cities is adequate to understand the effects of the intervention in the city. The next section presents the details of the method for the proposed problem.

## 4. EMPIRICAL STRATEGY

### Identification

In this study, we analyze the effect of the introduction of the organized criminal group FDN on local economic activity based on the synthetic control method proposed by Abadie and Gardeazabal (2003). This method consists of finding an artificial

[15] This can be seen more clearly in the second phase of Operation *La Muralla*, whose specific objective was precisely to focus on the Judiciary. In that phase, 15 search warrants were issued by the Superior Tribunal of Justice (STJ, the highest court for non-constitutional matters in Brazil).

counterfactual (synthetic) for the unit that has undergone some type of intervention by means of the combination of units of the control group (donor pool)[16]. In our case, we have a single treated unit (city of Manaus) because of the creation of FDN in the city. For the cities of the control group, we selected those with the hundred largest municipal GDPs in the states of Goiás, Mato Grosso and Tocantins[17]. As emphasized by Abadie, Diamond and Hainmueller (2015), the control group units cannot have been affected by the treatment, meaning the FDN cannot act in those states. Moreover, it is desirable that the states not be under the influence of other organized criminal groups.

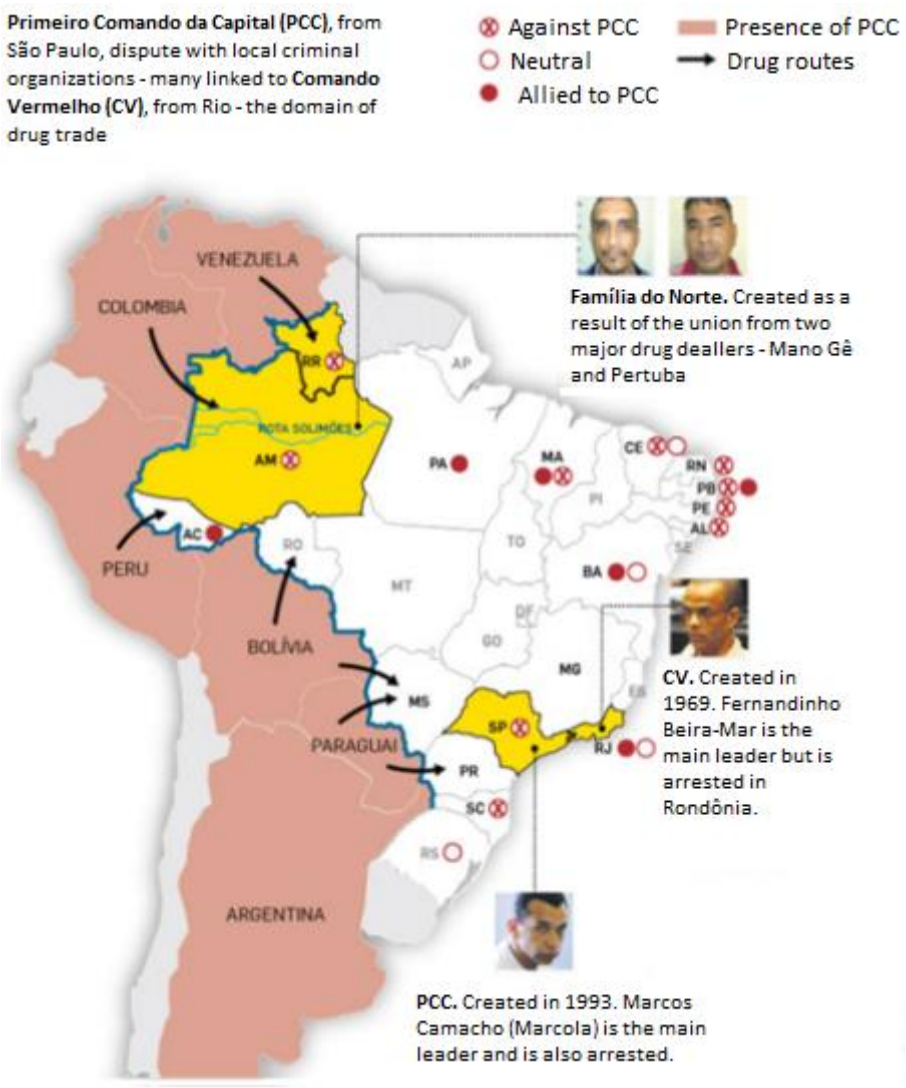
Regarding the first problem, the Federal Police points out that the criminal group is present in other northern states, but none of the three states used in the donor pool are on the list. Regarding the activities of criminal groups in the states of the control group, the map of violence in Brazil for 2016, prepared by Hisayasu (2016), shows the pattern of criminal organizations in the country. The three states considered as control are not on this list. Another survey, conducted by the National Penitentiary Department (Depen), also corroborates the lack of organized criminal groups operating in these states[18]. We emphasize that this does not mean that the three states used in the control group are free from drug trafficking (there certainly is limited action by isolated traffickers), but these regions are not yet under the control of powerful and structured criminal organizations.

