Compulsory High Schooling, Over-Crowding and Violent Youth Crime- Evidence from A Recent Constitutional Amendment in Brazil*

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Abstract

The paper uses the 2009 Constitutional Amendment in Brazil that introduced compulsory high schooling of 16-17 years olds as a natural experiment to investigate the effects of high schooling on selected violent youth crime indices. Using a unique data compiled from various official sources for over 5000 Brazilian municipalities over 2000-2013, we find that the Amendment was successful to lower violent youth crime rates in the overall sample and it worked primarily through incapacitation enforced by compulsory high schooling. While there is no evidence that the Amendment boosted employment prospects or returns to schooling in the treated municipalities, it was accompanied by an increase in class size and night school enrolments in the treated municipalities. These problems were worse in the treated poorer municipalities leading to rather weak crime reduction effects; further, violent crime rates went up in the treated poorer municipalities in the north east after the Amendment.

Keywords: Violent youth crime; Constitutional Amendment 59; Compulsory high Schooling; Overcrowding and night schooling; Difference in Difference; Endogenous treatment; Brazil.

JEL Classification: H43; I25; O12;

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1. Introduction

Crime reduction is a high policy priority of most governments, primarily because it brings large economic and social benefits. Policies to tackle crime include both punishment and incentive (through compulsory schooling/training) mechanisms. Since criminal justice system can be lengthy, slow and costly and re-offending rates are usually very high too, the value of incentive mechanisms to tackle crime cannot be ignored.[1] In this context, the present paper examines the effect of compulsory high schooling on violent youth crime rates in Brazil, using the 2009 Constitutional Amendment as a natural experiment.

Brazil is surely an important case in point where the violence among youth has particularly grown into a major public policy issue in recent years. The country has the highest years of life lost to violence out of any World Health Organization (WHO) member states. Also there has been an enormous rise in homicides in Brazil over the last three decades and victims of homicide in Brazil are most likely to be young, male, and black (Murray at al., 2013). Despite various public interventions, the rate of deaths by homicides among 16 and 17 years old has increased 496% between 1980 and 2013. While decentralization has significantly improved the access to education in recent years (Paim et al., 2011), there are still significant challenges to be overcome; these include, among others, high enrolment and overcrowding in classes, double school shifts (day and night), lack of teacher's training and weak school governance, drug use and anti-social behaviour (Nardi et al. 2012) in public schools; the problems are worse in poorer regions of the country (Cavalcanti et al., 2010). Soares and Naritomi (2010), Burdett, Lagos and Wright (2003), and Kelly (2000) also identify income inequality as one of the key drivers of crime in Brazil. While the country has generally been successful to improve its

[1] According to Aizer and Doyle (2015), juvenile incarceration results in substantially lower high-school completion rates and higher adult incarceration rates, including for violent crimes.

income distribution in recent years (e.g., see Figure 1),[2] systematic drop in inequality seems to have little impact on crime, especially youth crime rates in Brazil, thus motivating our study.

In this context, we examine the impact of the 2009 introduction of compulsory high-schooling of 16-17 year old, by the constitutional Amendment 59 on violent youth crime rates in Brazil. Naturally compulsory high schooling, if implemented well, may directly promote "incapacitation effect" that limits the opportunity for criminal activity during the schooling hours. Second, high schooling may directly affect the financial rewards from crime itself. The latter is especially true when high schooling leads to better schooling quality and therefore higher returns to legitimate work, thus raising the opportunity costs of illicit behaviour. However, these potential benefits of compulsory schooling amendment could be limited if the local school resources are limited and/or school governance is weak leading to poor learning environment. Why? First, in the absence of sufficient resources, compulsory high schooling of all 16-17 year olds may lead to overcrowding in existing schools, thus adversely affecting the quality of learning (see further discussion in Section 2). Given high enrolments and the pressure on school places, double shifts (day and night) in public schools are common especially in poorer areas. An important implication of this schooling system is that hours spent in schools are shorter than in other countries, thus limiting incapacitation effect. Further, incapacitation effect of high schooling could be weakened because of the possibility of night schooling, giving rise to the possibility of committing crime during day time. Moreover school attendance may not necessarily enhance learning quality and returns to schools. In particular, the quality of night schooling is known to be inferior[3]. Learning environment in public schools is also affected by overcrowding in classes, drug problems and related anti-social behaviour, especially when school resources are limited and/or school governance is weak. According to a 2010 UN report 6.3%

[2] Although, Instituto Brasileiro de Geografia e Estatística (IBGE) data suggest that the level of inequality has been reducing in Brazil, huge political instability at the time of the impeachment of President Dilma Roussef brought the economy down and there are now signs that these inequality trends are reversing. In particular, using data from income tax and aggregate accounts, Morgan (2017) contradicts the IBGE finding and suggests that the Brazilian income distribution did not change in the long run and is being driven by the upward inequality trend for the top 1% richest income.

[3] About 28% of 9th graders attend night schools because of lack of space in day schools; as high as 60 percent of students enrolled in upper secondary education are enrolled in night schools because of the need to work. Grade repetition is common among night school students; also poor are over-represented among the repeaters.

of students aged 15 to 16 years use marijuana at least once yearly. With regard to cocaine, Brazil and Argentina are the countries with the largest markets for this drug in South America (over 900 and 600 thousand users, respectively). Nardi et al. (2012) suggest that drug use and anti-social behaviour are correlated among 14-19 year olds attending public schools in poor localities in Brazil. Finally, compulsory high schooling may not necessarily increase the cost of crime if it is not accompanied by improving employment situation and/or the returns to high schooling is lower in a locality (especially the poorer ones without much social opportunities and greater reliance on informal jobs). Taken together, it is not obvious that compulsory high schooling of 16-17 year olds would necessarily lower youth crime rates. In the absence of any prior literature on the limits of compulsory schooling, examine and explain if the adoption of the Constitutional Amendment 59 instituting compulsory high schooling of 16-17 year olds has lowered youth crime rates in our sample, using municipality-level annual data from all 5560 Brazilian municipalities over 2000-2013.

Given the circularity between schooling and selected youth crime indices, we use the Constitutional Amendment 59 as a natural experiment to identify the causal effect of high schooling on selected violent youth crime indicators using a difference-in-difference framework. Note however that the Amendment was adopted in a staggered fashion during 2010-16. All municipalities would have adopted the reform by 2016. We therefore study the impact of the Amendment during 2010-13 when 53% of our sample municipalities had adopted the reform. Note however that an early adoption of the Amendment is unlikely to be random.[4] In order to redress this non-randomness of the adoption of the Amendment before 2016, we use a two-stage instrumental variable (IV) approach. We choose the distance of the municipality from the provincial capital and its interaction with a binary variable Post indicating the post Amendment years as the relevant and exogenously given IVs (see discussion in Section 3 on the rationale and validity of the IV selection), controlling for all other factors that may have affected youth crime rates. While the distance is correlated with the early adoption of the Amendment in the post-Amendment years, it is unlikely to affect youth crime rates since most youth crimes take place near their place of residence.

[4] We truncate our analysis by the year 2013, as all municipalities would be treated by 2016.

2SLS-IV estimates suggest that compulsory high schooling has been accompanied by a drop in crime rates among treated communities that adopted the Amendment and also that the OLS was underestimating the effect of the Amendment on violent crime rates in our sample. In particular, we find that the treatment is associated with 3 gun deaths and 3 assault deaths for every 10000 15-19 year olds in our sample. In terms of standardised coefficients, this translates into 0.273 sd reduction in gun death rates and 0.286 sd reduction in assault death rates for every 1 sd increase in treatment (i.e., adoption of the Amendment) in our sample. We examine various possibilities and find that the observed drop in youth crime rates in our sample can only be attributed to incapacitation associated with compulsory high schooling though the extent of incapacitation is likely to be limited for students attending night schools. There is no evidence of an increase in employment or income in the treated municipalities after the introduction of the Amendment.

Finally, the Amendment failed to have a perceptible impact on youth crime rates in the poorer municipalities in our sample. We offer two explanations in this respect: (a) increase in class size in the treated municipalities after the Amendment may deteriorate school environment and may, in fact, breed further crime, especially when combined with drug/alcohol abuse. The latter is also accompanied by an increase in night school enrolment rates among this age group that weakens incapacitation effect of compulsory high schooling. (b) No improvement in school/municipal governance: Treated municipalities, especially those in poorer areas, are less likely to have Education Board and security board which may lower school governance, thus weakening the crime reduction effect of the Amendment.

These results contrast with the existing literature that generally tends to highlight the beneficial effects of compulsory schooling on crime rates primarily in the US, UK and some other developed European countries (e.g., Machin, Marie and Vujic, 2010; see further discussion in Section 2) with the important exception of Levitt and Lochner (2001). In doing so, we also depart from the existing Brazilian literature that primarily focuses on specific regions (e.g., Sao Paulo) and overall crime rates rather than youth crime rates. Given the high costs of crime, especially among the youth, the prevention of youth crimes is high on the public policy agenda in most countries including Brazil. Results from the present study have thus important implications for further policy making not only in

Brazil, but also beyond its border.

The paper is developed as follows. Section 2 provides the background information, develops the hypotheses and describes the data. Section 3 introduces the empirical strategy while Section 4 discusses the results in section 4. Section 5 concludes.

2. Literature Review and Background

2.1. Literature review

Economists have long advocated for the beneficial role of education in fighting crime (Becker, 1978). The underlying rationale is that schooling increases the returns to legitimate work, thus raising the opportunity costs of criminal behaviour. Surely this is not a new idea and has long been tested for many developed countries (Ehrlich, 1975a; Lochner and Moretti 2004; Machin et al. 2011; Deming 2011).

The research on crime has generally focused on either deterrence issues like punishment or economic factors like schooling, employment/wages that may affect the costs and benefits related to criminal actions. There is a well-established literature on the efficacy of punishment to prevent crime (Ehrlich 1975a; 1975b; Archer and Gartner, 1984; Grogger 1991; Levitt, 1996; 1997) though the findings are mixed. On the other hand, Lofstrom and Raphael (2016) argue that the declining crime rate in the US has been accompanied by an enormous and unprecedented expansion of its correctional populations.

The literature on economic deterrents of crime has, however, heavily focused on the role of education. While most studies find a negative effect of schooling on crime (Ehrlich (1975a); Grogger (1998); Machin and Meghir, 2004), education may also increase the earnings from crime and the tools learnt in school may be inappropriately used for criminal activities (e.g., Levitt and Lochner, 2001). Deming (2011) measures the effect of school quality on crime and concludes that better school quality is associated with fewer serious crimes and fewer days spent in incarceration, and these results come largely from years after enrolment in the better school is complete.

