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LAW INCENTIVES FOR JUVENILE RECRUITING BY DRUG TRAFFICKING GANGS: EMPIRICAL EVIDENCE FROM RIO DE JANEIRO [*]

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ABSTRACT: We evaluate the deterrence effects of the age of criminal responsibility on total drug trafficking and homicide crimes per age, based on a quasi-experiment generated by differences in punishment severity for these crimes prescribed by the Statute of the Child and Adolescent and by the Penal Code in Brazil. To this end, information from arrests conducted by the civil and military police of the state of Rio de Janeiro in 2016 and 2017 is used to estimate the local effects of treatment through a Regression Discontinuity Design. Instead of using recidivism data and/or grouping crimes with distinct punishment severity, we use as outcome variable the total number of arrests (crimes) per age for drug trafficking and homicides, which are the most common crimes related to organized crime in Rio de Janeiro. The results indicate that the increase in punishment severity generated by the Penal Code can reduce the number of drug trafficking-related crimes by 9% and homicides by 37%. Through a simple cost-benefit analysis, we suggest that increasing the punishment severity for minors who commit homicide could reduce juvenile's engagement in a criminal career associated with gangs and generate gains in social well-being.

JEL Codes: D9, K4
Keywords: Deterrence, Quasi-Experiment, Punishment Severity, Regression Discontinuity Design

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1. Introduction

Brazil is one of the most violent countries in the world and much of the violent criminality can be linked to guns and drug trafficking operations by organized crime groups (Carvalho and Soares, 2016). This link is more prominent in the Brazilian state of Rio de Janeiro where the illicit retail drug market is dominated almost exclusively by three criminal organizations called *Comando Vermelho*, *Terceiro Comando* and *Amigos dos Amigos*.

Such drug trafficking gangs, which formed within the Brazilian penitentiary system, recruit gang members who gradually perform more important roles in their careers. They start out as lookouts or local transporters, after that, they can become sellers or soldiers and, at the top of their career, they can be appointed managers. Drug trafficking gang members earn on a commission basis or are paid a monthly or weekly salary according to their role in the organization, so they can progress on a criminal career path. Their recruitment process starts at early ages and many of them are juveniles (Silva and Urani, 2002; Dowdney, 2003; Carvalho and Soares, 2016).[1]

Gang association comes with a price and young gang members suffer a great deal of the violence involved in drug trafficking activities. Carvalho and Soares (2016) reported that 20% of their sample, composed of members of drug-trafficking gangs in the *favelas* of Rio de Janeiro, had been murdered at two years after the first interview. A similar situation can be observed in other cities of the country. Nearly four in every 1,000 Brazilian adolescents living in the country's biggest cities are murdered before the age of 19, making Brazil not only the world's most homicidal country but also one of the countries with the highest levels of lethal violence against children and adolescents (Waiselfisz, 2017).

The recruitment of juveniles by organized crime occurs in many other places in the world (Comunale *et al*., 2020). Numerous studies have sought to understand the causes of youth engagement in such organizations. Literature on juveniles' recruitment for criminal activities has focused basically on three factors as potential explanations: social, psychological and economic. Ostrosky *et al*. (2012) argue that juveniles are attracted by lifestyles dominated by the cult of violence and by the experience of owning material goods. The likelihood of being recruited at younger ages is also positively associated with problems at school, drug use, low socio-economic conditions and a lack of prospects (Silva and Urani, 2002; Arsovska, 2015; Carvalho and Soares, 2016). In this regard, growing up in a poor neighborhood in a socio-economically deprived environment facilitates recruitment into drug trafficking gangs (Carvalho and Soares, 2016; Decker and Chapman, 2008; Sergi, 2016; Van San and Sikkens, 2017). Other studies show that family ties are facilitators to access criminal careers, since family members and close friends are easier to trust in the criminal environment where there are no third parties to regulate disputes (Arsovska, 2015; Salinas *et al*., 2011; Sergi, 2016; Van Koppen, 2013). Substance abuse, childhood conduct disorder and some psychopathological traits, such as a lack of empathy and cruelty, have been related with an increase in juveniles'

[1] Carvalho and Soares (2016) estimated that 6.5% of men aged 10 to 25 living in the *favelas* were members of drug trafficking gangs in the city of Rio de Janeiro (the capital of the state with the same name).

likelihood of involvement in criminal activities. Such profiles are compatible with risky and violent activities like the drug trafficking business (Ostrosky *et al*., 2012).

In this article we examine a further factor that could explain the recruitment of juveniles by criminal organizations and the environment of violence; reaching the age of penal majority. We argue that the lenient Brazilian Penal Code encourages recruitment of juveniles by drug trafficking gangs. Our hypothesis is that drug trafficking-related crimes committed by juveniles are significantly reduced when they reach the age of majority and face more severe punishments. We use a quasi-experiment generated by the age of criminal responsibility to evaluate the impacts that punishment severity has on crimes in the vicinity of adulthood.

To achieve this, we gathered detailed information on all arrests made in 2016 and in the first half of 2017 in the Brazilian state of Rio de Janeiro. We address two important issues when we process this crime data: aggregation bias and the possible existence of incapacitation effects. First, instead of using aggregated crimes types (including crimes types with different severity of punishment) we focus on two crimes that can be largely related to Rio de Janeiro's criminal organizations: drug trafficking and homicides. Importantly for us, both types of crime have predicted and real differences regarding punishment severity for minors and for those over 18 years of age in Brazil.[2]

Second, instead of focusing on recidivism,[3] we evaluate the deterrence effects of differences in the severity of punishment on the total number of crimes per age. This way, we avoid the censorship problem in the observed sample of offenders. This problem arises when recidivism is used as an outcome variable, since many individuals do not reoffend due to the incapacitation effects of applied punishments.[4] Therefore, we adopt three strategies that produce very robust results. First, we consider each crime an independent occurrence (independent of who perpetrated it) to compute the total number of crimes per age. Second, we consider each crime an independent occurrence for minors while for adults we consider only the first appearance in the dataset. This option is selected because at 18 years of age all Brazilians are considered first-time defendants so all previous criminal records as minors are erased. Hence, all individuals start adulthood with no previous records. If they are arrested for an offense, it can be considered the "first crime" of adult life.[5] Finally, we only consider arrest data for individuals when they appear for the first time in our data set. The results are robust and very consistent for the three options to compute our outcome variable.

The deterrence effects of criminal law at early stages are important to evaluate because many authors, such as Bell *et al.* (2018), have highlighted the significance of the first crime to determine criminal careers. These authors argued that earlier experiences of crime can increase juveniles' stock of criminal knowledge and potentially reduce the costs of subsequent crime

[2] In the appendix we show as a placebo exercise that for crimes such as thefts, assaults and threats, for which differences in punishment severity are not as great or are inexistent, there are no statistically significant differences in total crimes per age in the vicinity of 18 years old.

[3] If recidivism is used as an outcome variable, individuals will be excluded from the sample because they are serving a sentence or waiting for a prison sentence (see Arora 2019; Loeffler and Grunwald, 2015).

[4] For the case of youngsters (17–19) arrested for homicides (including attempts to commit homicide and homicide), 37% of our sample were repeat offenders. Note that this reoffending percentage comes mostly from attempts to commit homicide at 42%, compared to 14% of those that committed homicide. In the case of drug trafficking crimes, the average reoffending probability was 27% for individuals aged 17–19.

[5] By restricting the data set to the first crime as adults we also abstract from incentives to reoffend as adults that could vary due to the Penal Code.

participation. In addition, a first criminal record can reduce the adult's expected wage in the legal labor market. Both effects would increase the likelihood of an individual ending up becoming a career criminal, and once he or she starts a criminal career, the chances of leaving it are very small.

Our main results show that the increase in punishment severity generated by the Brazilian Penal Code can reduce the number of drug trafficking crimes and homicides committed by youngsters by 9% and 37%, respectively. Therefore, as long as these crime types can be attributed to gang activity, harsher punishment can inhibit recruitment and, consequently, the participation of juveniles in jobs related to drug trafficking gangs such as dealers and soldiers.