[16] One of the criticisms to this method is the fact that its applicability can be limited by the presence of unobservable factors that affect the variable of interest, as well as by the heterogeneity of observed and unobserved factors. However, the factor model, proposed by Abadie, Diamond and Hainmueller (2010), controls for unobserved factors constant in time (fixed effects) and for fixed effects interacted with aggregate shocks (effects of time), which confers great flexibility to the method. In addition, the authors show that if the number of pre-intervention periods in the data is large, the bias of the estimator converges to zero.

[17] Abadie, Diamond and Hainmueller (2015) also state that if the control group suffered a great idiosyncratic shock, it should be excluded from the sample - a reason that led us to exclude the city of Alto Horizonte, where a gold mine was discovered in 2007, which considerably affected its municipal GDP.

[18] Mariz (2016).

**Figure 3: Organized crime map**




Source: *O Estado de São Paulo* newspaper

Another important point that we analyzed in the choice of donor pool was its similarity to the unit treated in the pre-intervention period (the variables of interest, GDP per capita, and control variables of the treatment group should belong to the convex set of potential control variables). For this, we use cities in geographically close states of the treated region: a state in the North (Tocantins); and two states in the Midwest (Goiás and Mato Grosso). Another geographical feature that helps explain the municipal production is the proximity to the ocean (especially in a country where most important cities are on the coast). Cities of Tocantins, Mato Grosso and Goiás, in this case, are also equal to the conditions of Manaus, a region that lies inland, away from the coast. Finally, to select the cities of these states, the hundred largest municipal GDPs were selected. Thus, we

excluded from the sample the very small municipalities[19], which would generate more noise in the model, besides having growth dynamics very different from the city of Manaus.

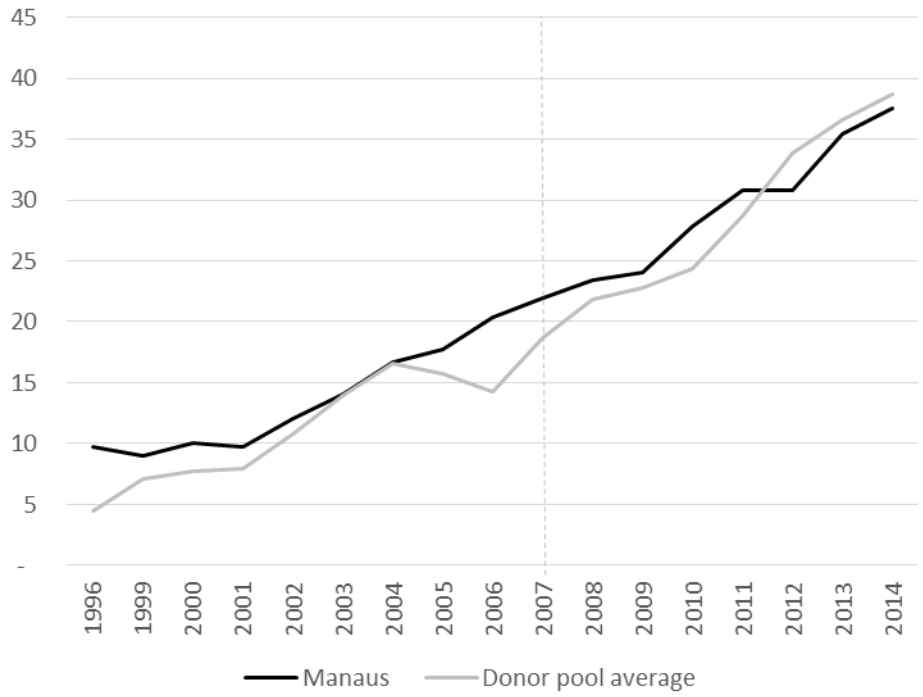
One issue taken into account refers to the fact that Manaus is a city with a strong industrial center (Manaus Free Trade Zone), while the cities of the three states mentioned have a strong agricultural and cattle-raising influence. However, the synthetic control method itself can make this selection, aligning and giving more weight to the industrial cities within the donor pool.

In response to the international crisis of 2008, the federal government, in order to promote consumption, increased the supply of credit in the economy and reduced taxes on manufactured products, especially those known as white goods. With this, Manaus, which is an industrial city, benefited from policies to the detriment of the control group, which could lead to underestimating the effects we find. However, the shock was distributed throughout the country, and since the largest donor pool weights went to industrial cities, it is expected that they also benefited from this policy.