A common problem of examining the impact of schooling on crime is that there is

simultaneity between education and crime. Thus more recent crime research has increasingly relied on various exogenous shocks to identify the causal effect of education/unemployment on crime rates with a view to address the issue of endogeneity. Along this line, Biderman, Mello and Schneider (2010) use a difference-in-difference design to estimate the causal impact of the adoption of dry laws in the Sao Paulo Metropolitan Area (SPMA) on violent behaviour. Chioda et al. (2016) examine the impact of the extension of Bolsa Familia in 2008 on crime in Sao Paulo municipality in Brazil. Dix-Carneiro et al. (2016) exploit the 1990s trade liberalization in Brazil and show that regions facing more negative shocks experience large relative increases in crime rates in the medium term, but these effects virtually disappear in the long term. Further, Damm and Dustmann (2014) explore the impact of early exposure to neighbourhood crime on subsequent criminal behavior of youth in Denmark; they find strong evidence that the share of young people convicted for crimes, in particular violent crimes, in the neighbourhood increases convictions of male assignees later in life.

In the literature using natural experiments to deal with endogeneity problems, there are many papers evaluating specifically the effect of compulsory schooling laws on crime. There is a general consensus in this literature that these interventions including compulsory schooling help tackling various crime indices. Lochner and Moretti (2004) studied the beneficial role of compulsory education laws in the US. Machin, at al. (2011) find a negative causal relation of education, measured by compulsory school leaving age laws, on criminal activities in the United Kingdom. Bell at al. (2016) investigate if compulsory schooling laws, in U.S. using data from Census years 1980, 1990, 2000 and 2010, reduce crime and find different causal effect for black and white people and for age group, since the younger have more years of education. Beatton et al. (2016) also investigate the causal effect of education on male youth crime, using individual level state-wide administrative data for Queensland, Australia, and find an incapacitation and deterrent effects leading to a reduction in crime among young males, around late teens and early twenties, with different impact according to the type of crime.

Focusing on the case of Brazil, as an important case in point, we consider the effect of high schooling on selected youth crimes rates among 15-19 year olds and examine whether the compulsory schooling is necessarily associated with crime reduction. In this respect, we depart from the existing

literature in that we consider violent youth crime rates (rather than overall crime rates) in Brazil's emerging economy, using all Brazil municipality-level data, rather than specific regions. This allows us to explore if the positive compulsory schooling effects observed in the UK, US or Australia necessarily hold in Brazil and if not, why. Surely the success of compulsory schooling to tackle crime relies on the assumption that compulsory schooling will improve school attendance, quality of learning and hence will boost returns to schooling and thereby increase the opportunity cost of committing crime. What if it is not necessarily the case? We explore these possibilities in the paper.

2.2. Background

International evidence suggests that crime rate starts increasing during teen years reaching its peak at around 20 years of so (see Figure 2). The social and economic costs of crime and violence are large especially when considering youth crime as the country's future depends on them. Despite ensuring significant expansion of the access to education between 1976 and 2008 (Paim et al 2011) and reduction in income inequality, incidence of youth crime does not show much sign of remission; tackling crime, especially youth crime, thus remains a policy priority of the government in Brazil.

Not surprisingly, the social and economic costs of crime and violence are large especially when considering youth crime as the country's future depends on them. In addition, injuries, fear, and psychological health problems (Andrade et al., 2012; Lopes, et al., 2008) have profound impacts on individuals' quality of life. Wider societal costs, including expenditure on healthcare and public and private security, are no less important: summing expenditure on police, prisons, private security, public health, and loss of human capital (from premature deaths caused by violence), and personal loss from robbery and theft, the total cost of crime in Brazil was estimated to be about 5.1% of GDP (Cerqueira et al. 2007). Human capital costs of homicide alone were equal to 2.3% of GDP in 2007 (Murray et al., 2013) most of which could be attributed to youths. Criminal involvement rises sharply with the onset of adolescence in the US (Levitt and Lochner, 2001) and also in Latin America (Carvalho and Soares, 2016; see Figure 2). So the prevention of youth crimes is high on the public policy agenda in most countries including Brazil.

There has been a series of educational reforms in Brazil. The 1998 Amendment of the

Brazilian Constitution has decentralised primary and secondary education to the municipalities, but the process is still ongoing, especially for secondary education. The law number 11.274 of 6 February 2006 introduced 9 years of compulsory education from age 6-14 years replacing the former 8 years (age 7-14) compulsory education programme. Constitutional amendment no 53 of February 2006 replaced 1996 FUNDEF by the Fund for Maintenance and Development of Basic Education and for enhancing the value of the teaching profession (FUNDEB). The Amendment 53 is regulated by the law number 497 of 2007 and by the decree number 6.253 of 2007. Finally, the Constitutional Amendment 59 of 11 November 2009 further increased the duration of compulsory schooling from 9 to 14 years, which made it mandatory for all 15-17 year old to attend schools. It is required that the states and municipalities would complete the progressive extension by 2016.

Adoption of Amendment 59 necessitated directing additional resources to implement the compulsory schooling among 4-17 year old, which meant a change in all budget. Before the introduction of the Amendment 59, the central government was willing to reduce some education resources earmarked for "linked expenses". After the introduction of Amendment 59, the central government altered the policy and instead promised more resources for compulsory basic and high school using the resources set aside for “linked expenses”. Accordingly, the municipalities that adopted the policy of mandatory education of 4-17 year old in the post-amendment years are more likely to get federal transfers marked to be spent on education.

In addition to ensure the resources for the implementation, the Federal Government also ensured enforcement of the Amendment through monitoring. In particular, the Public ministry is required to do a Census to audit if public schools are obeying the compulsory schooling rule by providing free education to 4-17 year olds. The punishment for the municipalities is regulated by the Constitution of 1988 (art. 208, § § 1º e 2º), the Law of guidelines and base of 1996 (Law nº 9,394 of December 20 of 1996) that set the general characteristics of mandatory primary education, and (widening the last Law) the Law nº 12,796 of 2013 to include changes of Amendment 59. The ministry is also given the authority to punish the public schools if they fail to obey the compulsory schooling laws. Constitution of 1988 (art. 208, § § 1º e 2º), the Law of guidelines and base of 1996 (Law nº 9.394, of December 20 of 1996, that sets the general characteristics of mandatory primary

education), and (widening the last Law) the Law nº 12.796, of 2013 to include changes of Amendment 59.[5]

Further, there have been mechanisms to punish the parents (Código Penal Brasileiro (art. 246), Law nº 11.114, of 2005, for mandatory primary education among 6 years old; and the new writing of Law nº 12.796, of 2013, for mandatory education from 4 years. Also the Child and Adolescent Statute (Law nº 8.069, of 1990) and the Brazilian penal code indicate punishment for the parents in case of not enrolling their children in schools. However the Law nº 12.796 of 2013, that punish public institutions and parents in case of failure to abide by the Amendment 59 will be applied only from 2016 when all municipalities are expected to adopt the Amendment.

3. Data description

Using various official sources, we compile a novel dataset of municipality level annual information on a wide ranging variables including violent youth crime rates for 5560 municipalities over a period of 2000-2013 from all the Brazilian states. Appendix Table A1 shows the variables definitions and their sources.

We use the following indices of violence-related death among 15-19 years old from the Brazilian health ministry: (a) death by assaults, (b) death by guns. (c) We further aggregate (a) and (b) to construct a composite index of violent deaths incidence due to assault and guns. Since, there is no crime data from the Security Ministry for all the Brazilian municipalities, we use the alternative information about deaths from the Health ministry to study the whole country. Only the state of Sao Paulo and its municipalities have more specific data on various property crimes; the latter may be one explanation as to why the bulk of existing studies focus on this region.

Unfortunately, we could not get crime data specifically for 16-17 year olds and hence we focused on 15-19 crime rates for which the information is available. In order to trace the evolution of crime-rates among 15-19 year olds after the Amendment, we check the crime rates among 10-14 year

[5] See http://www.famurs.com.br/arq_upload/20150624130609_Relat%C3%B3rio%20GT%20Ed%20Inf%20-%20%C3%8Dndice%20de%20Necessidade%20de%20Creche.pdf .

old cohort in the pre-Amendment years, who became 15-19 during 2010-2013 (after the Amendment) in our sample. Simple mean comparisons suggest that compared to the crime rates among 15-19 year olds during 2010-2013, the average 10-14 crime rates in the treated communities were significantly higher during 2006-2009; in the absence of any other changes, the latter seems to highlight a beneficial effect of the Amendment 59 on 15-19 crime rates in the treated municipalities during 2010-13. Later we shall also explore whether this result can necessarily be attributed to the Amendment and if so, what are the possible mechanisms.

Regional variation in crime is striking in Brazil – it not only depends on the region's socio-economic conditions, but also on its crime prevention strategy. Figures 3 and 4 suggest that the violence is lower in the richer region, e.g., the Southeast that included Sao Paulo and Rio de Janeiro, but higher in poorer regions, especially the Northeast. The capital of states municipalities in Brazil are the more populated and more developed regions in terms of human capital, infrastructure development and also stronger institutions. In general, except for some cases in the Northeast and North regions,[6] these are the municipalities near the capital state and their metropolitan region (the conurbation of the capital state with other near municipalities). Other exception relates to the dormitory municipalities that are very poor. This is because the big and more developed municipalities attract poor migrants largely employed in the informal sector who start living in the borders and new municipalities are created as a result. The latter can be attributed to the federal monetary incentive to create new municipalities.

Traditionally big cities tended to be very violent in Brazil. However, recent trend highlights incidence of increasing violence in the smaller municipalities as well, particularly those located in the Northeast and North regions of the country (Campos et al., 2011). The latter can be attributed to increasingly better security and safeguards against crime in more developed municipalities; in our empirical exercise we would attempt to identify the pure effect of the Amendment, by eliminating all the confounding effects.

Finally, we compare the poor and non-poor municipalities in our sample in terms of certain observable characteristics as summarised in Table A2. In this respect, we follow the Ministry of

6 In these regions even the capital states are not developed.

Health definition: poor municipalities are the ones where the income per capita is less than half of minimum wage. In general, we find that poorer municipalities in our sample tend to be significantly smaller (both in geographic size and in population) and are also more distant from the provincial capital. Poorer municipalities are more likely to have significantly lower GDP, lower employment/income index, higher income inequality as reflected in the Gini index and so returns to higher schooling are likely to be lower. Third, class sizes and drop-out rate are significantly higher while teachers are less likely to be graduates in poorer municipalities. Finally, poorer municipalities are less likely to have educated Mayors, municipal safety board as well as municipal education board monitoring school performance; the latter surely have implications for weaker municipality governance and also school governance in poorer municipalities and may assume greater importance under decentralised governance.

4. Empirical Strategy and Results

The 2009 Constitutional Amendment allowed states and municipalities[7] to adopt the reform by 2016 – so all the sample municipalities did not adopt the reform immediately; rather it was a case of staggered introduction given the heterogeneity of municipalities in each state. We, however, do not observe the timing of the adoption of the reform for each sample municipality. Thus, to identify the municipalities that adopted the reform during 2010-13, we use the high school enrolment rate data available from the Education Ministry such that an increase in high school enrolment was supported by an increase in educational expenditure of the community, as these municipalities were granted federal transfers to enact the Amendment (see Section 2.2). Accordingly, we generated a binary variable '*treated*' that assumes a value 1 if the municipality-level average high school enrolment rate for the 15-19 age group during 2010-2013 is greater than its corresponding rate in 2009[8] and also if

[7] High school is largely under state administration and in the process of being decentralised to the municipalities; but given the differences among municipalities regarding high schools, the Amendment adoption decision must be shared between state and municipalities.