The remainder of this article is organized into five sections. Section 2 reviews the theoretical and empirical literature about deterrence effects of punishment severity. Section 3 presents the institutional background that generates a significant change in punishment severity for the crimes of drug trafficking and homicide in Brazil. Section 4 describes the database and the methodology used, Section 5 presents the results and Section 6 presents the main conclusions of this study.

2. Deterrence effects of punishment severity: a literature review

The seminal work of Becker (1968) presented a simple decision-making model in which potential criminals respond rationally and consistently to incentives. In this model, crime arises in a decision-making process by rational agents who maximize the expected utility of crime. On the one hand, they consider the psychological and monetary benefits of crime. On the other hand, they consider its costs, measured by the likelihood of there being some punishment and by the monetary equivalent of the severity of the punishment. Given that in the model the agents have no income restrictions, any combination of punishment probability and punishment severity greater than the benefits of the crimes would be able to deter potential offenders. Considering this reasoning, the author concluded that more severe punishments would be more efficient because, in general, they have lower costs than the expenditure needed to increase the likelihood of punishment. Among other things, this effect would justify the adoption of maximum penalties.[6]

In terms of deterrence, there is no consensus that the combination of low punishment probability with more severe punishments is the best combination to deter potential criminals. For example, contrary to what Becker (1968) suggested, Andreoni (1991) argued that the severity of the punishment must be proportional to the crime. The author claimed that the severity of the punishment and its likelihood are not entirely independent because judges tend to apply more severe sentences less often. This distinction occurs because, in the face of more severe sentences, judges tend to apply the punishment only when they are absolutely certain of

[6] In the same vein, Polinsky and Shavell (1984) showed that punishment in the form of fines is more efficient than imprisonment because the public costs of applying this type of punishment are low. Thus, in accordance with Becker (1968), the maximum pecuniary fine (the total income of the offender) would be optimal. However, the authors draw attention to the fact that this fine could be less than the loss caused by the criminal. Therefore, some combination with a period of incarceration would be optimal, as long as the marginal cost of the incarceration is not too high. Thus, in theoretical models, incarceration occurs as a complement to pecuniary fines and as an alternative to changes in the likelihood of punishment. Of course, this analysis disregards the fact that incarceration can also reduce crimes due to effects of incapacitation.

the defendant's guilt. Furthermore, Garoupa (1998) argued that severe punishments associated with low punishment probability only work under specific conditions. They fail when there are social costs in punishing or there is imperfect information regarding punishment probability.[7]

Faced with this lack of consensus on the most efficient combination to deter crime, a natural path is evaluation through empirical evidence. However, these effects are not easy to separate empirically because whenever the severity of the punishment changes, as proposed by Andreoni (1991), there is also a change in the likelihood of the punishment. Even when the interest is not in separating these effects but in analyzing them together, there are still endogeneity problems inherent to any empirical study that uses variations between locations or variations in time to identify deterrence effects. These problems are mainly caused by simultaneity, because locations and periods of time with greater levels of crime tend to have more severe punishments, and by the omission of relevant variables because it is difficult to have controls for all the variables that are associated with punishment severity and the number of crimes. For example, the behavior of judges regarding punishment established by legislation affects both the number of crimes and the willingness of legislators to change legislation on punishments.

Alternatives found in the empirical literature are the search for natural experiments and quasi-experiments. For example, changes in laws and government policies can generate exogenous variations that allow the data in the sample to be separated into control and treatment groups, so that observational studies can be approximated to controlled experiments. In other words, although there are no random samples, research designs are sought to generate selections from these groups that are as good as if they were random. In this context, to evaluate the impacts that changes in punishment severity have on crimes, the use of both natural experiments and quasi-experiments can be seen in the literature.

Kessler and Levitt (1999) used the natural experiment generated by Proposition 8, which was approved in the state of California. This proposition increased the punishment severity for reoffending criminals by adding five years for each crime committed previously if it was a violent crime and one year for each previous crime if it was non-violent. These new rules were applied to the crimes of homicide, rape, robbery, attempted murder with firearms and burglary (treatment group). However, the previous legislation was maintained for the crimes of attempted homicide without the use of firearms, vehicle theft and other thefts (control group). Their results indicated that the treatment group's crimes plummeted in the first year of the proposal due to deterrence effects and continued to fall in subsequent years. According to the authors, this result was due to the combination of the effects of incapacitation and dissuasion.

Helland and Tabarrok (2007) used the quasi-experiment generated by the Three-Strikes Law in the state of California. In this law, punishment severity changes abruptly from the second to the third strike. Criminals can be divided into two groups: one group of criminals who reoffended after the first crime (control group) and the other group of those who reoffended after the second crime (treatment group). After analyzing crimes in California, the authors concluded that the legislation reduced recidivism by 48% after the first strike and by 12.5% after the second strike. In other words, more severe punishments can generate an anticipatory effect that reduces crime upon the first strike.

[7] It should be noted that the likelihood of punishment used in economics of crime models is that which is perceived by the individual, which is not necessarily the true one. Bebchuk and Kaplow (1992) showed that more severe punishments are not efficient when individuals have imperfect information about punishment probability.

Drago *et al*. (2009) used the natural experiment generated by the Collective Clemency Law that was approved by the Italian parliament in July 2006. This law established a reduction of three years in the sentences of those convicted. It also determined that, in the case of recidivism, criminals must receive the residual punishment for the crime whose sentence had been reduced in addition to the sentence imposed by the new crime. Thus, each potential act of recidivism would have a different punishment. Using these different punishments as a source of exogenous variation, the authors concluded that each month of an additional (residual) sentence reduces the likelihood of recidivism by 1.24%.

Closely related to us, Lee and McCrary (2017) used a quasi-experiment generated for the age of criminal responsibility because this legal device generates an increase in punishment severity, which also enables a sample to be separated into two groups. The first group would consist of minors (control group) who receive softer punishments, while the second group would be formed by adults who receive more severe punishments (treatment group). Using a longitudinal database that tracked the "criminal career" of various individuals in the state of Florida between 1989 and 2002, the authors found a reduction of 2% in recidivism (outcome variable) for an increase in punishment estimated at 230%.

However, the study had some limitations that also appear in related studies. The results were severely affected by incapacitation effects. That is, many who were convicted for the first crime did not reoffend because they were still serving prison sentences, especially if the first offense was serious and consequently severely punished. This is a limitation of every study that uses recidivism data and studies that gather data from too short a time interval to recidivate. Secondly, the grouping of arrests for crimes with different punishments makes it impossible to obtain specific comparative crime statistics, such as how many homicides can be reduced with an increase in punishment severity for this crime.[8] For example, the FBI classification for violent crimes includes homicide, attempted homicide, rape and robbery. Besides having very different punishments under any penal code, the number of robberies is generally much higher than that of other crimes. We show this for the Brazilian case in which variations in the total number of violent crimes is almost exclusively determined by variations in the number of robberies.