In a simplified way, we present the trajectories of the per capita GDP of Manaus and the simple average GDP per capita of the control group for an initial discussion. As shown in Figure 4, the two curves do not present similar trajectories in the period (both pre-treatment, until 2007, and post 2007). Thus, the creation of synthetic control will be important to replicate the pre-treatment trajectory of Manaus.

[19] The municipality is the local administrative unit in Brazil. It is akin to a county, except with a single mayor and municipal council. Municipalities range from lightly populated rural ones with one or two small towns to heavily populated urban ones that are part of greater metropolitan regions. There are no unincorporated areas in Brazil.

**Figure 4: GDP per capita– Manaus and control group (in R$ thousand)**




The intuition of this result is that only the units that are similar in the observed and unobserved characteristics of the variable of interest, as well as in the effects of these determinants on the product of its variable, can produce similar trajectories for long periods of time. Once it has been established that the treated unit and its synthetic control have similar behavior for long periods of time before the intervention, a discrepancy in the outcome variable after the intervention is interpreted as being produced by the intervention itself.

## Data

Data on the municipal GDP of Manaus and cities of the states of Goiás, Mato Grosso and Tocantins were collected by the Brazilian Institute of Geography and Statistics (IBGE) between 1999 and 2014. For 1996, we used data from the Institute for Applied Economic Research (IPEA)[20].

The other covariates used were: industry added value (% GDP); agriculture added value (% GDP); human capital (R$ thousand per capita); capital (R$ thousand per capita); and income (R$ thousand per capita). Both added value of industry and added value of

[20] The data were harmonized using the national GDP implicit deflator.

agriculture represent the share of these segments in GDP, as calculated by IBGE between 1996 and 2007. For the human capital variable, we use data from 2010 (IPEA calculates the variable using income, schooling and local professional experience). The capital variable refers to the present value of the monthly rent flow for 2010, calculated by IPEA. Finally, the income variable refers to the average monthly income for 2000 (IBGE)[21]

The temporal restriction of data and the restriction of variables are due to the lack of Brazilian data. Ideally, by the adopted method, we would like to have a longer pre-treatment period (pre-2007). However, the data are not available.

As robustness, we use data from municipal exports collected by the AliceWeb platform of the Ministry of Industry, Foreign Trade and Services. In our analysis, this basis was presented from 1999 to 2007.

In some of our analyses the homicide data were used. For this base, the Department of Informatics of the Unified Health System - DATASUS was used.

## 5. RESULTS

Table 1 compares the main variables of Manaus with those of its synthetic control and the simple average of the cities of Tocantins, Mato Grosso and Goiás. As can be seen, the simple average of the donor pool would not be a good control group for Manaus, given its discrepancy in relation to the characteristics. We highlight the participation of industry, which shows that the cities in Goiás, Mato Grosso and Tocantins have a low level of industrialization, with this sector representing only 21% of the economy. On the other hand, when synthetic control was applied, the matching of cities improved, with industry participation increasing to 35% vis-à-vis the 38% of Manaus. In general, synthetic control seems to better replicate the predictive characteristics of GDP.

[21] To generate the per capita variables, we used the IBGE resident population data, referring to the years 1996, 2000, 2007 and 2010.

**Table 1: Manaus' main characteristics before FDN's creation**

| | Manaus | Synthetic Manaus | Donor pool average |
|---|---|---|---|
| Income per capita | 0.20 | 0.20 | 0.22 |
| Manufacturing share | 38% | 35% | 21% |
| Capital per capita | 3.5 | 3.9 | 3.6 |
| Human capital per capita | 27.4 | 25.4 | 23.1 |
| GDP per capita (1999) | 8.4 | 8.3 | 6.7 |
| GDP per capita (2002) | 12.0 | 12.2 | 10.7 |
| GDP per capita (2004) | 16.7 | 16.7 | 16.6 |
| GDP per capita (2006) | 20.3 | 20.2 | 14.2 |