[8] Until 2006, states and municipalities could inflate the student enrolment numbers to get more federal resources, however as of 2006 the central government changed the way that the municipalities and states need to report the number of enrolments in order to receive federal transfers; in addition to the student numbers in each

the municipality had an increased educational spending in the post-Amendment years; it is 0 otherwise. A tabulation of the treatment dummy suggests that about 53% sample communities adopted the reform during 2010-2013 in our sample.

Table 1 compares the mean high school enrolment, educational expenses and dropout rates after middle schools for treated and non-treated municipalities before and after the Amendment. By definition, the municipalities that adopted the reform within the sample period (2010-13) not only have significantly higher high school enrolment rates, but also received significantly higher educational spending. Note however that the education spending was allotted in such a way that per student education spending was still equated between the treated and non-treated communities, thus rendering the mean difference in per capita educational spending insignificant. Further it is evident that the treated municipalities had lower dropout rates after the adoption of the Amendment.

Figure 3 illustrates the trend in 15-19 enrolment in treated and control groups in our sample. Both these groups experienced a drop in high school enrolments before 2009. Since the federal transfers are linked to number of enrolment, there has been an incentive to over-report student enrolment. But this became difficult as the schools needed to provide additional information on student grades, thus resulting in a gradual drop in total enrolment between 2006-2009. However, high school enrolment started diverging in the treated and control communities from 2009 onwards when the Amendment was initiated; in particular, high school enrolment of treated communities exceeded that of control communities soon after 2010.

Further to Figure 3, we obtain some parametric evidence that high school enrolment started increasing only after the Amendment and that there was no pre-reform trend. To this end, we regress the treatment dummy Treated, year dummies (2001-2013) and the interaction between Treated and year dummies on high school enrolment rate of 15-19 year olds. Results summarised in column (1) of Table 2 show that the interaction dummies are insignificant for all the pre-reform years, thus

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year group, states and municipalities are also required to report the student grades after 2006. As a result the reported student numbers kept falling for the next two year and then stabilised around the year 2009. Accordingly 2009 can be regarded as a normal year reflecting the true enrolments, thus justifying our choice of 2009 as a reference point for identifying the treatment municipalities.

suggesting that there was no pre-reform trend in high school enrolment between treatment and control groups in our sample. Note that these interaction dummies are only significant in the post-Amendment years.

Second, we check that there was no other changes in the treated municipalities that could also affect youth crime rates. In particular, we checked that the treated group did not adopt greater policing during the post-Amendment years. Since security is under the state provision, having a municipal police is not mandatory. We define the municipal police dummy as follows: it takes a value 1 if the municipality is concerned about security and has a municipal police force; it is zero otherwise. As before, we regress the treatment dummy Treated, year dummies (2001-2013) and their interactions on the binary municipal policing variable. These estimates are summarised in column 2 Table 2. As with high school enrolment, we find that Treated*$Year_t$, t= 2001….2013 remains insignificant for all the sample years in our sample, thus confirming that municipal policing remained unchanged among the treated communities in our sample, especially in the post-Amendment years, ruling out the possibility that crime was influenced by changes in policing in the treated communities in the post-reform years.

Table 3 compares the mean crime rates between treatment and control groups before and after the reform. Evidently, youth death due to violent assault as well as gun was not significantly different between treated and non-treated municipalities before the Amendment, but these two groups diverged only after 2009 such that crime rates measured by gun deaths and assault deaths were significantly lower in the treated districts in the post-Amendment years, thus signifying the role of the Amendment.

Assuming the exogeneity of the Treated dummy, we first use the pooled data to estimate a difference-in-difference model of youth crime rate C_{it} in community i in year t as follows:

$$C_{it} = \alpha_0 + \alpha_1 Treated_{it} + \alpha_2 Post + \alpha_3 Treated * Post + \alpha' X_{it} + u_{it} \quad (1)$$

where *Treated*=1 if the i-th community adopts the Amendment in any year t where t>=2010 and 0 otherwise. Post is a second binary variable that takes a value 1 for year>=2010 and 0 otherwise. The set of control variables X include the following: if mayor is male, if mayor is graduate, if mayor party is the same of President's party, size of municipal population, GDP per capita, illiteracy rate, Gini index, presence of public inter-municipal transport, presence of municipal internet services, number of public health clinics, number of public libraries (see Appendix Table A1 for variable definitions). We

also control for a set of state and State*Year dummies ~~state and State Year dummies~~ to account for the unobserved state (e.g., culture and traditions) as well as state-level time-varying factors including job opportunities, unemployment rate, wage rates, natural calamity or any change in provincial government policy that may also influence youth crime rates. The coefficient of particular interest to us is $\alpha_{3,}$ which yields the effect of the adoption of the reform on selected crime rates among treated (relative to control) communities.

2SLS IV estimates

Early adoption of the Amendment by the municipalities before 2016 is unlikely to be random since these communities are only required to adopt it before the end of 2016, which would make the estimates of Eq. (1) biased. Vella and Verbeek (1998) have compared the IV method with the control function procedure for estimating the impact of endogenous treatment as in our case and suggest that the two methods generate comparable estimates including their accompanying endogeneity tests. Following Vella and Verbeek (1998) we use a two-stage least square instrumental variable (2SLS-IV) method to redress the estimation bias arising from the endogenous treatment in our set up.

The natural question is what drives the early adoption of the Amendment. Clearly, the successful adoption of the reform depends on the availability of resources to implement the reform, which is managed by the provincial authority who are also supposed to monitor the adopting municipalities. We argue that the location of the municipality, measured by its physical distance from the provincial capital, could be an important driver in this respect. Surely, location of the municipality in relation to the state capital is given historically and the individual municipalities are unlikely to influence it in our sample. It follows from Table 3 that the treated municipalities that adopted the reforms earlier were not located closest (in terms of log distance) to the provincial capital than the control municipalities and this did not change after the reform. Further our data show that the distant municipalities are poorer and also had lower high school enrolment, therefore making it easier for them to accept additional high school students that also guaranteed additional federal transfers. So when the 2009 Amendment was introduced, the relatively more distant municipalities had the incentives to adopt the reform that enabled them to get additional resources too, disbursed by the

provincial authority located in the provincial capital.

However, the likelihood of adopting the law earlier by a municipality may not be exactly linear to its distance from the capital state. Municipalities at the border of the capital state are in general dormitory municipalities with poor transport infrastructure from where residents travel to the capital to work. In contrast, municipalities farther from the provincial capital tend to have better public goods provision including public transport. However, the municipality located at a medium distance to the provincial capital is likely to have a stronger network with the provincial authority, which may enable them to secure the essential resources for the implementation of the Amendment earlier than those located farther that are more rural in general. At the same time, geographic closeness of the municipality may make it easier for the provincial authority to monitor the schools and parents in the municipality. In order to address the possible non-linearity involved in the link between the distance from the provincial capital and the likelihood of adopting the Amendment earlier, we use log(distance from the provincial capital) as the relevant instrumental variable for determining the adoption of the reform.

It is also important to establish that our chosen IV, i.e., log (distance from the provincial capital) is unlikely to be directly related to the youth crime indices (see further discussion below and in Section 5). First, very often youth tend to commit crimes locally where they live and where they spend most of their leisure time (Costello and Wiles, 2000: http://library.college.police.uk/docs/hors/hors207.pdf). In particular, youths residing in economically disadvantaged neighbourhoods are more likely to be exposed to models of behavior that promote violence and aggression over normative behaviors. Anderson (1999) argued that the decay of the traditional family in disadvantaged areas, coupled with the rising absence of males as a result of incarceration and early mortality, has led to a diminution of positive male role models. In turn, this deficit of role models has created a youth culture stressing hyper-masculinity and promoting violence as a means to establish and reaffirm one's social status. Adolescents in such areas perceive the rewards (e.g., “status” or “respect”) garnered by the most violent of their peers and then attempt to model their peers’ behavior. We observe similar pattern in Brazil too: given high degree of inequality, there are deprived neighbourhoods within a municipality and most youth crimes are committed in

areas where they reside; crime committed in schools are not uncommon (Cocco and Lopes, 2010: http://www.lume.ufrgs.br/handle/10183/28262?show=full).[9] Accordingly, we would argue that the distance to the provincial capital is unlikely to have a direct effect on youth crime in our sample. This is further confirmed by Figure 4 that shows that the relationship between log(distance from the provincial capital) and youth crime rates in our sample is rather weak (see further discussion in Section 5 below). Given that we consider municipality level data, we can rule out any direct nexus between municipality's distance from the provincial capital and the youth crime rates in our sample so long as these crimes are taken place within the municipality of the young offenders.

Accordingly, we adopt a two-stage least squares instrumental variable (IV) model as follows: we first determine the likelihood of being a treated (i.e., adopting the Amendment) early (as proxied by the binary variable Treated) and also Post*Treated as a functions of the log(distance) and Post*log(distance) as follows:

$$Treated_{it} = \beta_0 + \beta_1 \, log(distance)_{it} + \beta_2 \, Post*log(distance)_{it} + \beta' X_{it} + u_{it} \qquad (2a)$$

$$Post*Treated_{it} = \beta_0 + \beta_1 \, log(distance)_{it} + \beta_2 \, Post*log(distance)_{it} + \beta' X_{it} + u_{it} \qquad (2b)$$

where X is the same set of controls as in equation (1). Indeed, our first stage estimates show that the treated communities that adopted the reform early are farther from the provincial capital (in logarithm of distance) than the control communities and this holds only in the post-reform years (see further discussion below and also in Section 5).

We use the estimates of (2a) and (2b) to generate the IVs for the binary variable *Treated IV and Post*Treated IV*, which are then used to replace *Treated and Post*Treated* in equation (1) respectively with a view to obtain the IV estimates of (1) as follows:

$$C_{it} = \gamma_0 + \gamma_1 \, Treated\ IV_{it} + \gamma_2 \, Post + \gamma_3 \, Post * Treated\ IV + \gamma' X_{it} + u_{it} \qquad (3)$$

Equation (3) constitutes the second stage IV estimates of youth crime rates and is argued to be an improvement over the simple ols estimates of equation (1). The underlying idea is that the Treated IV in equation (3) is correlated with the binary variable Treated in equation (1), but uncorrelated with the residual of equation 3, conditional on a sex of X, thus helping us to ensure unconfoundedness of the

[9] https://veja.abril.com.br/blog/cidades-sem-fronteiras/por-que-a-proporcao-de-homicidios-e-maior-nas-cidades-do-nordeste-do-que-no-resto-do-pais-especialistas-respondem/

treatment and minimising the potential endogeneity of estimates of (3). In particular, we include a wide ranging control variables in both equations 2(a), 2(b) and (3). This is because endogeneity bias may arise if the omitted variables are correlated with the error term u in equation (3). Thus, in addition to the characteristics of the municipality mayor (gender, education, party), we include the municipality characteristics (population size, GDP per capita, illiteracy rate, Gini index) and also its access to public inter-municipal transport, presence of municipal internet services, number of public health clinics, number of public libraries. By controlling for the municipality's access to inter-municipal transport and internet services in both stages of 2sls-IV model, we ensure that municipality's distance from the provincial capital cannot influence crime directly; it does so only indirectly through its influence on inducing them to adopt the constitutional Amendment imposing compulsory schooling before the 2016 deadline. Later we also test for the relevance of the IV (that distance is correlated with Treated) and also IV validity (that the IV is uncorrelated with the crime rates directly). This is discussed in Section 5 below.