Also using Lee and McCrary's (2017) methodology, Costa *et al*. (2018) tried to overcome this considerable limitation using a proxy variable for the number of crimes: the number of homicides by age in Brazil provided by victimization data (death records). According to the authors, this variable would overcome the problems caused by the underreporting of crimes. In other words, the study assumed that the profile of the criminals would be very similar to that of the victims of this type of crime. Faced with possible criticism about the use of this proxy, the authors complemented the study by using information about four years of arrests in the state of Rio de Janeiro, which were aggregated into four categories (violent index crimes, property index crimes, drug-related non-index crimes and other non-index crimes) in accordance with their severity. Considering this proxy and the crime aggregations, the authors did not find a

[8] Loeffler and Grunwald (2015) evaluated recidivism probability through the quasi-experiment generated by the law of the State of Illinois using four-year data from drug felonies in the city of Chicago. The authors found that processing juveniles as adults reduced recidivism probability by 3 to 5 percent. Since they used data from a single felony that is not usually punished severely for first offenders, their study was not limited by the problems generated by the aggregation of crimes or by the presence of incapacitated individuals in the sample.

significant reduction in the number of homicides or arrests for violent crimes, crimes against property or other minor crimes. However, they found a reduction in drug-related crimes.[9]

3. Institutional background

Similarly to Lee and McCrary (2009), Loeffler and Grunwald (2015) and Costa *et al*. (2018), we use the quasi-experiment generated by the parallel existence of two criminal laws that generate discontinuity in punishment severity at 18 years of age. In Brazil, individuals younger than 18 are governed by the Statute of the Child and Adolescent, which provides for seven types of warning and punishment that last from 0 to 3 years. The most severe punishment is juvenile incarceration. In this case, crimes are treated as infractions and, therefore, they do not count as cumulative crimes for the individual's adult life. In other words and as mentioned before, at 18 years of age all Brazilians are considered first-time defendants. In turn, those older than 18 are governed by the Penal Code, which prescribes three punishment regimes (open, semi-open and closed), with a duration of 0 to 30 years.[10]

Therefore, the existence of these two regimes for the same infraction/crime means that there are differences in punishment severity. However, these differences are not the same for all crimes. In crimes with lower offensive potential, the punishments tend to be soft or inexistent. For example, in the case of theft, it is highly unlikely that incarceration (in a juvenile facility) would be applied to minors because this type of measure prioritizes cases involving violence.[11] For this same crime, article 155 of the Penal Code prescribes incarceration from one to four years, as well as a fine. However, if the sentence of the convicted person is less than two years, this provision may be suspended for two to four years, provided that the convicted person is not a reoffender. If the sentence is between two and four years of incarceration, the convicted person may serve this sentence under the open regime, again as long as he or she is not a reoffender.[12] We use these types of crime with no large discontinuity in the severity of punishment as a placebo.

In the case of heinous crimes, such as drug trafficking and homicide, the situation of soft punishments changes significantly. For these crimes, convicted people must start their sentence in the closed regime, and regime progression occurs under more rigid conditions: the progression for first-time offenders occurs after 2/5 of the sentence in a closed regime (with tougher conditions for reoffenders) while for other crimes it occurs after serving 1/6 of the sentence. Table 1 compares the maximum penalties applied to minors with the minimum

[9] In addition to the limitation imposed by the use of questionable proxies, the number of homicides and the victims' age, and the grouped data, the study combined the use of a log transformation of the data with nonlinear models (polynomials of high order) which made it impossible to know what the estimated coefficients actually mean.

[10] Recently, Law 13,964/2019 raised the maximum penalty to 40 years.

[11] According to a survey by the National Socio-Educational Service System from 2016, approximately 3% of juvenile incarcerations were due to cases of theft. This same survey showed that almost 66% of incarcerated youths are affected by this measure due to infractions against people. The survey can be accessed from the following link: http://www.mdh.gov.br/todas-as-noticias/2018/marco/Levantamento_2016Final.pdf (last accessed September 2020).

[12] A similar situation occurs with other quite frequent crimes, such as assault and threat. These crimes are defined in articles 129 and 147 of the Penal Code that prescribes a sentence of imprisonment for three months to a year and for one month to six months, respectively. In other words, as for the crime of theft, first-time offenders will probably have their sentence suspended or served in the open regime.

penalties applied to adults to estimate the differences in punishment severity that exist between the two legislations (the Statute of the Child and Adolescent and the Penal Code) for these crimes. As evidenced, despite juvenile incarceration not being perfectly comparable to adult imprisonment, in practice the length of incarceration would be approximately six times higher in terms of time served under the Penal Code for both drug trafficking and homicide.

Table 1. Differences in punishment severity, in accordance with Brazilian legislation, for the crimes of drug trafficking and homicide.

		Drug trafficking (Art. 33, Law 11,343/2006)	**Qualified homicide (Art. 121, Penal Code)**
Statute of the Child and Adolescent (< 18 years)	Punishment prescribed	0 to 3 years	0 to 3 years
	Progression rule	Summary statement 492 of the Superior Court of Justice: there is no requirement for incarceration in a juvenile facility for the first infraction	No specific rule
	Actual punishment	Only 17% receive sentences of incarceration in a juvenile facility, which are rarely longer than 3 months	9 months of juvenile incarceration
Penal Code (> 18 years)	Punishment prescribed	Incarceration of 5 to 15 years and payment of a 500 to 1,500 day fine	Incarceration of 12 to 30 years
	Progression rule	2/5 of the sentence	2/5 of the sentence
	Actual punishment	2 years of incarceration[13]	4.8 years of incarceration

Note: homicide attempts are the intention to kill but the goal is not achieved. The punishment in the Statute of the Child and Adolescent is also 0 to 3 years, with an actual punishment far below the 9 months observed for homicides. For adults, the Brazilian Penal Code prescribes a reduction of 1/3 to 2/3 in case of attempt, but even if a sentence is cut by the maximum, 2/3, the minimal sentence would be 4 years with at least one year and seven months in a closed regime.

A relevant issue is that it cannot be guaranteed, a priori, that the punishment probability is the same above and below the age threshold for the crimes we are considering. Arora (2019) drew attention to the fact that, in general, there may be a rate of underreporting for underage crimes. This situation would lead to an underestimation of the effects of the increase in

[13] However, the punishment for first-time offenders may vary according to the judge's discretion. In addition, an offender may serve the sentence in an open regime, since the Brazilian Supreme Court decided that could be a possibility if the defendant is caught with a small amount of drugs, has a good background and does not belong to a criminal organization.

punishment severity that occurs with the age of criminal responsibility. In the case of drug trafficking, it may be realistic to assume that a certain percentage of crimes are not recorded by police officers for either minors or adults due to the insignificance of the amount of drugs possessed. One cannot rule out the possibility that there are a priori differences between this underestimation. This would result in differences in the likelihood of punishment among minors and adults for this type of crime. In the case of drug trafficking one could, in principle, expect a possible change in (under)reporting behavior of police officers (with more leniency towards minors). Hence, the incentives faced by adults in terms of the probability and severity of punishment go in the same direction. In the case of homicides or homicide attempts it is not plausible to suppose that police fail to record these crimes, for whatever reason, or reduce their effort to arrest suspects if it is determined that the person responsible is a minor (see Lee and McCrary, 2017). Thus, in this case, stability is expected in the punishment probability, which enables a more accurate estimation of the effects from the change in punishment severity.

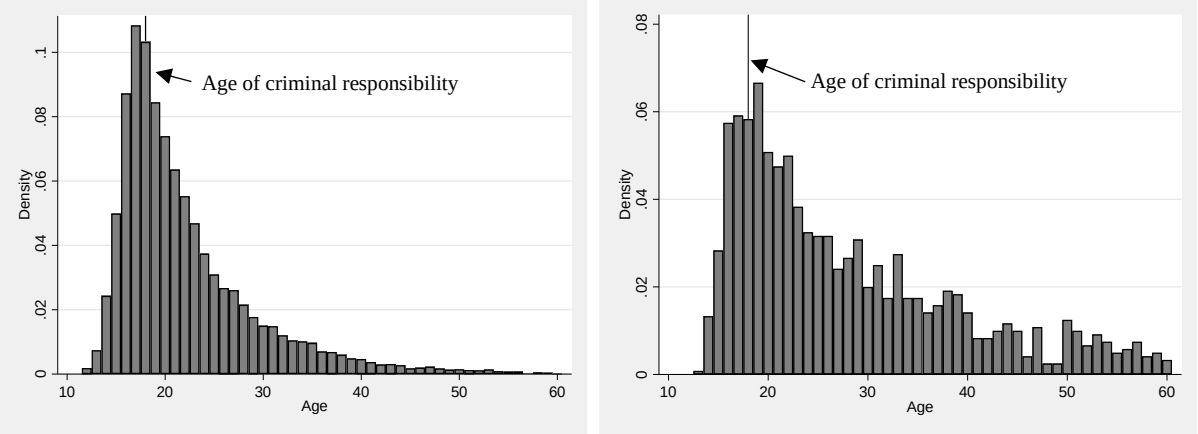
4. Data and methodology

The database used in this study includes all the arrests made by the police (civil and military) in the state of Rio de Janeiro during 2016 and the first half of 2017. During this period, 59,117 total arrests were made, for which there is information about the type of crime and the date it occurred, as well as information about the suspects, such as their date of birth, sex, race and municipality of origin (see Table A1 in the appendix for the main crime categories).