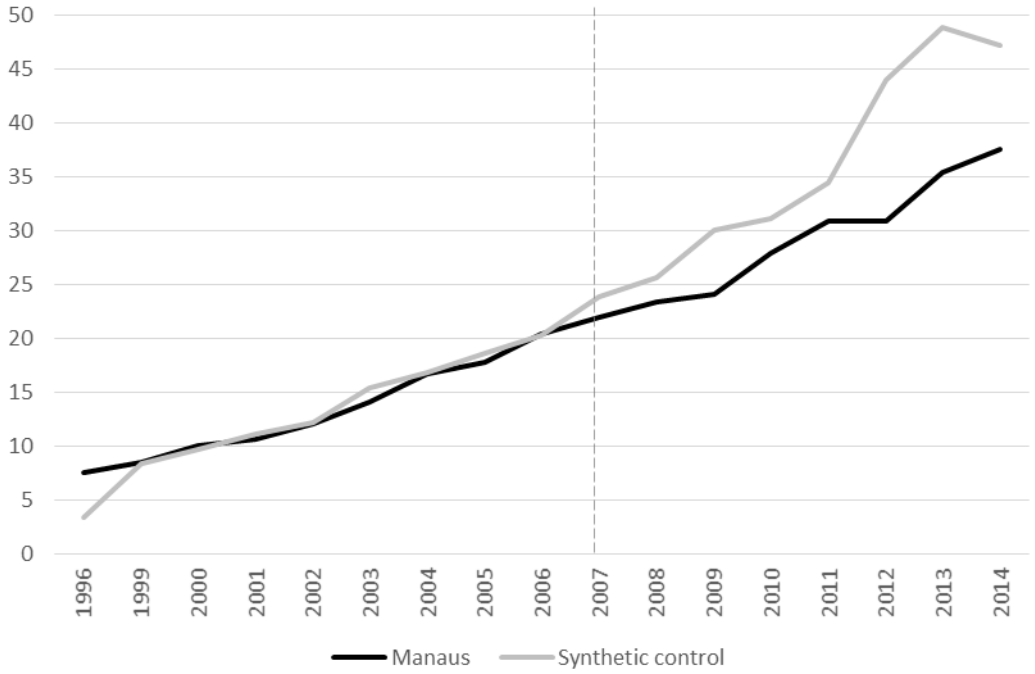
Table 2 shows the selected cities (weights greater than zero) and their respective estimated weights. In most of the cities, industry is an important productive activity: Corumbaíba, Catalão (automotive industry), Cuiabá (agribusiness), Minaçu (electric power industry) and Mozarlândia (meatpacking).

**Table 2: Each city weight in the synthetic control**

| State | City | Weight |
|---|---|---|
| GO | Corumbaíba | 56% |
| GO | Minaçu | 15% |
| MT | Cuiabá | 12% |
| MT | Alto Araguaia | 8% |
| GO | Cavalcante | 4% |
| GO | Catalão | 4% |
| GO | Mozarlândia | 2% |

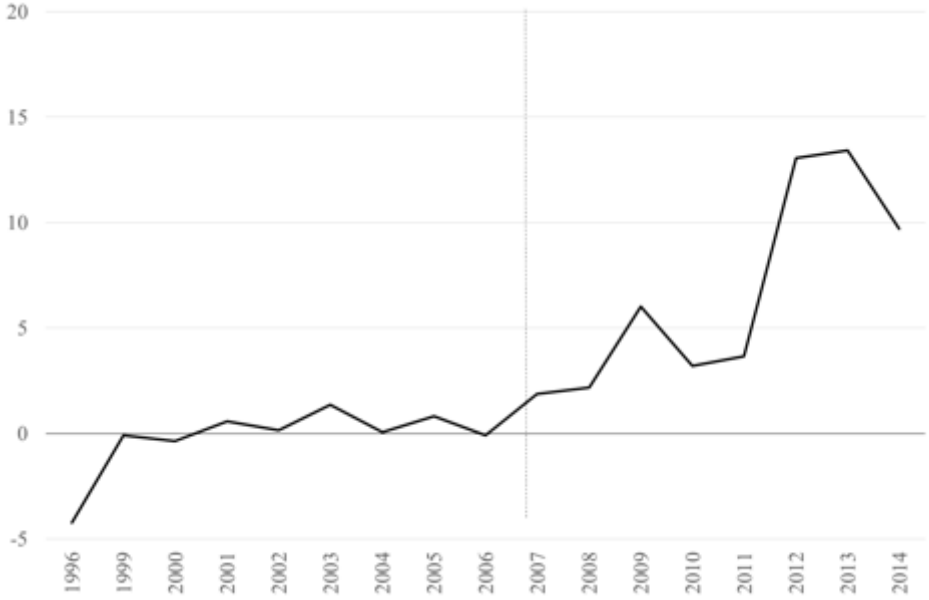
Figure 5 shows the GDP per capita trajectory of Manaus and the synthetic control. The two trajectories are quite similar in the pre-treatment period. Only in the first year did we obtain a greater difference, due to the mismatch of data (we did not obtain data from 1996 to 1999). As of 2007, the curves take off. That was the year in which FDN operations began in earnest in the city of Manaus. From then on, the growth of the per capita GDP of Manaus falls short of that found by its synthetic control, going in line with our initial thesis that FDN negatively influences the growth and prosperity of the city of Manaus. The GDP per capita of Manaus in 2014 was R$ 37 thousand, while that of its synthetic control (without the influence of FDN) would have reached R$ 47 thousand.