All estimates are clustered at the municipality level to minimize the autocorrelation of errors across years for a given municipality, thus producing cluster-robust standard errors.

5. Empirical Findings and discussion

OLS estimates

We start with the simple OLS estimates of the selected youth crime indices, namely, deaths by gun, deaths by assault, and violent deaths (a composition of deaths by gun and by assault) using equation (1) within a difference-in-difference framework.

Note that the consistency of the difference-in-difference crime estimates of equation (1) depends on the fact that there are parallel trends between the treatment and control groups in the pre-reform years. In the absence of a better alternative, we follow McCrary (2008) to run a simple regression as follows: we regress the reform adoption dummy *treated*, year dummies (2001-2013) and the interaction between *treated* and year dummies on selected crime indices, after controlling for state dummies in our sample. Figure 7 plots the estimated coefficients of the interaction terms (also see Table 5), which are the coefficients of our interest for the three outcome variables, namely, rates of

deaths by guns, assault and also the sum total of the two that we label as violent death rates. The fulfilment of the parallel trends assumption requires that the interaction terms remain statistically insignificant in the pre-2010 years and our estimates confirm this for all three selected youth crime rates. We can therefore conclude that the treated municipalities were not significantly different from the control municipalities in the pre-Amendment years.

Having established the validity of the parallel trends in treatment and control municipalities, we can now consider the OLS youth crime estimates summarised in Table 4. For each index, we provide two sets of difference-in-difference estimates – estimates for death *rates* among 15-19 years old and also those for logarithm of *total number of deaths* among 15-19 years old and we focus on the estimated coefficient of the interaction term that captures the differential effect of the constitutional Amendment on specific crime rates among treated (relative to control) communities, after controlling for all other factors that may also influence these violent crime rates. Table 4 estimates show that the estimated coefficients of the interaction terms are all negative and statistically significant for the logarithm of the levels of each crime index; but compared to the level regressions, the beneficial effect of the treatment is much weaker when we consider the rates of relevant crime rates. In terms of the levels of crime, the treated communities experience about 3% drop in levels of crime in the post reform years relative to the control communities. However, in terms of crime rates, treated communities experience a drop of 2 assault death per 10000 youth, for example. While the estimated interaction coefficients are all negative for various crime rates, it is statistically significant only for assault death rates in our sample.

2SLS-IV estimates

To redress the concern of circularity between the adoption of the Amendment and crime rates, we next estimate the 2sls-IV (see Table 6).[10] We argue that the municipality distance from the provincial capital is a key determinant of its early adoption and is a good instrumental variable, since it is

[10] For comparisons, we also estimate crime rates using fixed effects models (see Annex 1); these results are in general compatible with OLS and 2SLS-IV estimates.

historically given and is therefore beyond the control of the municipality. Accordingly, we use log(distance) from the provincial capital to allow for the non-linearity in the effect of distance on the likelihood of being treated by the reform. We also include its interaction with the Post dummy to explore if the distance became more relevant for adoption in the post-Amendment years in our sample.

Table 6 summarise the first (Equation 2a and Equation 2b) and second stage (Equation 3) estimates. The first stage estimates as summarised in the top panel of Table 6 confirms our expectation that the municipalities located farther from the province capital (as measured by log(distance)) are significantly more likely to adopt the Amendment and this happens only in the post-2009 years in our sample. The statistical significance of the IV, after controlling for all other factors that may also influence crime rates, establishes its relevance in our sample. We also perform the F-test for the joint significance of Treated=0 and Post*Treated=0 and the statistical significance of the F-statistics highlight that we can reject the null in favour of the alternative, thus formally establishing the IV relevance.

Using these first stage estimates, we generate the IVs for the Treated and Post*Treated, which are then used to determine various violent youth crime rates at the second stage, using equation (3). These IV estimates of selected violent youth crime rates are summarised in the bottom panel of Table 6. Before discussing the results it is important to consider the validity of our IV in that log(distance) of the municipality from the provincial capital does not directly affect crime rates (as a share of population), after controlling for all other factors that may also influence violent youth crime rates. Further to our argument in Section 4 that youth crimes are usually committed near the residence of the young offenders, note that we also control for the municipalities' access to inter-municipal transport and public internet services, among other controls, with a view to eliminate the possibility that the distance from the provincial capital may affect crime rates directly. In order to allay concerns, we further consider the Epanechnikov kernel fit in Figure 4 that plots the non-parametric association between log(distance) and the relevant youth crime rates in our sample. These plots indicate that each selected crime rate remains rather flat, especially when the logarithm of the distance from the provincial capital is greater than 2km in our sample, thus providing indirect support to our conjecture

that most youth crimes are located near the residence of the young offenders; hence log(distance) is unlikely to be correlated with the selected youth crime rates in our sample. Finally, we perform two formal tests for IV validity: (a) Cragg-Donald test statistic that tests the null hypothesis that the equation is under-identified. Since all the Cragg-Donald chi-square statistics are statistically significant, we can reject the null hypothesis in favour of the alternative that the crime equations are all exactly identified. (b) Hansen J-statistics suggests that the system is exactly identified as we have exactly two instruments, namely, log(distance) and Post*log(distance) to determine two potentially endogenous variables Treated and Post*Treated.

The coefficient of the interaction term *PostxTreated* IV that accounts for the differential effect of the Amendment on violent crime rates in the treated municipalities is negative and statistically significant for all crime indices in our sample. Evidently, the absolute values of these IV coefficient estimates are bigger than the non-IV OLS estimates summarised in Table 4, but have the same signs; in other words, OLS underestimated the coefficient estimates. We thus infer that municipalities that adopted the Amendment experienced lower violent youth crime rates compared to communities that did not adopt it. In particular, adoption of the Amendment causes a drop in 3 gun deaths, 3 assault deaths and 6 violent deaths for every 10000 15-19 year olds.

Table 6B further summarises the corresponding standardised coefficients and these are -0.273, -0.286 and -0.325 respectively for gun death rate, assault death rate and violent death rates as shown in columns (1)-(3) of the table. Thus 1 s.d. increase in treatment (i.e., adoption of the Amendment) would lower gun death rates by 0.273 sd, assault death rates by 0..286 sd and violent death rates by 0.325 sd after 2009 in our sample.

Possible explanations

How do we explain the differential effects of the Amendment on violent crime rates? First, by definition, the high school enrolment rate has gone up in the treated municipalities only after the Amendment (see column (1) of Table 2). The latter is likely to generate an "incapacitation effect" to reduce crime rates in our sample as these high school students are contained in schools during the

school hours.

Second, we rule out the possibility that there has been any change in municipal policing in the treatment communities after the introduction of the Amendment 59 (see column (2) of Table 2) so that the drop in crime rates in the treated districts cannot be attributed to increased policing.

Third, we have already examined if there has been any change in the employment rate in the treated districts after the Amendment. It appears from columns 3 and 4 of Table 2 that neither overall nor under-17 employment rates increased significantly among the treated municipalities after the Amendment in our sample, thus ruling out the possibility that compulsory high schooling would lower crime because it increases the costs of committing crime.

Thus, it appears that the observed reduction in crime rate in the treated districts after the Amendment can solely be attributed to the increased high school enrolment that generates the incapacitation effect.

The incapacitation effect associated with compulsory schooling may however be weakened because of the overcrowding in classes and the associated possibility of night schooling in the treated municipalities right after the Amendment. Using the class size information available from INEP, we compare the average class size in treated and control municipalities. The left panel of Figure 5 shows that the average class size is significantly higher in the treated municipalities that adopted the Amendment, thus implying that the adoption of the Amendment has given rise to larger class size in the treated municipalities in our sample, at least in the immediate aftermath of the adoption. This is also confirmed in Table 9 that highlights a significant positive effect of the treatment on class size and also on 15-19 enrolment rate in night schools. In particular, the interaction terms are positive and statistically significant on both class size and night school enrolment rates, thus suggesting that both class size and night school enrolment went up significantly in the treated (relative to control) municipalities after the Amendment. Thus, overcrowding in classes in general as well as higher enrolment rates in night schools are both likely to worsen schooling environment and schooling quality especially if the school governance is weak (see further discussion in Section 5.2).

5.1. Eliminating competing explanations

We next attempt to ensure that our results are not biased because of any confounding events.

For decades, many of Rio de Janeiro's favelas have been controlled by gangs of armed drug traffickers. Beginning with the launch of 2008 Police Pacification Unit (UPP for short) that was implemented in Dona Marta in 2008, many of Rio's major favelas have received pacifying police forces. The favelas chosen for the UPP program have previously not paid for public utilities, but would have to pay fees to whatever criminal organization controlled the area; this often leads to a recurrence of extortion and tax evasion. Therefore, the concept for the UPP, which was given even more impetus once Rio was chosen to host the FIFA World Cup and the Summer Olympic Games, was finally put into action as a first-step solution to deal with the urban cycle of violence.

There are 21 municipalities drawn from Rio de Janeiro in our sample. In order to test that our results are not influenced by the UPP intervention, we dropped these 21 Rio municipalities and re-estimated our regression model. These results, summarised in Table 7, confirm the robustness of our estimates: we find that the size, sign and significance of the interaction coefficients are rather similar to those in Table 6.

Second, we argue that the state of Sao Paulo has traditionally devoted significant resources for tackling all sorts of crime and so we want to examine if our results hold even when we drop Sao Paulo. Estimates excluding Sao Paulo state are shown in Table 8. Both these sets of estimates confirm our baseline results as in Table 6 that indices of violent youth crime rates had significantly dropped in the treated municipalities in the post-2009 years. A comparison of the treatment impact between the full sample (Table 6) and states excluding Sao Paulo (Table 8) shows the robustness of our estimates – we get rather comparable treatment effects for all three violent crime rates.

Appendix Table A3 examines that the same treatment effects are not generated if we consider a placebo for the years 2006-09, which were before the introduction of the Amendment. Controlling for all other factors, the estimated interaction coefficients are all statistically insignificant in all three columns, thus eliminating the possibility that the observed treatment effects triggered by the constitutional Amendment can be attributed to any other changes during 2006-09.

Appendix Tables A4-A6 summarise the fixed effects estimates of the selected violent crime

indices. The underlying idea is that inclusion of the municipality level unobserved factors may help minimising the endogeneity bias of the selected crime indices, which otherwise remains unaddressed in the OLS estimates shown in Table 4. Note that these fixed effects estimates are rather comparable to the 2sls-IV estimates in Table 6 in terms of size, sign and statistical significance, thus confirming the robustness of our estimates.