As explained, we focus on drug trafficking crimes and homicides (see Figure 1). From a statistical point of view, the occurrences of homicides among youngsters aged 17–19 were not enough to provide robust estimates in terms of the number of observations. Hence, at the cost of losing a clear downward jump at the cut-off age observed for homicides (see Figure A.2 in the appendix), we aggregate homicides and homicide attempts to gather enough information to estimate the non-parametric models.

Figure 1 shows that arrests for drug trafficking and homicides (including attempts) peak between 16 and 19 years of age. In the histogram, the data is aggregated by year. Behavior around 18 years of age may vary and a more formal evaluation is necessary. Potential differences in socio-economic characteristics and psychological development mean that these groups cannot be treated as equal without proper controls for these differences. The problem is that information about these features is rarely available. In this context, a Regression Discontinuity Design is a robust methodology that consists of a non-experimental approach in which the assignment of treatment of an individual is continuously linked to a measurable exogenous variable/characteristic that enables control and treatment groups to be separated based on a cut-off. In other words, for our identification strategy of local treatment effects, the discontinuity that matters is total arrests by age in the vicinity of 18 years old and not arrests aggregated by year of age.

Figure 1. Distribution of arrests by age for the crimes of drug trafficking and homicide (including attempts) in the state of Rio de Janeiro (2016–2017).



(a) Drug trafficking (b) Homicides (including attempts)

Note: these figures are obtained using as an outcome variable arrests of individuals when they appear for the first time in our data set. The figures for each crime independently of the offender, and for adults' first offense only, can be found in Figure A.1 in the appendix.

The application of this method depends on the choice of a continuous classification variable. According to Cattaneo *et al*. (2018), non-parametric methods for estimating local polynomials are not applicable when the choice variable is discrete, unless the probability mass points have a large amount of information. This problem is evident when the total number of crimes (arrests) by age is used. Over the course of a year there are 365 possible dates for individuals to be arrested. However, there may be a reasonable number of dates without crimes (i.e., with values missing), or there may also be a problem if the number of arrests is not large enough each "day", so that one does not have the information per mass point needed to perform a local polynomial estimation.[14]Alternatively, we use the total number of homicides (including attempts) and drug trafficking crimes for a seven-day interval (bin). Even though this empirical strategy implies a loss of variability in the data used, it gives us an effective number of observations that is large enough to estimate a local polynomial model with good confidence. Thus, the estimated local effect of the treatment informs us whether the total number of arrests for homicides/drug trafficking increases or decreases with the age of criminal responsibility.

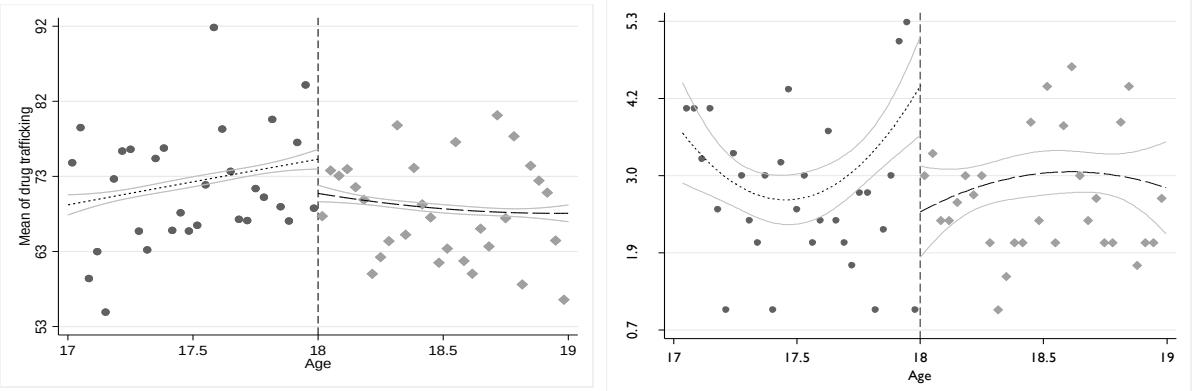
A necessary requirement to ensure method robustness is for the classification variable not to be caused or influenced by the treatment. In our case, it is quite plausible that this requirement is satisfied because the individuals included in the sample cannot decide in which group they will be because their age (running variable) is defined exogenously. In other words, suspects cannot choose to which punishment regime they are subjected, as this is defined by their age, over which they have no control. Additionally, it should be assumed that discontinuity at the cut-off point is due only to the change in treatment status. The other variables, when there are covariates, should show smooth (and continuous) behavior during the observations: there

[14] To overcome this problem, Lee and McCrary (2017) used recidivism as an outcome variable instead of total number of crimes. That is, the entire sample is used. Zero is assigned to the criminals who did not reoffend and one to those who reoffended. Thus, there is a sufficiently large amount of information to treat the age variable (discrete) as if it were continuous.

should be no differences between individuals near this threshold beyond the receipt or non-receipt of this treatment.[15]

Another sensitive point of this method is the choice of functional forms and bandwidths. Information is required on what functional form should be used for the relationship between the outcome variable and the classification variable; which information interval in the neighborhood should be included in the estimation; and how much information should be included in each bin. All of this information is necessary to estimate the non-parametric models. In this latter case, there is a trade-off between bias and variance, in which smaller bandwidths have a smaller bias. However, a larger bandwidth means greater variance. Thus, several authors have proposed methods for obtaining a bandwidth that minimizes both the bias and the variance of the estimates (Ludwig and Miller, 2007; Imbens and Kalyanaraman, 2012; Calonico *et al*., 2014).

Figure 2. Second-order local polynomial regression of total arrests for the crimes of drug trafficking and homicide in the state of Rio de Janeiro in 2016–2017.



(a) Drug trafficking (b) Homicides (including attempts)

Note: these figures are obtained using as an outcome variable arrests of individuals when they appear for the first time in our data set. The figures for each crime independently of the offender, and for adults' first offense only are practically identical (not reported but available upon request).

Figure 2 provides a preview of our estimates. It shows non-parametric estimates in a second-order polynomial for total arrests for drug trafficking and homicides (including attempts). Thirty bins are used to the right and to the left throughout the classification variable (age) in an interval with one year more and one year less than the cut-off point (18 years of age). The identification strategy is based on the separation of arrests into two groups (treatment and control) to estimate non-parametric models for each of them, so that they could be extrapolated to the cut-off point to simultaneously obtain the values of the treatment group and the control group. The difference (at the dashed vertical line) is the local average treatment effect.

As shown in Figure 2, there is a positive trend in drug trafficking arrests before 18 years of age, with a subsequent jump down and change in this trend after the threshold. The confidence

[15]In this case, there are some characteristics that change in Brazil at 18 years of age. These include emancipation of the individual and the right to drive, buy legal drugs and work in activities of any nature. We rely on results presented in Costa *et al*. (2018), who conducted a series of empirical tests to rule out the possibility that their estimated treatment effects due to the age of criminal responsibility, as in our case, were due to changes in these other characteristics such as ability to drink, drive and work without any restriction.

intervals for this model are narrow since there are many more observations for this crime than for others. The total number of homicides is more disperse, and it is not easy to observe any trend or functional form before the estimation. However, a second order polynomial model shows an increase starting six months before 18 years, and a significant jump down after 18 years of age. However, these results should be viewed with caution, given that the estimates do not consider the choice of optimal bandwidth. In the present study, the choice of optimal bandwidth follows the procedures proposed by Calonico *et al*. (2014; hereafter CCT), and the results presented in the next section follow only these procedures.

5. Results

The results presented in Table 2 (drug trafficking) and Table 3 (homicides including attempts) are estimated with two orders of polynomial[16] and generally show a significant negative treatment effect in all the estimated models.