**Figure 5: GDP per capita (R$ thousand) – Manaus and synthetic control**




In Figure 6 we calculated the gap observed in Figure 5. Notice that this gap remained around zero during the pre-treatment period and, as expected, increased as of 2007. The Manaus' GDP per capita became 20% lower (in cumulative terms) than it would have been without the presence of FDN, i.e., a loss of almost 3% per year. In nominal terms, Manaus' output per capita could be increased by R$ 10,000 for the analyzed period (between 2007 and 2010).

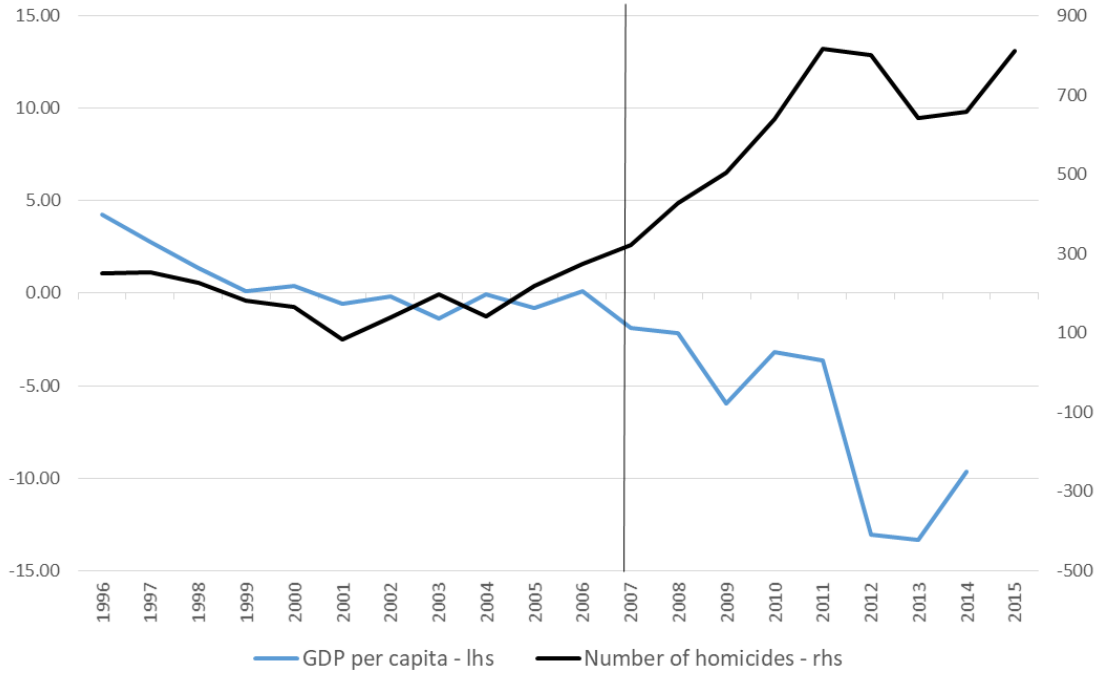
**Figure 6: Difference between Manaus' GDP per capita and its synthetic control (R$ thousand)**




Source: Authors

Finally, comparing the level of violence, measured by the total number of murders from the chosen cities of the donor pool (Corumbaíba, Minaçu, Cuiabá, Alto Araguaia, Cavalcante, Catalão, Mozarlândia) prior to 2007, we note that the difference with Manaus remained fixed around the same value. However, this dynamic shows an abrupt rupture as of 2007 and the difference between Manaus homicide rate and the rate of the donor pool increased significantly. This is the same trend for GDP per capita of the synthetic control and of Manaus: constant until 2007 and a downward trend since then.