5.2. Heterogeneous impact

Finally, we consider the heterogeneous impact, if any, of the Amendment on violent crime rates in poor and non-poor municipalities in our sample (see discussion in section 3). The 2SLS-IV estimates, summarised in Table 10, highlight the differential effect of the Amendment: the estimated coefficient of the interaction term is negative and statistically significant for all three crime rates in the non-poor municipalities while it has a very small weakly significant (only at 10% level) negative effect on assault death rates, but no significant effect on death by guns in the poor municipalities. In thus appears that the full sample effects of the Amendment on the selected violent crime rates as observed in Table 6 appear to be driven by the effect realised by the non-poor municipalities in our sample.

As discussed earlier, the municipalities in the north-eastern region of Brazil are particularly underdeveloped relative to the rest of the country. In order to probe the matter further, we also split the north-eastern region municipalities into poor and non-poor categories to reassess the effect of the Amendment for this subsample. These estimates summarised in Table 11 further reaffirms the heterogeneous impact of the Amendment in poor and non-poor municipalities: in this case, we find a statistically significant positive effect of the Amendment on all three crime indices in poor municipalities of the north-eastern region; the corresponding effects however remain statistically insignificant for the non-poor municipalities thus suggesting little impact of the 2009 Amendment on non-poor municipalities of the north east after the adoption of the Amendment.

How can we explain the heterogeneous impact? We examine some possible hypotheses here. (i) Class size: The right hand panel of Figure 6 indicates that the class sizes are larger in the poorer municipalities in the north-eastern region; in fact, the difference in class size between the treated and control municipalities goes up significantly in the poor municipalities in the north-eastern region. (ii)

Municipality governance: Second, Appendix Table A2 suggests that poor and non-poor municipalities tend to differ significantly in terms of various selected governance indices too. For example, in comparison to the non-poor municipalities, poor municipalities are less likely to have a municipal education board that monitors school performance. They are also less likely to have a safety board that oversees the overall safety and security issues of the municipalities. Further these poor municipalities are worse-off when we compare their composite index (both municipal education board and safety board) using the principal component analysis with that for the non-poor municipalities. The discrepancy between the poor and the non-poor municipalities is magnified when we consider the north-eastern region that lags in the process of development behind other Brazilian regions, generating less productive employment opportunities too.

Taken together, the Constitutional Amendment 59 has led to greater class size in general and also an increase in night school enrolment rates. The latter is likely to be more problematic if school governance is weak as well (as per Table A2) as overcrowding and weak governance may worsen the problems of drug use and anti-social behaviour within the school premises,[1] thus worsening the school learning environment, learning quality as well as the crime situation and considerably weakening the incapacitation effect of the Amendment. Further, poorer municipalities (including those in the north-eastern region) tend to suffer from lower job prospects, lower income/employment opportunities and hence lower returns to high schooling, even after the Amendment. In other words, incentives associated with compulsory high schooling are considerably limited in the poorer and more deprived regions in our sample. As a result, the costs of the Amendment introducing compulsory high schooling may outweigh its benefits so that the compulsory high schooling after the adoption of the Amendment may not be successful enough to lower youth crime rates in poorer municipalities.

In addition, it is possible that weaker governance may arise from the fact that poorer and smaller regions in remote areas may not have enough human and physical capital needed to conduct their administrative services to the fullest capacity, especially when decentralised (e.g., see Bardhan

[1] Interviews with people from the Secretary of Security of Sao Paulo State also indicate that drug traffic was common in overcrowded schools, especially in night schools.

and Mookherjee, 2005). Appendix Table A2 suggests that poorer municipalities are less likely to have an education board or safety board, making it likely for the schools in poorer regions to be poorly administered and therefore perform worse especially under Brazilian decentralised governance. Similar argument is made by Galiani, Gertler and Schargrodsky (2008) in the context of Argentina. Thus an important implication of our results is that the effectiveness of the compulsory high schooling after the Amendment crucially depends on school resources as well as the quality of municipal and school governance in decentralised Brazilian municipalities.

6. Concluding comments

In order to assess the beneficial role of education in fighting youth crime, we compile a unique annual municipality-level data over 2000-2013 drawn from all Brazilian territory and use the staggered implementation of the Constitutional Reform 59 as a natural experiment to identify the causal impact of compulsory high schooling of 16-17 years olds on selected violent crime rates among 15-19 years old. Given the administrative window of implementing the reform between 2010-16, the adoption of the reform prior to 2016 is likely to be non-random, thus justifying the use of a 2SLS-IV model. In this respect, we use the variation in the exogenously given geographic distance of the municipality from its state capital to identify the adoption of the reform, which suggests that the distance of the municipality from its state capital is a significant predictor of early adoption of the reform only after the introduction of the Amendment. We argue and show that it is a valid IV in that most youth crimes are committed near the place of residence where distance from the provincial capital plays an insignificant role, thus justifying the choice of the IV.

Departing from the previous studies in Brazil, we consider the impact of compulsory high schooling on violent youth crime rates (rather than overall crime rates) in all Brazilian municipalities (rather than municipalities in specific regions, e.g., Sao Paulo). Our estimates performed within a IV difference-in-difference framework, suggest that the Amendment significantly reduced youth crime rates in the treated municipalities though the size was small as it worked mainly through incapacitation which was also weakened by overcrowding and night schools in Brazil. Further, there

is suggestion that compulsory high schooling only worked in the non-poor municipalities, but has no/weak beneficial effect on death rates by guns in the poorer municipalities after the Amendment. The latter can be attributed to the overcrowding in classes, possibility of night schooling as well as weaker school governance, all of which tend to outweigh the benefits of the Amendment on youth crime rates in poorer (relative to non-poor) regions of the country.

Evidently, the criminal involvement rises sharply with the onset of adolescence in the US (Levitt and Lochner, 2001) and also in Latin America (see Figure 1). Given the enormous real and psychological costs of crime, the prevention of youth crime is high on the public policy agenda in most countries including Brazil. An important value-added of our analysis is to highlight that the compulsory high schooling may not necessarily lower youth crime rates; we show that success of compulsory high schooling to lower youth crime rates crucially depends on school's learning environment and job market prospects, bearing important implications for future policies for tackling youth crime not only in Brazil, but also beyond its border.

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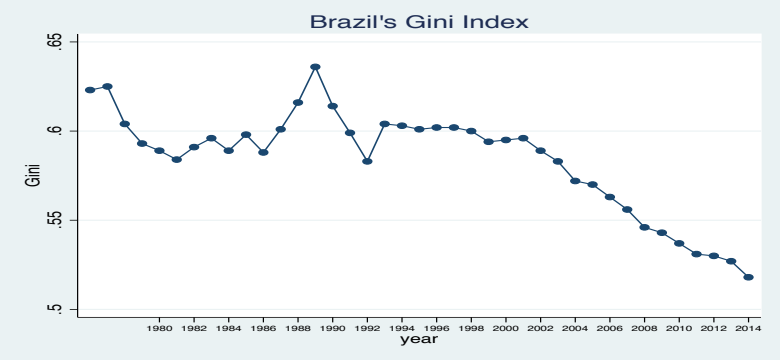
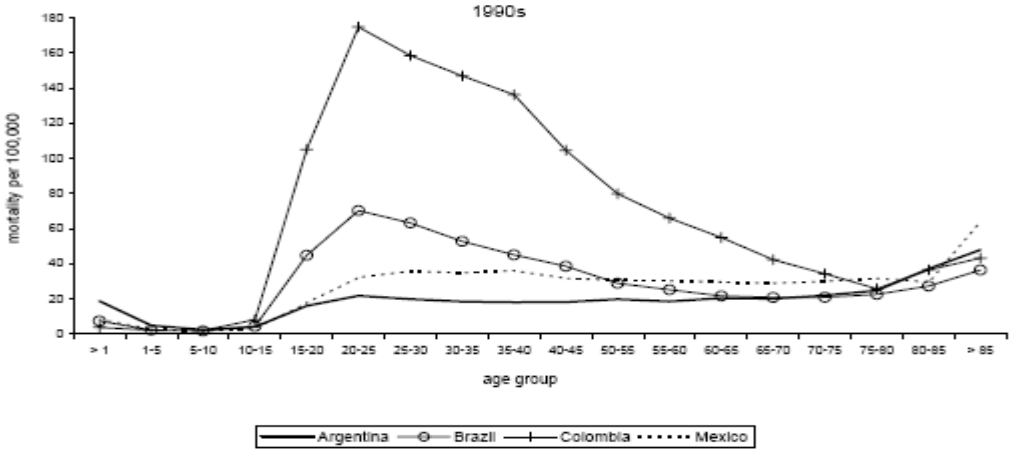
Figures

Figure 1 – Evolution of Gini Index in Brazil



Source: Authors calculation using IBGE data

Figure 2 - Age profile of criminals in selected South American Countries



Source: Paim et al 2008

Figure 3 – Trend in total enrolments among 15-19 year old among treated and control municipalities

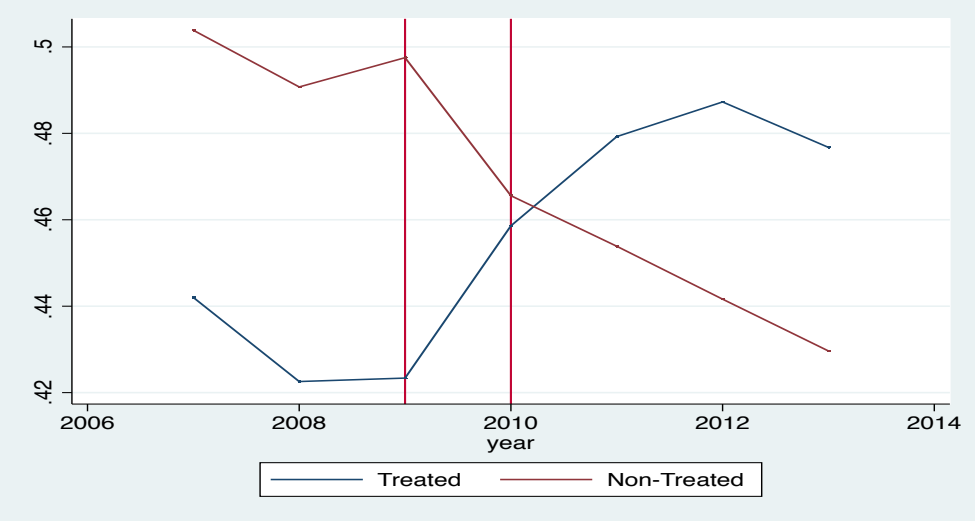
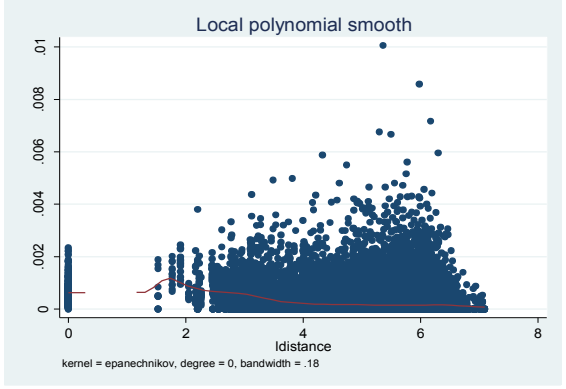
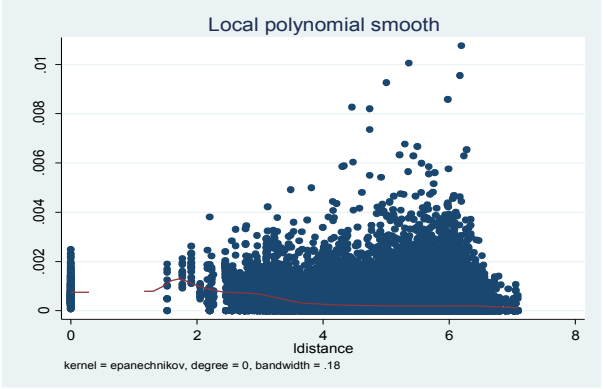