In the case of drug trafficking (Table 2), an increase in punishment of incarceration in a juvenile facility for a maximum of three months to a minimum prison sentence of five years (which may, or may not, be served in the closed regime) reduces the number of arrests by between 3.1% and 9.1%. Note that this result should be considered with caution, since there could be two forces with opposite signs acting on the total arrests of juveniles that cannot be observed. First, we cannot rule out the possibility of underreporting of this crime for juveniles as described by Lee and McCrary (2017) and Arora (2019), which reduces the observed total arrests below 18 years old. Second, it is very common for juveniles to assume the crime of drug trafficking committed by adults because their punishment is very soft compared to that of an adult.

For homicides (including attempts; Table 3), an increase in punishment severity from nine months of incarceration in a juvenile facility to at least four years and ten months in a closed regime prison reduces total arrests for homicides by between 34.94% and 39.72%. For homicides, underreporting is expected to be very low, and the incentive for juveniles to assume the crime of homicide committed by adults is lower than for drug trafficking because the punishment of juveniles, although it is still lower than that of an adult, it is not close to zero.

We analyze the robustness of these results by first evaluating the existence of discontinuities at other ages close to the cut-off age (Table A.2 for drug trafficking crimes and Table A.3 for homicides including attempts, in the appendix). The results indicate that there is no significant reduction in the total arrests for drug trafficking and homicide at the ages of 17 or 19 considering the three sample arrangements. For homicides, the hypothesis that all estimated coefficients are zero could not be rejected, while for drug trafficking the coefficients are positive and significant in all linear models. However, most of these positive jumps disappear in non-linear models. The only exception is the model that consider only the first offense in our sample, which shows

[16] The option to estimate models with two orders of polynomial is justified by the flexibility that is necessary for the functional form to avoid the error of interpreting a change that occurs more abruptly than that predicted by a linear model as being a discontinuity. However, according to Gelman and Imbens (2019), the use of polynomials of an order higher than two is not recommended because these generate estimates with substantial noise and usually extrapolate plausible confidence intervals.

a significant positive jump at the age of 17, probably as a result of the positive trend observed in the arrests for drug trafficking before the age of penal majority.

Table 2. Local average treatment effect on the total of arrests and on the percentage of arrests for the crimes of drug trafficking.

Polynomial order	**All observations**	Percentage variation	**Excluding adults' re-offenses**	Percentage variation	**Only first offense**	Percentage variation
1	-3.235***	-4.49%	-3.184***	-4.28%	-2.295***	-3.12%
	(0.3982)		(0.3890)		(0.4030)	
Bandwidth (h)	0.346 (4.1 months)		0.266 (3.2 months)		0.526 (6.3 months)	
2	-5.845***	-8.58%	-5.944***	-8.74%	-6.236***	-9.10%
	(0.5600)		(0.5745)		(0.6416)	
Bandwidth (h)	0.275 (3.3 months)		0.274 (3.3 months)		0.250 (3 months)	

Notes: entries are the local average treatment effects using the CCT to select the bandwidth, with the standard errors shown below in parentheses. The values indicated in the bandwidth refer to the intervals below and above 18 years of age. The first column indicates the order of the polynomial used in the non-parametric estimation. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3. Local average treatment effect on the total of arrests and on the percentage of arrests for the crimes of homicide.

Polynomial order	**All observations**	Percentage variation	**Excluding adults' re-offenses**	Percentage variation	**Only first offense**	Percentage variation
1	-1.8432***	-35.03%	-1.9772***	-39.72%	-1.4294**	-34.94%
	(0.6410)		(0.5778)		(0.7105)	
Bandwidth (h)	0.422 (5 months)		0.492 (5.9 months)		0.671 (8 months)	
2	-1.8757***	-37.62%	-1.9466***	-39.61%	-1.6206**	-37.00%
	(0.5973)		(0.5944)		(0.8440)	
Bandwidth (h)	0.927 (11 months)		0.998 (12 months)		1.107 (13.2 months)	

Notes: entries are the local average treatment effects using the CCT to select the bandwidth, with the standard errors shown below in parentheses. The values indicated in the bandwidth refer to the intervals below and above 18 years of age. The first column indicates the order of the polynomial used in the non-parametric estimation. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The second robustness exercise uses other crimes for which there are no large differences in punishment severity. Considering all observations, the results for thefts, threats and assaults indicate that, as expected, there is no significant reduction in these crimes at the age of criminal responsibility (see Table A.4 in the appendix). In fact, in these cases, the punishments were

very soft or almost inexistent for both groups (treatment and control). However, there is an increase in the total number of robberies, which may be an indication that the actual punishment severity applied to minors close to 18 years of age for this type of crime may be greater than that applied to adults who are "first-time" offenders, as criminal records are deleted when individuals turn 18 years of age.[17]

Our main results differ somewhat from those obtained by Lee and McCrary (2017) and Costa *et al.* (2018). Regarding the first study, the differences are only in relation to magnitude. There are no differences with respect to the sign or significance of the estimated local average treatment effects. Regarding the second study, the differences are statistically significant, given that the authors did not find significant impacts of the increase in severity of punishment due to age of criminal responsibility with regard to violent crimes. However, they found significant negative impacts for drug-related crimes, as we do in the present study.

One possible explanation for the differences in magnitude between this study and that of Lee and McCrary (2017) is that both Lee and McCrary (2017) and Costa *et al*. (2018) grouped violent crimes. This empirical strategy may produce misleading conclusions about the deterrence effects of increasing punishment severity. This crime is the most common of violent crimes (as shown in Figure A.3 of the appendix). Therefore, the non-significant impact of violent crimes found by these authors, especially Costa *et al*. (2018) who used a database similar to ours, is the result of aggregating crimes that have quite different numbers of arrests and punishment severity.

6. Discussion and conclusions

This article uses a quasi-experiment generated by the age of criminal responsibility in Brazil to evaluate the impacts of increased punishment severity on two types of crime: drug trafficking and homicides. These crimes were chosen because they have significant differences in punishment severity between minors and adults in Brazil and they are closely related to drug trafficking gangs in the state of Rio de Janeiro. The results indicated a significant reduction in the total number of these crimes with the increase in punishment severity provided for in the Penal Code. Therefore, it can be concluded that, in the particular set up of Rio de Janeiro, increasing punishment severity would reduce these crimes and would reduce engagement in criminal activities. These results differ from studies that used similar methodologies, such as Lee and McCrary (2017) and Costa *et al*. (2018). However, they are in agreement with those of other authors such as Kessler and Levitt (1999), Helland and Tabarrok (2007), Drago *et al*. (2007) and Loeffler and Grunwald (2015), who also used robust methods (i.e., based on natural experiments and quasi-experiments).

This empirical study differs from its predecessors by analyzing the crimes in a non-grouped manner. This enables more precise estimates of crime elasticities with respect to punishment

[17] For robberies, the punishment provided by article 157 of the Brazilian Penal Code is incarceration of four to ten years. However, if this punishment is less than eight years and if the defendant is a first-time offender, the sentence may be served in the semi-open regime. Therefore, there is no punishment in a closed regime. For minors, the punishment of juvenile incarceration for this crime is unlikely to be applied for the first infraction, but when applied (for recidivists) in the state of Rio de Janeiro, it is usually for five months of detention in a juvenile facility. So, at least for robbery, the punishment severity may be more severe for juveniles than it is for adults, since a detention period is more likely to be sentenced for juveniles than for adults.

severity and the outlining of a counterfactual scenario of what would occur if there were a reduction in the age of criminal responsibility for these crimes. The results indicate that an increase in the detention period of approximately one year and nine months (or 800%) for drug trafficking and four years (or 500%) for homicides, respectively, combined with the more inhospitable environment of prisons, can reduce drug trafficking and homicide crimes, assuming that there is stability in the percentage of arrests per crime, by approximately 9% and 37%, respectively. These elasticities appear to be very low considering the required percentage increase in the detention period. However, the costs involved may not be as high.

If instead of completing detention in a prison, the increase in the detention period is served in the form of incarceration in a juvenile facility, then each extra year of incarceration would cost the state of Rio de Janeiro approximately BRL20,000 per inmate, according to DEGASE accounting information. Thus, a four-year increase in the length of incarceration (so that the period of detention is equivalent to the minimum stipulated for an adult for homicide) would cost approximately BRL80,000 per inmate. If it is considered that 34 minors were arrested in 2016 for homicide and that each one would result in a cost increase of this amount, it can be concluded that the total cost of applying these more severe punishments would be BRL2.72 million per year.