**Figure 7: Difference in homicide number and GDP per capita**



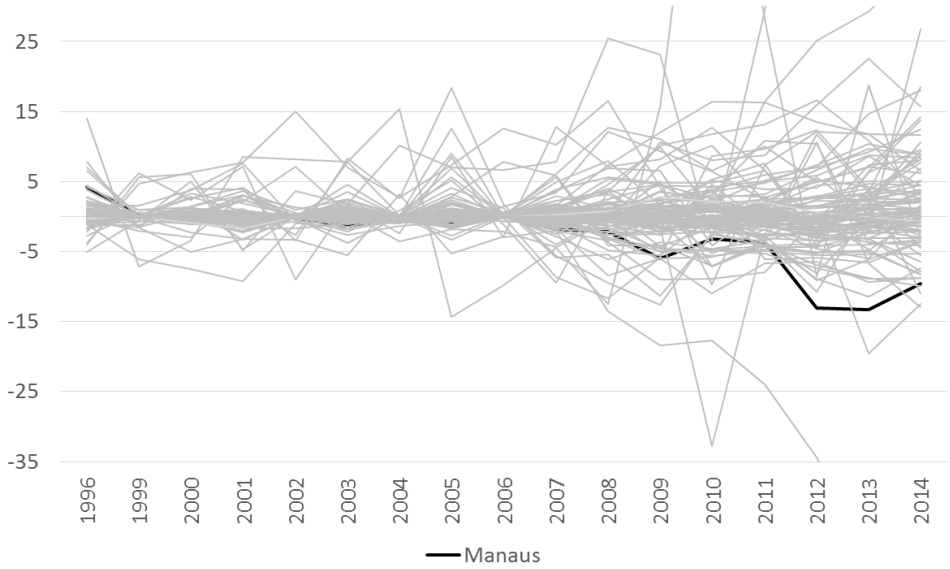

Source: Authors

The results found resemble those of other papers that address the issue of crime and its effects on economic growth. Pinotti (2012), who analyzed the entry of the Italian mafia in the regions of Apulia and Basilicata, observed a 16% reduction in the GDP per capita of these regions compared to its counterfactual. Abadie and Gardeazabal (2003) found a 10% drop in the GDP per capita of the Basque Country in contrast with the synthetic control. The impact calculated for Manaus was even more accentuated, both because we calculated for just one city - where a shock has less dispersion - and because our data come from a developing country.

## 6. ROBUSTNESS CHECK

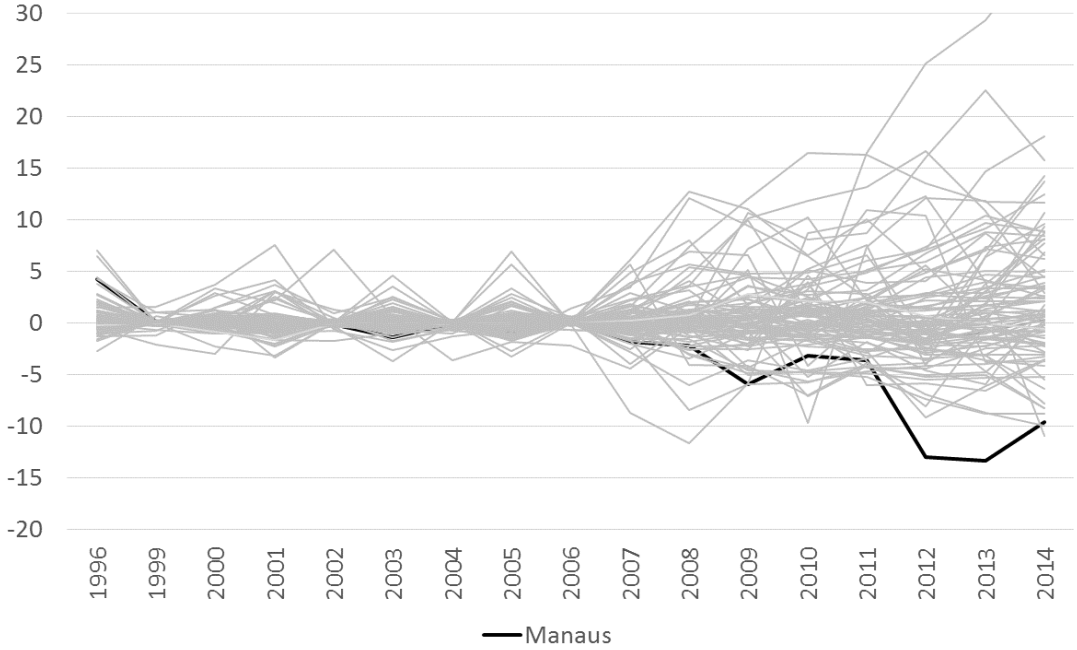
For the best assessment and credibility of the estimated effect, we present the placebo test, proposed by Abadie, Diamond and Hainmueller (2015). The test consisted of applying the method to all other cities of the donor pool (excluding Manaus from the sample) considering, in each application, one of the cities as treated. If the cities used in the donor pool present a post-2007 gap similar to that found in Manaus, our results may not be statistically significant. Figure 8 shows the GDP per capita gap calculated for each location.

**Figure 8: Placebo test**




As shown in Figure 8, the gap for Manaus is one of the largest gaps in comparison to the other cities, which reinforces the idea that the difference in Manaus in relation to its synthetic control is due to the creation of the criminal organization. Statistically, there are 5 out of 98 observations presenting a greater difference than Manaus, giving a p-value of approximately 5%, leading to rejection of the hypothesis that the effect is null at 5 and 10% significance. However, within this sample we have some controls with high mean square prediction error, so we followed the recommendation of Abadie, Diamond, and Hainmueller (2015) and took from our sample those cities with a high prediction error. After this process we have the following results.