Figure 4. Identification of IV validity

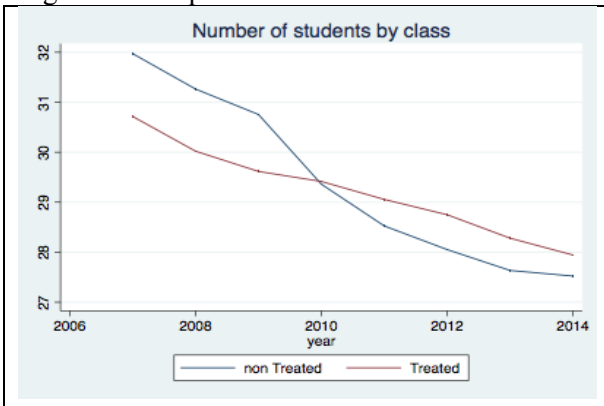


Epanechnikov kernel fit for the association between log(distance) and 15-19 gun death rates



Epanechnikov kernel fit for the association between log(distance) and 15-19 assault death rates

Figure 5. Comparison of class size in treated and control municipalities, full sample and north-east



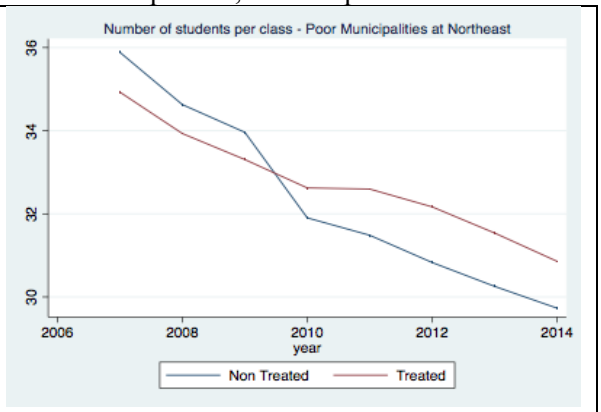
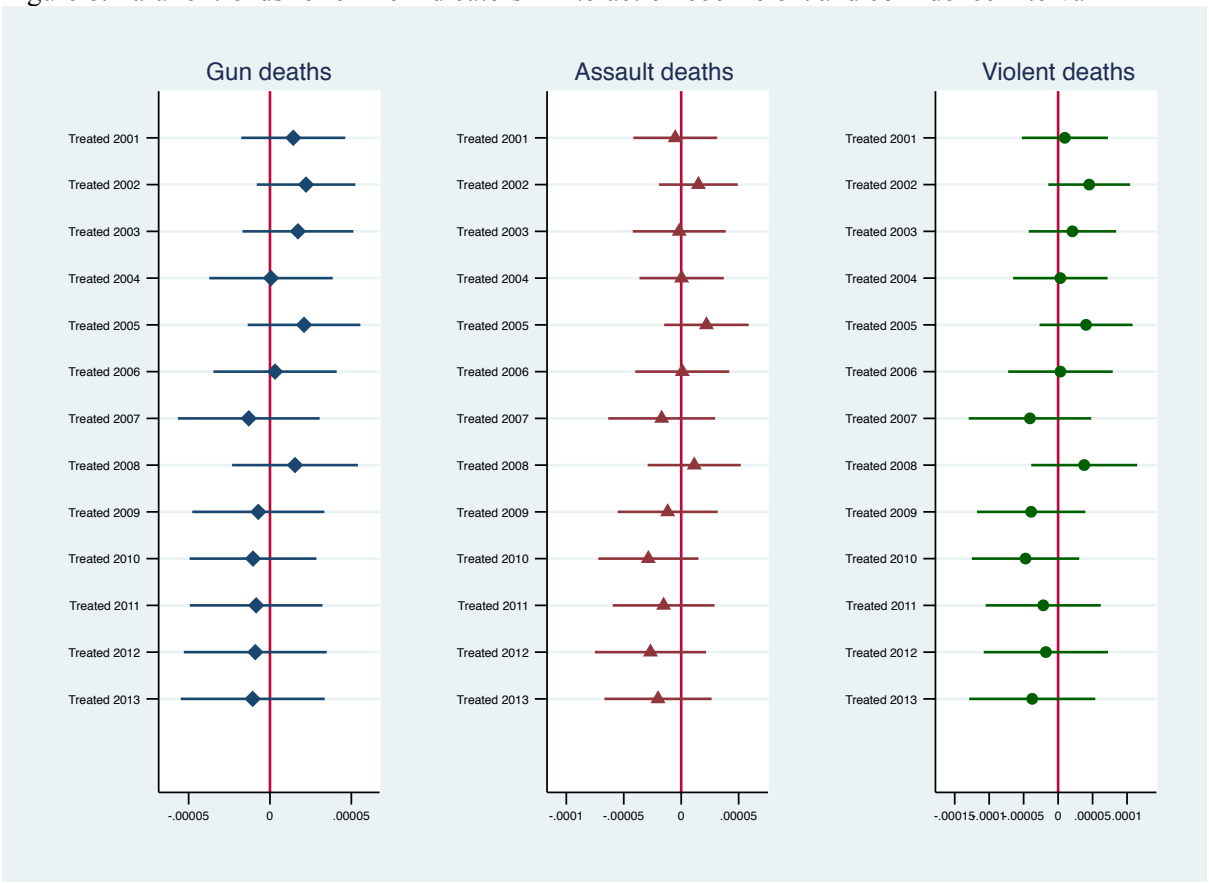


Figure 6. Parallel trends for crime indicators – interaction coefficient and confidence interval



Tables

Table 1 – Rationale for treatment and control municipalities: Mean comparisons

	2000-2009			2010-2013		
Variables	Treated=1	Treated=0	T-stat	Treated=1	Treated=0	T-stat
Number of enrolments at middle school	2844.86	2587.86	2.09**	2634.91	2248.13	2,108**
Number of enrolments at high school	1600.86	1523.83	0.905	1601.13	1376.45	1.880*
Rate of enrolment at high school and population between 15-19 years old	0.4231	0.4622	-27.825***	0.4755	0.4477	18.402**
Age lag (school delay)	43.29	46.75	-16.72***	33.38	35.72	-9.467***
Share of dropout after middle school	0.000366	0.0004422	-6.842***	0.000235	0.000288	-7.303***
Total education spending	2273844	2142740	1.188	3126076	2903411	1.883*
Education spending per student	357,679	349,703	1.412	762,518	793,464	-1.553

Note: Municipalities that adopted the reforms and those that did not. The first had significantly higher high school enrolment, but lower dropout rates after the middle school, thus suggesting that the reform was successful to lower dropout rates after middle schools and also to increase high school enrolment in the post-reform years. *** p<0.01, ** p<0.05, * p<0.1

Table 2. Time trend in high school enrolment, employment and municipal policing

Variables	1.Enrolment rate for 15-19 year olds	2.Dummy of municipal police	3.Employment/income Index	4.Under 17 employment share
Treated	-0.03059***	0.00812	0.017***	-0.0271***
	(0.005)	(0.007)	(0.004)	(0.00806)
treatx2001	-0.00642**	0.00053	-0.001	
	(0.003)	(0.003)	(0.001)	
treatx2002	0.00114	0.00380	-0.003	0.00903
	(0.004)	(0.004)	(0.002)	(0.0114)
treatx2003	0.00054	0.00474	-0.004*	
	(0.004)	(0.005)	(0.003)	
treatx2004	-0.00171	0.00641	-0.006*	0.00858
	(0.005)	(0.005)	(0.003)	(0.0112)
treatx2005	-0.00151	0.00582	-0.007*	-0.00913
	(0.005)	(0.006)	(0.004)	(0.0113)
treatx2006	-0.00069	0.00422	-0.003	-0.00457
	(0.005)	(0.007)	(0.004)	(0.0112)
treatx2007	-0.00323	0.00400	-0.008**	-0.00662
	(0.005)	(0.007)	(0.004)	(0.0112)
treatx2008	-0.01921***	0.00043	-0.014***	-0.00267
	(0.004)	(0.007)	(0.004)	(0.0112)
treatx2009	-0.02356***	-0.00284	-0.017***	0.000202
	(0.004)	(0.008)	(0.004)	(0.0111)
treatx2010	0.02533***	-0.00506	-0.011***	-0.00231
	(0.004)	(0.008)	(0.004)	(0.0110)
treatx2011	0.04170***	-0.00680	-0.017***	0.00203
	(0.004)	(0.008)	(0.004)	(0.0110)
treatx2012	0.04977***	-0.00888	-0.012***	
	(0.004)	(0.009)	(0.004)	
treatx2013	0.05187***	-0.00452	-0.009**	
	(0.004)	(0.009)	(0.004)	
Constant	0.25233***	-0.00312	0.352***	0.467***
	(0.016)	(0.003)	(0.003)	(0.00594)
Year dummies	Yes	Yes	Yes	
Observations	77,180	83,355	82,999	54,619
R-squared	0.253	0.160	0.090	0.005

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Since security is under the state provision, having a municipal police is not mandatory. We define the municipal police dummy as follows: it takes a value 1 if the municipality is concerned about security and have a municipal police force.

Table 3- Mean comparisons of crime rates for treatment and control municipalities before/after 2010

	Before 2010			After 2010		
Variables	Treated=1	Treated=0	T-stat	Treated=1	Treated=0	T-stat
Assault deaths	0.0002	0.0002	0.4124	0.00027	0.00034	-6.749***
Gun deaths	0.00016	0.00017	0.1689	0.00021	0.00028	-7.867***
Ln(Distance from capital)	5.28	5.25	3.8008***	5.28	5.25	3.8008***
Log. GDP per capita	1.412	1.322	13.578***	1.718	1.668	5.158***

*** p<0.01, ** p<0.05, * p<0.1

Table 4 –OLS estimates for selected crime indicators in rates and levels

	Crime rates (15-19 years old) as a share of 15-19 municipal population			logarithm of number of youth crimes (15-19 years old)		
Variables	Gun deaths	Assault deaths	Violent deaths	Gun deaths	Assault deaths	Violent deaths
Post 2009	0.000065	-0.000063	0.000130	0.067133	-0.123253	0.061364
	(0.000)	(0.000)	(0.000)	(0.085)	(0.078)	(0.117)
Treated	-0.000010	-0.000002	-0.000015	0.001085	0.006271	0.001657
	(0.000)	(0.000)	(0.000)	(0.013)	(0.013)	(0.017)
PostXTreated	-0.000014	-0.000020*	-0.000033	-0.028552**	-0.031898***	-0.036395**
	(0.000)	(0.000)	(0.000)	(0.012)	(0.011)	(0.016)
Observations	41,745	46,797	39,684	41,745	46,797	39,684
R-squared	0.094	0.088	0.107	0.490	0.509	0.504

Robust standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1
Controls included in both stages are: if mayor is male, if mayor is graduate, if mayor party is the same of President's party, size of municipal population, GDP per capita, illiteracy rate, Gini index, presence of public inter-municipal transport, presence of municipal internet services, number of public health clinics, number of public libraries, state dummies and also state*year dummies. See Appendix Table A1 for variable definitions.