However, in this case, there would be no guarantees that the reduction in the number of crimes/arrests would occur at the same magnitude as would occur in the event of a reduction in the age of criminal responsibility. It should be emphasized that the results obtained in this study refer to a composition of time and type of punishment. In addition to differences in time detained, incarceration in a juvenile facility is qualitatively different from an adult prison. Nevertheless, these limitations do not prevent conjecture regarding some scenarios that enable evaluation of the benefits and costs of implementing this measure. If the more conservative estimate by Pereira *et al*. (2020) of BRL3.78 million[18] for the value of statistical life in Brazil is accounted for, the benefit of applying this new punishment would exceed its costs by almost BRL1 million if only one life was saved. So, this measure would be worthwhile even without accounting for the benefit of preventing a juvenile from starting a criminal career in a drug trafficking gang of Rio de Janeiro.

In the case of reducing the age of criminal responsibility (i.e., serving this additional period in prisons), the estimated costs would be similar: approximately BRL22,000 per additional year of detention, with a total cost (approximately BRL2.992 million) that is still lower than the statistical value of one life. However, the costs of punishing a child or adolescent as an adult can be added to these costs. These costs involve the psychological damage caused to these minors due to their presence in an unhealthier and more dangerous environment, including a higher risk of death. Even if these additional costs are not considered, it cannot be ignored that this type of measure can lead to a proportional reduction in the likelihood of punishment because judges may become aware of the adverse situation experienced by these children and adolescents and, therefore, reduce the number of convictions, as suggested by Andreoni (1991).

However, regardless of these aspects, it must be emphasized that the results obtained in this study indicate that the most severe punishment provided for by the Penal Code leads to a

[18] These values are estimated based on the risks involved in employment activity. Thus, each worker has a value of his or her life calculated according to their willingness to accept risks. In a model with fixed effects, the values of statistical life estimated for Brazil vary between BRL3.78 million and BRL4.69 million.

reduction in the total number of arrests for the crime of homicide. Assuming that there is stability in the percentage of arrests per crime, there would also be a reduction in the number of arrests (which would further reduce the cost of applying the measure) and in the number of homicides (which would increase the benefits of the measure), due to the deterrence effects of this more severe punishment. Therefore, even in the most pessimistic scenario, some lives are expected to be saved and some criminal careers interrupted, so that the benefits far outweigh the costs of applying more severe punishments to minors in the case of homicides, regardless of the method of application, whether in the form of incarceration in a juvenile facility or an adult prison.

This net benefit observed in the case of homicides is most likely not observed in the case of drug trafficking. This difference is probably because, besides the low impact of the harsher punishments imposed by the age of criminal responsibility on the total arrests for this crime (a reduction of approximately 9%), it is unlikely that arrests for drug trafficking will lead to a reduction in the occurrence of this type of crime because detained criminals are quickly and easily replaced by others. In this context, an increase in punishment severity suggests a higher cost for potential criminals, who in turn will have to be compensated financially for this higher expected cost. Thus, recruiters of juveniles will have to spend more resources on the drug trafficking workforce. It is possible that equalizing punishment severity between minors and adults will reduce the number of juveniles involved in this type of crime, which would help solve the problem that clearly exists in the state of Rio de Janeiro regarding the use of minors as sellers and soldiers for drug trafficking. However, it cannot be ignored that there are psychological differences that make youngster (minors) more prone to crime. Therefore, it cannot be concluded that only increases in punishment severity can deter youngsters from crime, particularly a crime with high financial returns, as is the case with drug trafficking. There is evidence of public policies that are more effective in achieving this objective and are applied in childhood and adolescence in the rest of the world.[19]

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[19]It is worth mentioning a very successful program in the city of Chicago titled "Become a Man", which applies cognitive therapy to youngsters. The results of this study — which can be seen in Heller *et al*. (2017) — show a reduction in total arrests between 28 and 35%, a reduction of 45 to 50% in arrests for violent crimes, and an increase of 12 to 19% in completion of education levels.

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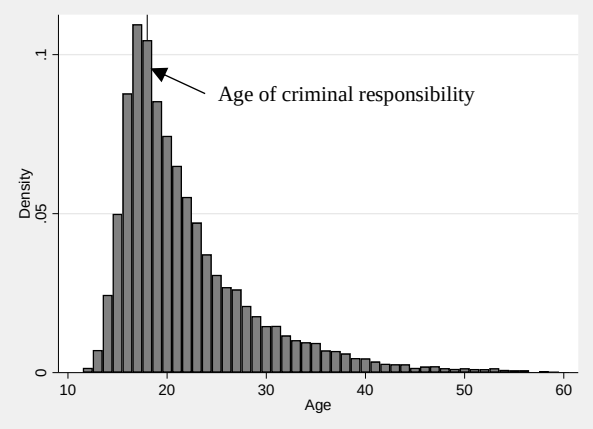
Appendix

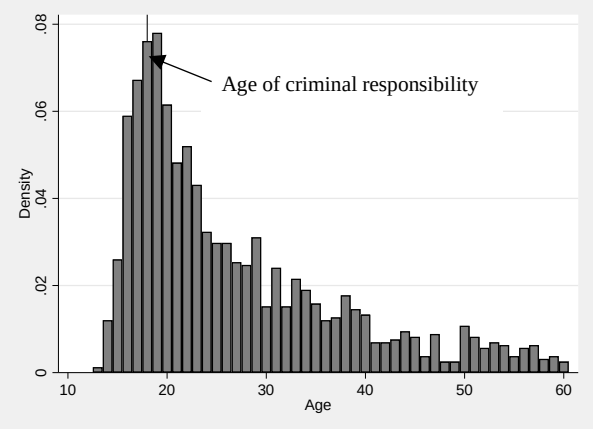
Table A.1. Total arrests by type of crime in the state of Rio de Janeiro (2016–2017).

Crime type	#	%
Assault	2,365	4.0%
Drug trafficking	33,570	56.8%
Extortion	109	0.2%
Homicides + attempts	1,608	2.7%
Rape	249	0.4%
Robbery	12,191	20.6%
Swindle	277	0.5%
Theft	7,433	12.6%
Threat	1,315	2.2%
Total	59,117	

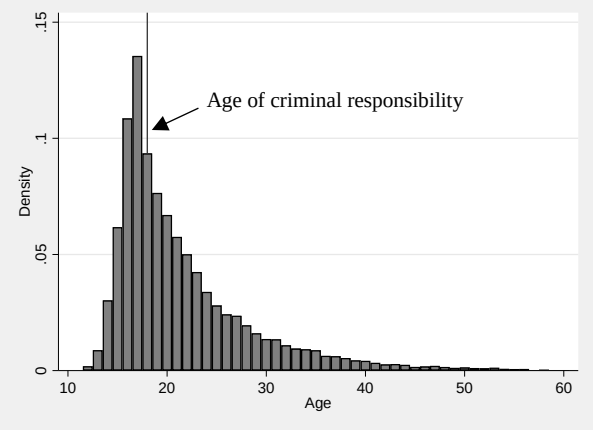
Figure A.1. Distribution of arrests by age for the crimes of drug trafficking and homicide (including attempts) in the state of Rio de Janeiro (2016–2017).