**Figure 9: Placebo test – discarding the bigger errors**

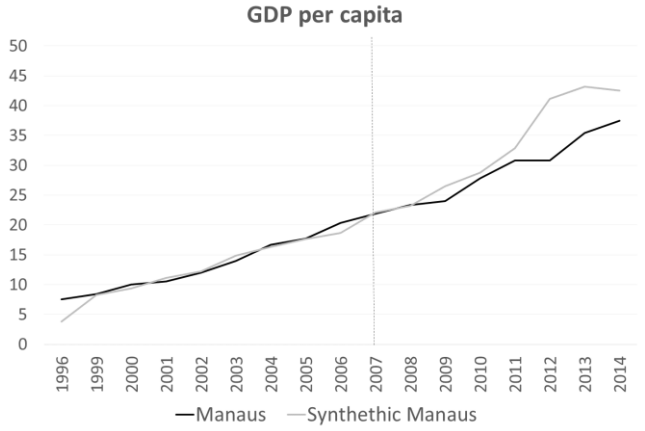



Source: Authors

In the new placebo test with no major prediction errors, the p-value declines further, reaching 2.3% (2 cities out of 87). Therefore, we reject the hypothesis of zero effect at 5 and 10% of significance and we are more confident that the deviation of the per capita GDP after 2007 was due to the presence of the criminal group FDN in the capital of Amazonas.

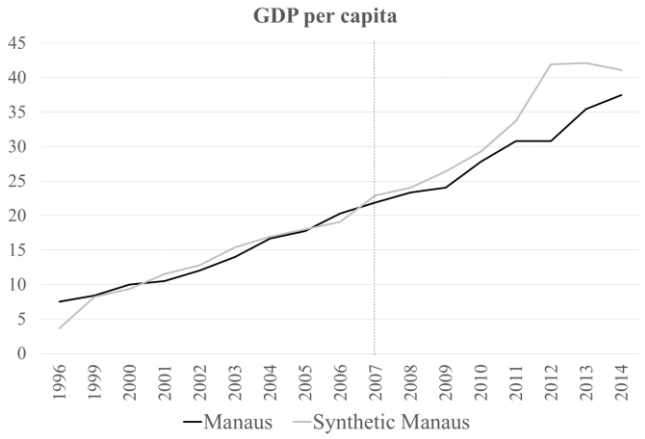
Another test produced by Abadie, Diamond, and Hainmueller (2015) consists of reducing the number of units treated. For this purpose, when we used the synthetic control, it was found that seven cities replicated the city of Manaus: Corumbaíba (GO), Minaçu (GO), Cuiabá (MT), Alto Araguaia (MT), Cavalcante (GO), Catalão (GO) and Mozarlândia (GO). In this test, we excluded from our sample the least important city to find out the new optimum weight W* with the remaining cities. After that, we repeat the same steps with the rest of the sample.