Table 5 – Test of Parallel Trend

VARIABLES	Youth gun death rates (15-19 y.o.)	Youth assault death rates (15-19 y.o.) by	Youth deaths due violent crimes (15-19 y.o.)
Treated	-0.00002*	-0.00001	-0.00003
	(0.000)	(0.000)	(0.000)
treatx2001	0.00001	-0.00001	0.00001
	(0.000)	(0.000)	(0.000)
treatx2002	0.00002	0.00001	0.00005
	(0.000)	(0.000)	(0.000)
treatx2003	0.00002	-0.00000	0.00002
	(0.000)	(0.000)	(0.000)
treatx2004	0.00000	0.00000	0.00000
	(0.000)	(0.000)	(0.000)
treatx2005	0.00002	0.00002	0.00004
	(0.000)	(0.000)	(0.000)
treatx2006	0.00000	0.00000	0.00000
	(0.000)	(0.000)	(0.000)
treatx2007	-0.00001	-0.00002	-0.00004
	(0.000)	(0.000)	(0.000)
treatx2008	0.00002	0.00001	0.00004
	(0.000)	(0.000)	(0.000)
treatx2009	-0.00001	-0.00001	-0.00004
	(0.000)	(0.000)	(0.000)
treatx2010	-0.00001	-0.00003	-0.00005
	(0.000)	(0.000)	(0.000)
treatx2011	-0.00001	-0.00002	-0.00002
	(0.000)	(0.000)	(0.000)
treatx2012	-0.00001	-0.00003	-0.00002
	(0.000)	(0.000)	(0.000)
treatx2013	-0.00001	-0.00002	-0.00004
	(0.000)	(0.000)	(0.000)
Constant	0.00013***	0.00014***	0.00027***
	(0.000)	(0.000)	(0.000)
Observations	46,801	52,640	44,411
R-squared	0.063	0.060	0.074

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Controls included: state dummy and crossed dummies of state and year.

Table 6– 2SLS IV estimates for crime rates, all municipalities

First stage		
	Treated	PostXTreated
Predicted value of treated using Logarithm of distance from the capital state as IV	0.850***	-0.057
	(0.006)	(0.125)
Post2009 x Predicted value of treated using Logarithm of distance from the capital state	-0.012	1.059***
	(0.017)	(0.0488)
Observations	41688	41688
F-test exclusion	14.97	103.57
R-squared	0.1199	0.4834

Second stage – IV estimates of crime rates among youths 15-19 years old			
VARIABLES	Gun deaths as a share of youth population	Assault deaths as a share of youth population	Violent deaths as a share of youth population
Post 2009	0.00025***	0.00030***	0.00062***
	(0.000)	(0.000)	(0.000)
Treated IV	0.00003	0.00001	0.00002
	(0.000)	(0.000)	(0.000)
PostXTreated IV	-0.00026***	-0.00026***	-0.00057***
	(0.000)	(0.000)	(0.000)
Observations	41,688	46,746	39,651
R-squared	0.051	0.053	0.056
Cragg-Donald test Chi-square(P-value)	39.11(0.00)***	45.72 (0.00)***	44.03 (0.00)***

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Controls included in both stages are: if mayor is male, if mayor is graduate, if mayor party is the same of President's party, size of municipal population, GDP per capita, illiteracy rate, Gini index, presence of public inter-municipal transport, presence of municipal internet services, number of public health clinics, number of public libraries, state dummies and also state*year dummies. See Appendix Table A1 for variable definitions.
Cragg-Donald test: Ho: matrix of reduced form coefficients has rank=K-1 (under-identified)
Ha: matrix has rank>=K (identified). Hansen J-stat tests for over-identification – a value of 0 means that the equation is exactly identified.

Table 6B –Standardised estimates of crime rates corresponding

Second stage – IV estimates of crime rates among youths 15-19 years old			
VARIABLES	Gun deaths as a share of youth population	Assault deaths as a share of youth population	Violent deaths as a share of youth population
Post 2009	0.273***	0.286***	0.325***
Treated IV	0.036	0.014	0.008
PostXTreated IV	-0.232***	-0.201***	-0.249***

Robust standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1
Controls included in both stages are: if mayor is male, if mayor is graduate, if mayor party is the same of President's party, size of municipal population, GDP per capita, illiteracy rate, Gini index, presence of public inter-municipal transport, presence of municipal internet services, number of public health clinics, number of public libraries, state dummies and also state*year dummies. See Appendix Table A1 for variable definitions.

Table 7. 2SLS-IV estimates of youth crime rates excluding Rio de Janeiro Metropolitan area

Second stage - Crime rates excluding RJ metropolitan area – youths 15-19 years old			
VARIABLES	Gun deaths as a share of youth population	Assault deaths as a share of youth population	violent deaths as a share of youth population
Post 2009	0.00026***	0.00031***	0.00064***
	(0.000)	(0.000)	(0.000)
Treated IV	0.00003	0.00001	0.00001
	(0.000)	(0.000)	(0.000)
PostXTreated IV	-0.00026***	-0.00026***	-0.00058***
	(0.000)	(0.000)	(0.000)
Observations	41,475	46,533	39,438
R-squared	0.049	0.050	0.053

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Controls included in both stages are: if mayor is male, if mayor is graduate, if mayor party is the same of President's party, size of municipal population, GDP per capita, illiteracy rate, Gini index, presence of public inter-municipal transport, presence of municipal internet services, number of public health clinics, number of public libraries, state dummies and also state*year dummies. See Appendix Table A1 for variable definitions.

Table 8. 2SLS IV estimates of 15-19 Crime rates after excluding Sao Paulo state

Second stage - Crime rates excluding Sao Paulo State – youths 15-19 years old			
Variables	Gun deaths as a share of youth population	Assault deaths as a share of youth population	violent deaths as a share of youth population
post2009	0.00025***	0.00028***	0.00060***
	(0.000)	(0.000)	(0.000)
Treated IV	-0.00012	-0.00011	-0.00030
	(0.000)	(0.000)	(0.000)
Post* Treated IV	-0.00016***	-0.00015***	-0.00036***
	(0.000)	(0.000)	(0.000)
Observations	37,531	41,916	35,598
R-squared	0.039	0.052	0.039

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Controls included in both stages are: if mayor is male, if mayor is graduate, if mayor party is the same of President's party, size of municipal population, GDP per capita, illiteracy rate, Gini index, presence of public inter-municipal transport, presence of municipal internet services, number of public health clinics, number of public libraries, state dummies and also state*year dummies. See Appendix Table A1 for variable definitions.

Table 9 – Treatment effect on number of students per class and night students

Variables	Students by class	Share of night students in total students
Post 2009	-3.257530***	-0.065801***
	(0.553)	(0.011)
Treated	-0.587488***	-0.013256**
	(0.135)	(0.006)
PostXTreated	0.930553***	0.018695***
	(0.092)	(0.004)
Observations	44,348	44,317

R-squared	0.399	0.190

Robust standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1
Controls included in both stages are: if mayor is male, if mayor is graduate, if mayor party is the same of President's party, size of municipal population, GDP per capita, illiteracy rate, Gini index, presence of public inter-municipal transport, presence of municipal internet services, number of public health clinics, number of public libraries, state dummies and also state*year dummies. See Appendix Table A1 for variable definitions.

Table 10 – 2SLS-IV second stage estimates of the crime rates for poor and non-poor regions

	Municipalities		
Indicator	Gun death rates among 15-19 years old		
	Brazil	Non-poor	Poor
Post 2009	0.00025***	0.00033***	0.00016***
	(0.000)	(0.000)	(0.000)
Treated IV	0.00003	-0.00015	-0.00001
	(0.000)	(0.000)	(0.000)
PostXTreated IV	-0.00026***	-0.00034***	-0.00009*
	(0.000)	(0.000)	(0.000)
Observations	41,688	28,528	13,160
R-squared	0.051	0.001	0.025
Indicator	Assault death rates among 15-19 years old		
Region	Brazil	Non Poor	Poor
Post 2009	0.00030***	0.00039***	0.00020***
	(0.000)	(0.000)	(0.000)
Treated IV	0.00001	-0.00018	-0.00005
	(0.000)	(0.000)	(0.000)
PostXTreated IV	-0.00026***	-0.00034***	-0.00008
	(0.000)	(0.000)	(0.000)
Observations	46,746	31,993	14,753
R-squared	0.053	0.001	0.032
Indicator	Violent death rates among 15-19 years old		
Region	Brazil	Non Poor	Poor
Post 2009	0.00062***	0.00079***	0.00041***
	(0.000)	(0.000)	(0.000)
Treated IV	0.00002	-0.00040	-0.00000
	(0.000)	(0.000)	(0.000)
PostXTreated IV	-0.00057***	-0.00073***	-0.00021*
	(0.000)	(0.000)	(0.000)
Observations	39,651	27,112	12,539
R-squared	0.056	-0.019	0.035

Robust standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1

Controls included in both stages are: if mayor is male, if mayor is graduate, if mayor party is the same of President's party, size of municipal population, GDP per capita, illiteracy rate, Gini index, presence of public inter-municipal transport, presence of municipal internet services, number of public health clinics, number of public libraries, state dummies and also state*year dummies. See Appendix Table A1 for variable definitions.

Table 11 –2SLS-IV estimates of crime rates for poor and non-poor municipalities in the North-east

Indicator	Gun death rates among 15-19 years old		Assault death rates among 15-19 years old		Violent death rates among 15-19 years old	
	NE - Non Poor	NE – Poor	NE - Non Poor	NE – Poor	NE - Non Poor	NE - Poor
Post 2009	0.00015	-0.00014	0.00027***	0.00002	0.00052***	-0.00018
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Treated IV	0.00011	0.00021	0.00011	0.00048	0.00013	0.00049
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
PostXTreated IV	0.00018	0.00073**	-0.00002	0.00042**	0.00011	0.00135**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Observations	7048	8534	7594	9260	6710	8146
R-squared	0.167	0.114	0.209	0.151	0.221	0.146

Robust standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1

Controls included in both stages are: if mayor is male, if mayor is graduate, if mayor party is the same of President's party, size of municipal population, GDP per capita, illiteracy rate, Gini index, presence of public inter-municipal transport, presence of municipal internet services, number of public health clinics, number of public libraries, state dummies and also state*year dummies. See Appendix Table A1 for variable definitions.