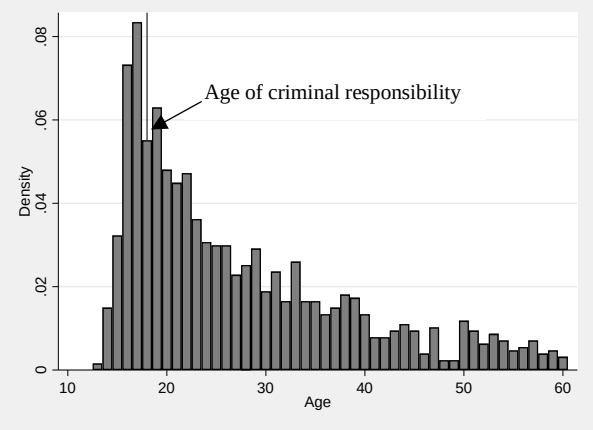
(a) Drug trafficking (all observations)



(b) Homicides + attempts (all observations)

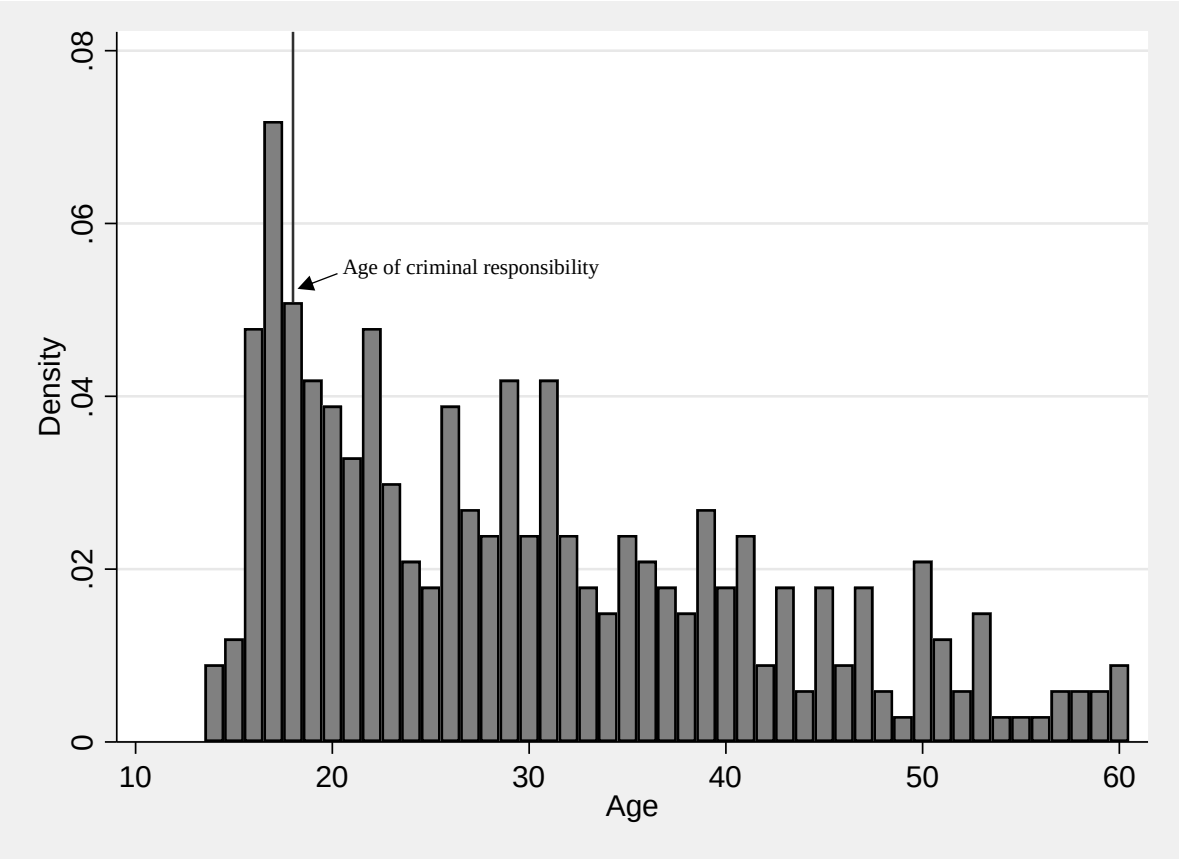


(c) Drug trafficking (excluding adults' reoffenses)



(d) Homicides + attempts (excluding adults' reoffenses)

Figure A.2. Distribution of arrests by age for the crime of homicide (not including attempts) in the state of Rio de Janeiro, for 2016–2017.



Note: figure obtained using as the outcome variable arrests of individuals when they appear for the first time in our data set.

Table A.2. Falsification tests: drug trafficking.

Polynomial order	Age	All observations	Excluding adults' re-offenses	Only first offense
1	17	2.7199***	3.9318***	2.6323***
		(0.4263)	(0.4192)	(0.4784)
	Bandwidth (h)	0.328	0.269	0.326
		(3.9 months)	(3.1 months)	(3.9 months)
2	17	0.5431	0.8644	4.6775***
		(0.7212)	(0.7186)	(0.8125)
	Bandwidth (h)	0.178	0.182	0.201
		(2.1 months)	(2.1 months)	(2.4 months)
1	19	3.8332***	2.858***	2.8588***
		(0.4284)	(0.4875)	(0.4876)
	Bandwidth (h)	0.092	0.097	0.097
		(1.1 months)	(1.1 months)	(1.1 months)
2	19	0.7801	-0.0611	0.1578
		(0.4767)	(0.5148)	(0.5264)
	Bandwidth (h)	0.195	0.213	0.202
		(2.3 months)	(2.5 months)	(2.4 months)

Notes: entries are the local average treatment effects using the CCT method to select the bandwidth, with the standard errors shown below in parentheses. The values indicated in the bandwidth refer to the intervals below and above the age shown in the first column. *** p<0.01, ** p<0.05, * p<0.1.

Table A.3. Falsification tests: homicides (including attempts).

Polynomial order	Age	All observations	Excluding adults' re-offenses	Only first offense
1	17	1.0972	1.1892	1.0779
		(0.7959)	(0.8269)	(0.9169)
	Bandwidth (h)	0.474	0.443	0.543
		(5.7 months)	(5.3 months)	(6.5 months)
2	17	0.7476	0.7727	0.9845
		(0.8865)	(0.9010)	(1.1169)
	Bandwidth (h)	0.812	0.793	0.799
		(9.7 months)	(9.5 months)	(9.5 months)
1	19	-0.0263	0.0021	-0.0831
		(0.5256)	(0.5243)	(0.5114)
	Bandwidth (h)	0.561	0.666	0.656
		(6.7 months)	(8 months)	(8 months)
2	19	-0.2484	0.6121	0.9931
		(0.7685)	(0.7726)	(0.929)
	Bandwidth (h)	0.619	0.613	0.575
		(7.4 months)	(7.3 months)	(6.9 months)