**Figure 10: Synthetic control without Catalão**



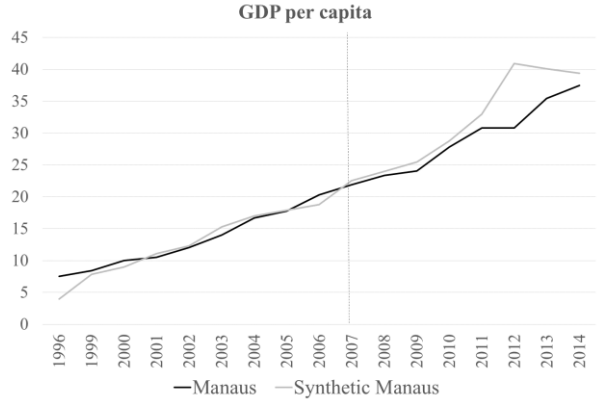

Source: Authors

**Figure 11: Synthetic control without Alto Araguaia and Catalão**




Source: Authors

**Figure 12: Synthetic control without Alto Araguaia, Catalão and Mozarlândia**

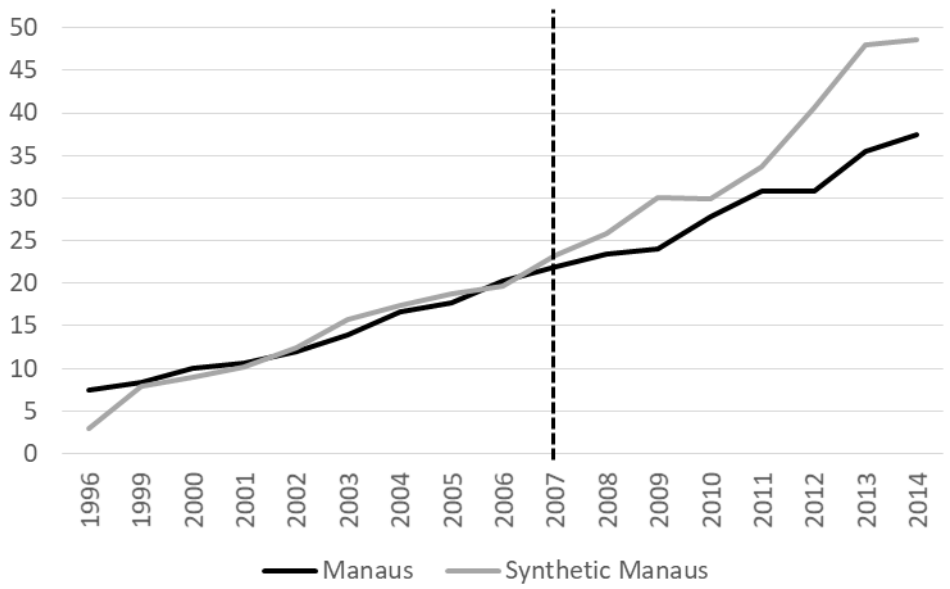


Source: Authors

When excluding the cities with lower weight, we gradually lost their good pairing in the pre-treatment period. With the exclusion of Catalão, we still managed a good alignment of the curves, but after dropping Catalão, Alto Araguaia and Mozarlâdia, we lost part of the characteristics. However, the overall results are maintained, with the two curves on similar trajectories until 2007, but different ones thereafter.

Another point that can be discussed in the creation of synthetic controls is the effect of exchange rates and the external market on the GDP of the cities mentioned. During the period examined (1996 to 2014) in this paper, the exchange rate with the dollar fluctuated a good deal. The exchange rate was fixed (a "sliding peg" regime until 1999, when a floating regime was established, with some interventions by the Central Bank (a "dirty float"). During the commodity boom period, Brazil's currency became overvalued, followed by gradual depreciation, but with occasional strong sharp swings in both directions. Therefore, to verify the exchange rate influence on the results, we added municipal exports as one of the predictive variables of GDP to capture these movements of the exchange as well as the elasticity to external demand. Figure 13 shows that the final result does not differ significantly from the results already found in the previous section.

**Figure 13: Nominal GDP per capita (in R$ thousand) with export data**




Source: Authors

## 7. FINAL REMARKS

In this paper we studied an important theme in economic development research: the relationship between crime and economic activity. The first contribution of the article is the analysis of this relationship for a developing country, since the literature is focused on developed countries. We found that criminal activity in the city of Manaus led to a cumulative reduction of 20% of local GDP per capita (or an annual rate of almost 3%). We also observed the intensification of criminal activity in the city after the advent of the FDN criminal organization.

Our results pose questions about the type of public investment needed to combat organized crime in the country, since we found that the benefits of reducing criminal activity are high in terms of economic activity growth. In a simplified tally for 2014[22], using the estimate found[23], if the country eradicated organized crime in the cities in which these groups operate, there would be an increase of R$ 62 billion to the public coffers in 2020 (considering an effective tax burden of 25% of GDP), which is close to the total amount invested in public safety in Brazil in 2016 (R$ 76 billion).

On the other hand, if nothing is done the negative effects on economic activity will be aggravated. This situation is particularly sensitive in the northeastern capitals of the country, where new criminal factions are being created - such as the *Sindicato do Crime* (Crime Syndicate) in Rio Grande do Norte[24] and *Okaida* in Paraíba - as well as the expansion of the traditional PCC and CV factions. These regions, which already have a low level of economic development, could have even more negative consequences in the coming years.

However, we also highlight the problem of political economy, as the leaders of criminal factions in the country point out. Marcinho VP (one of the heads of the Red Command) stated that "drug trafficking does not end because it finances political campaigns in Brazil." Thus, during electoral periods in the country, it is important for society to be aware of articulations of candidates both with criminal groups and investments in public safety.

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[22] Data taken from the Brazilian Institute of Geography and Statistics and the Federal Revenue Service.

[23] We use here the municipalities mentioned in the "Map of occupation by criminal factions": Salvador (BA), Natal (RN), São Luís (MA), João Pessoa (PB), Rio Branco (AC), Florianópolis (RS), Vitória (ES), São Paulo (SP), Rio de Janeiro (RJ) and Manaus (AM).

[24] In 2017 more than 2,000 people have already been murdered as of this writing, the largest number in the state's history, with two months still to go. According to the secretary of public security, about 78% of the crimes committed in the state are due to drug trafficking.

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