Appendix Tables

Table A1. Variable definitions, Sources and Summary Statistics

Full sample					
Variable	**Description**	**Obs**	**Mean**	**Std. Dev.**	**Source**
Rate of gun deaths 15-19	Rate of number of youth deaths by guns and resident youth population (15 to 19 years old)	46,843	0.00019	0.00045	DATASUS – Health Informatics Department of the Brazilian Ministry of Health.
Rate of Assault deaths 15-19	Rate of number of youth deaths by assault and resident youth population (15 to 19 years old)	52,640	0.00023	0.00051	DATASUS – Health Informatics Department of the Brazilian Ministry of Health.
Rate of Violent deaths 15-19	Rate of number of violent youth deaths and resident youth population (15 to 19 years old)	44,453	0.00044	0.00091	DATASUS – Health Informatics Department of the Brazilian Ministry of Health.
Gun deaths 15-19	Logarithm of number of deaths by guns - people from 15 to 19 years old	46,858	0.36625	0.76776	DATASUS – Health Informatics Department of the Brazilian Ministry of Health.
Assault deaths 15-19	Logarithm of number of deaths by assault (aggressions) - people from 15 to 19 years old	52,653	0.396	0.769	DATASUS – Health Informatics Department of the Brazilian Ministry of Health.
Violent deaths 15-19	logarithm of sum of deaths by gun and assault -people from 15 to 19 years old	44,463	0.599	1.00014	DATASUS – Health Informatics Department of the Brazilian Ministry of Health.
Treated	It takes a value 1 if average of number of enrollments in high school per population of 15-19 years old is greater than this rate in 2009; 0 c.c.;	83,460	0.5350	0.49877	INEP – National Institute for Educational Studies and Research "Anísio Teixeira".
Distance of capital state	Distance of municipality from the capital state em km	77,098	253.20	163.67	IBGE – Brazilian Institute of Geography and Statistics.
GDP per capita	logarithm of municipal gross domestic product per capita - prices of 2000	75,294	1.47	0.77	IBGE – Brazilian Institute of Geography and Statistics.
Mayor education	binary variable: 1 = mayor graduated at a college; 0=the opposite	73,762	0.41	0.49	TCU - Tribunal de Contas da União - Federal court accounts
Aligned with President	Mayor Party Aligned and Supports President Party	83,880	0.10	0.30	TCU - Tribunal de Contas da União - Federal court accounts
Gini index	Gini index by municipalities, according to the residents' distribution of income	77,896	0.52	0.08	IBGE – Brazilian Institute of Geography and Statistics.
Population	Municipal resident population	80,860	31193	187024	TCU - Tribunal de Contas da União - Federal court accounts
Population 15-19 years old	15-19 years old resident population	72,259	3129	16577	TCU - Tribunal de Contas da União - Federal court accounts

Cash transfer program 'Bolsa Família'	Number of people receiving cash transfers Bolsa Familia	50,040	2003	6090	Brazilian Social Ministry
High-school enrolments	Number of enrolments at high school	77,205	1545	9661	INEP – National Institute for Educational Studies and Research "Anísio Teixeira".
Dropout rate after middle school	Dropout rate at elementary and middle school	44,248	2.83	3.58	INEP – National Institute for Educational Studies and Research "Anísio Teixeira".
Mayor party	mayor party	83,880			TCU - Tribunal de Contas da União - Federal court accounts
President party	president party	83,880			TCU - Tribunal de Contas da União - Federal court accounts
Poor municipality	Municipality with less than half minimum wage as income per capita	83,460	0.28	0.45	IBGE – Brazilian Institute of Geography and Statistics.
Mayor gender	Mayor gender	79,480	2.16	0.55	TCU - Tribunal de Contas da União - Federal court accounts
Education Board	Municipality has an education board	83,460	0.23	0.42	IBGE – Brazilian Institute of Geography and Statistics.
Employment /Income index	Composite index of employment and income	82,999	0.45	0.14	FIRJAN – Federation of industries of Rio de Janeiro
Education Board	Municipality has an education board	83,460	0.23	0.42	IBGE – Brazilian Institute of Geography and Statistics.
Public transport	Existence of public transport to/from other municipalities in 2008	83,460	0.817	0.39	IBGE – Brazilian Institute of Geography and Statistics.
Internet services	Public services on Internet of municipal government in 2009	83,460	0.772	0.42	IBGE – Brazilian Institute of Geography and Statistics.
Public clinics	Number of public clinics in 2009	83,460	11.371	26.67	IBGE – Brazilian Institute of Geography and Statistics.
Public libraries	Number of public libraries	83,460	1.267	2.74	IBGE – Brazilian Institute of Geography and Statistics.

Note: Assault: Homicides by assault among 15-19 years old; Gun: homicides by gun among 15-19 years old; Violent: homicides by assault and gun among 15-19 years old; Car-crash: homicides by car crash among 15-19 years old.

Appendix Table A2. Comparison of governance indicators across regions

Brazil	**Poor**	**Non-poor**	**T-statistics**
Population	15220	39553	-4.2060***
Logarithm of GDP per capita in Reais of 2000)	8.4	16.40	-17.6002***
Distance from capital (km)	276	244	22.3607***
Northeast	0.59	0.21	29.0864***
Gini index	0.52	0.49	-13.1231***
Employment/income index	0.41	0.51	-26.6006***
Mayor professional	0.31	0.35	-2.5085***
Mayor graduate	0.39	0.45	-3.6893***
Class size	30	28	8.3571***
Drop out rate	4.33	2.22	57.9929***
Graduate teachers	0.83	0.92	20.9397***
Have an education board	0.2	0.25	-14.6320***
Have a safety board	0.04	0.09	-26.2972***
Have not been audited	0.96	0.97	-5.1055***
PCA Composite index[1]	-0.06	0.02	25.4693***
Northeast	**Poor**	**Non-poor**	**T-statistics**
Have an education board	0.18	0.26	26.0107***
Have a safety board	0.02	0.10	-37.8170***
Have not been audited	0.97	0.98	-4.8948***
PCA Composite index[1]	-0.08	0.04	-40.6054***
Employment/income index	0.36	0.40	- 23.2809***

Note: [1] We use the principal component analysis to derive the composite index of governance using the information on having an education board, safety board and not being audited.
*** p<0.01, ** p<0.05, * p<0.1

A3. Placebo Test – Intervention during 2006 to 2009

	Crime rates (15-19 years old) as a share of 15-19 municipal population		
Variables	Gun deaths	Assault deaths	Violent deaths
Year2006-2009	-0.00004	-0.00082	-0.00050
	(0.001)	(0.001)	(0.002)
Treated	0.00346***	0.00228**	0.00628***
	(0.001)	(0.001)	(0.002)
Year2006-09XTreated	-0.00040	0.00125	0.00015
	(0.002)	(0.002)	(0.004)
Observations	41,688	46,746	39,651
R-squared	0.094	0.088	0.107

Robust standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1
Controls included in both stages are: if mayor is male, if mayor is graduate, if mayor party is the same of President's party, size of municipal population, GDP per capita, illiteracy rate, Gini index, presence of public inter-municipal transport, presence of municipal internet services, number of public health clinics, number of public libraries, state dummies and also state*year dummies. See Appendix Table A1 for variable definitions.

Table A4 – Fixed effects gun deaths estimates for 15-19 years olds

Variables	Rate Indicator - Gun death rates (15-19 y.o.)			Level Indicator - logarithm of the gun deaths (15-19 y.o.)		
Post 2009	0.000041***	0.000078***	0.000065	0.041838***	0.075550***	0.065763
	(0.000)	(0.000)	(0.000)	(0.009)	(0.017)	(0.084)
PostXTreated	-0.00004***	-0.00004***	-0.00002	-0.06414***	-0.06454***	-0.03345***
	(0.000)	(0.000)	(0.000)	(0.012)	(0.012)	(0.011)
Controls included	yes	Yes	yes	yes	yes	yes
year dummies	no	Yes	yes	no	yes	yes
crossed year and state dummies	no	No	yes	no	no	yes
Observations	41,742	41,742	41,742	41,742	41,742	41,742
R-squared	0.016	0.018	0.050	0.027	0.030	0.085
Municipality code	3,308	3,308	3,308	3,308	3,308	3,308

Robust standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1
Controls included: mayor education (1 if college graduated, 0 c.c.), mayor party is the same of president party, municipality has safety board and municipal police (to control for municipal security expenditure, since security is in state charge), mayor gender, municipal population, GDP per capita, illiterate rate and Gini index.

Table A5 – Fixed effects assault death estimates for 15-19 years olds

Variables	Rate Indicator - Assault death rates (15-19 y.o.)			Level Indicator - Logarithm of the number of assault deaths (15-19 y.o.)		
Post 2009	0.00005***	0.00012***	0.00006	0.042854***	0.10220***	0.06244
	(0.000)	(0.000)	(0.000)	(0.009)	(0.016)	(0.071)
PostXTreated	-0.00005***	-0.00005***	-0.00002*	-0.06190***	-0.06254***	-0.03402***
	(0.000)	(0.000)	(0.000)	(0.011)	(0.011)	(0.010)
Controls included	yes	yes	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes	yes	yes
State*Year	no	no	yes	no	no	yes
Observations	46,807	46,807	46,807	46,807	46,807	46,807
R-squared	0.017	0.019	0.043	0.029	0.032	0.078
Municipality code	3,715	3,715	3,715	3,715	3,715	3,715

Robust standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1
Controls included: mayor education (1 if college graduated, 0 c.c.), mayor party is the same of president party, municipality has safety board and municipal police (to control for municipal security expenditure, since security is in state charge), mayor gender, municipal population, GDP per capita, illiterate rate and Gini index.

Table A6 – Fixed effects violent crime estimates 15-19 years olds

Variables	Rate Indicator: Deaths rate due to violent crimes (15-19 y.o.)			Level Indicator: Logarithm of the number of youth deaths due to violent crimes (15-19 y.o.)		
Post 2009	0.00010***	0.00022***	0.00013	0.06499***	0.15562***	0.08502
	(0.000)	(0.000)	(0.000)	(0.013)	(0.024)	(0.117)
PostXTreated	-0.00010***	-0.00010***	-0.00004	-0.09056***	-0.09124***	-0.04384***
	(0.000)	(0.000)	(0.000)	(0.016)	(0.016)	(0.015)
Controls included	yes	yes	yes	yes	yes	yes
Year dummies	no	yes	yes	no	yes	yes
State*Year	no	no	yes	no	no	yes
Observations	39,681	39,681	39,681	39,681	39,681	39,681
R-squared	0.021	0.024	0.059	0.031	0.034	0.087
Municipality code	3,141	3,141	3,141	3,141	3,141	3,141

Robust standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1
Controls included: mayor education (1 if college graduated, 0 c.c.), mayor party is the same of president party, municipality has safety board and municipal police (to control for municipal security expenditure, since security is in state charge), mayor gender, municipal population, GDP per capita, illiterate rate and Gini index.