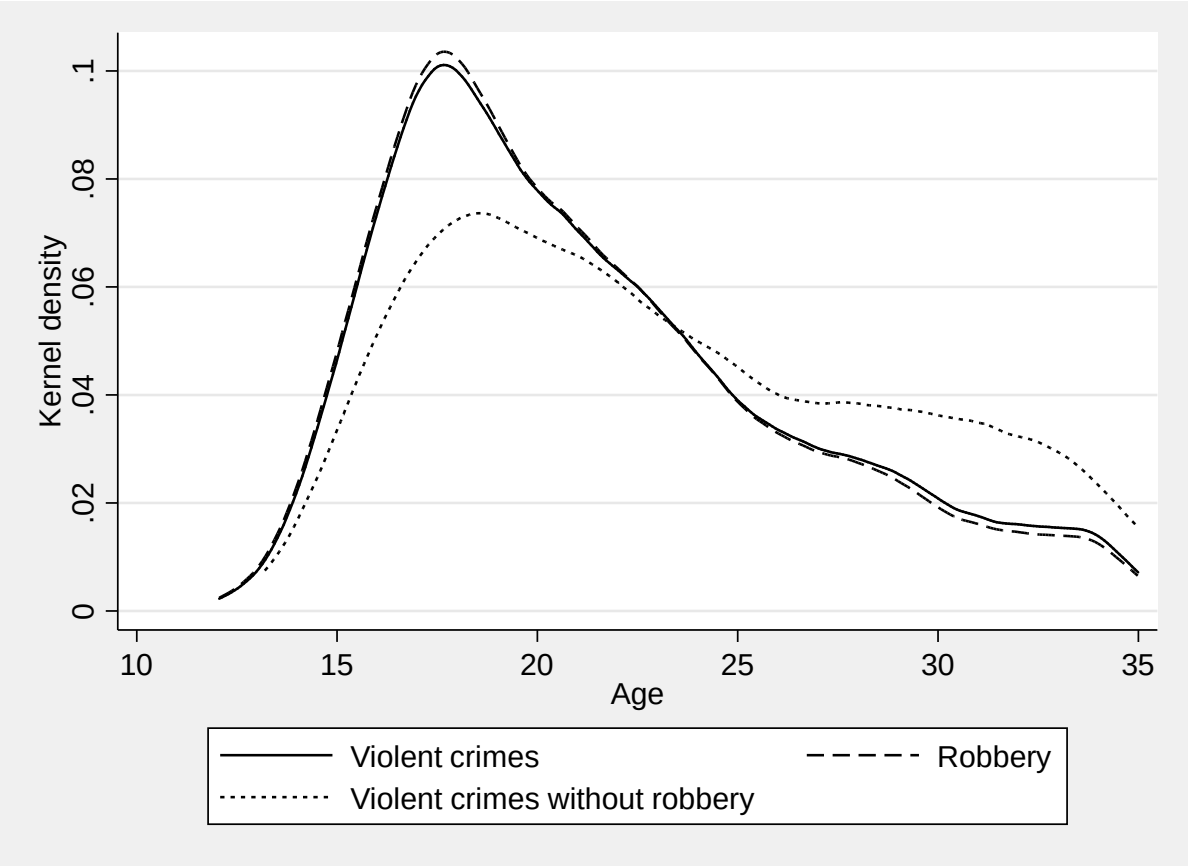
Notes: entries are the local average treatment effects using the CCT method to select the bandwidth, with the standard errors shown below in parentheses. The values indicated in the bandwidth refer to the intervals below and above the age shown in the first column. *** p<0.01, ** p<0.05, * p<0.1.

Table A.4. Local average treatment effect on the total arrests for thefts, robberies, threats and assaults (all observations).

Polynomial order	Robberies	Thefts	Threats	Assaults
1	4.7645***	0.6625	-0.3398	0.6279
	(0.3011)	(0.4770)	(0.0.3277)	(0.5540)
Bandwidth (h)	0.343	0.354	0.508	0.620
	(4.1 months)	(4.2 months)	(6 months)	(7.4 months)
2	6.2137***	0.5495	-0.5308	0.7431
	(0.3163)	(0.4464)	(0.3886)	(0.6639)
Bandwidth (h)	0.415	0.710	0.633	0.976
	(5 months)	(8.5 months)	(7.6 months)	(11.7 months)

Notes: entries are the local average treatment effects using the CCT method to select the bandwidth, with the standard errors shown below in parentheses. The values indicated in the bandwidth refer to the intervals below and above 18 years of age. The first column indicates the order of the polynomial used in the non-parametric estimation. *** p<0.01, ** p<0.05, * p<0.1.

Figure A.3. Distribution of arrests by violent crimes (homicides, robberies, aggravated assault and rapes) and robberies by age in the state of Rio de Janeiro (2016–2017).



Note: figure obtained using as the outcome variable arrests of individuals when they appear for the first time in our data set.

2015

2015/1, Foremny, D.; Freier, R.; Moessinger, M-D.; Yeter, M.: "Overlapping political budget cycles in the legislative and the executive"
2015/2, Colombo, L.; Galmarini, U.: "Optimality and distortionary lobbying: regulating tobacco consumption"
2015/3, Pellegrino, G.: "Barriers to innovation: Can firm age help lower them?"
2015/4, Hémet, C.: "Diversity and employment prospects: neighbors matter!"
2015/5, Cubel, M.; Sanchez-Pages, S.: "An axiomatization of difference-form contest success functions"
2015/6, Choi, A.; Jerrim, J.: "The use (and misuse) of Pisa in guiding policy reform: the case of Spain"
2015/7, Durán-Cabré, J.M.; Esteller-Moré, A.; Salvadori, L.: "Empirical evidence on tax cooperation between sub-central administrations"
2015/8, Batalla-Bejerano, J.; Trujillo-Baute, E.: "Analysing the sensitivity of electricity system operational costs to deviations in supply and demand"
2015/9, Salvadori, L.: "Does tax enforcement counteract the negative effects of terrorism? A case study of the Basque Country"
2015/10, Montolio, D.; Planells-Struse, S.: "How time shapes crime: the temporal impacts of football matches on crime"
2015/11, Piolatto, A.: "Online booking and information: competition and welfare consequences of review aggregators"
2015/12, Boffa, F.; Pingali, V.; Sala, F.: "Strategic investment in merchant transmission: the impact of capacity utilization rules"
2015/13, Slemrod, J.: "Tax administration and tax systems"
2015/14, Arqué-Castells, P.; Cartaxo, R.M.; García-Quevedo, J.; Mira Godinho, M.: "How inventor royalty shares affect patenting and income in Portugal and Spain"
2015/15, Montolio, D.; Planells-Struse, S.: "Measuring the negative externalities of a private leisure activity: hooligans and pickpockets around the stadium"
2015/16, Batalla-Bejerano, J.; Costa-Campi, M.T.; Trujillo-Baute, E.: "Unexpected consequences of liberalisation: metering, losses, load profiles and cost settlement in Spain's electricity system"
2015/17, Batalla-Bejerano, J.; Trujillo-Baute, E.: "Impacts of intermittent renewable generation on electricity system costs"
2015/18, Costa-Campi, M.T.; Paniagua, J.; Trujillo-Baute, E.: "Are energy market integrations a green light for FDI?"
2015/19, Jofre-Monseny, J.; Sánchez-Vidal, M.; Viladecans-Marsal, E.: "Big plant closures and agglomeration economies"
2015/20, Garcia-López, M.A.; Hémet, C.; Viladecans-Marsal, E.: "How does transportation shape intrametropolitan growth? An answer from the regional express rail"
2015/21, Esteller-Moré, A.; Galmarini, U.; Rizzo, L.: "Fiscal equalization under political pressures"
2015/22, Escardíbul, J.O.; Afcha, S.: "Determinants of doctorate holders' job satisfaction. An analysis by employment sector and type of satisfaction in Spain"
2015/23, Aidt, T.; Asatryan, Z.; Badalyan, L.; Heinemann, F.: "Vote buying or (political) business (cycles) as usual?"
2015/24, Albæk, K.: "A test of the 'lose it or use it' hypothesis in labour markets around the world"
2015/25, Angelucci, C.; Russo, A.: "Petty corruption and citizen feedback"
2015/26, Moriconi, S.; Picard, P.M.; Zanaj, S.: "Commodity taxation and regulatory competition"
2015/27, Brekke, K.R.; Garcia Pires, A.J.; Schindler, D.; Schjelderup, G.: "Capital taxation and imperfect competition: ACE vs. CBIT"
2015/28, Redonda, A.: "Market structure, the functional form of demand and the sensitivity of the vertical reaction function"
2015/29, Ramos, R.; Sanromá, E.; Simón, H.: "An analysis of wage differentials between full-and part-time workers in Spain"
2015/30, Garcia-López, M.A.; Pasidis, I.; Viladecans-Marsal, E.: "Express delivery to the suburbs the effects of transportation in Europe's heterogeneous cities"
2015/31, Torregrosa, S.: "Bypassing progressive taxation: fraud and base erosion in the Spanish income tax (1970-2001)"
2015/32, Choi, H.; Choi, A.: "When one door closes: the impact of the hagwon curfew on the consumption of private tutoring in the republic of Korea"
2015/33, Escardíbul, J.O.; Helmy, N.: "Decentralisation and school autonomy impact on the quality of education: the case of two MENA countries"
2015/34, González-Val, R.; Marcén, M.: "Divorce and the business cycle: a cross-country analysis"
2015/35, Calero, J.; Choi, A.: "The distribution of skills among the European adult population and unemployment: a comparative approach"
2015/36, Mediavilla, M.; Zancajo, A.: "Is there real freedom of school choice? An analysis from Chile"

2015/37, Daniele, G.: "Strike one to educate one hundred: organized crime, political selection and politicians' ability"
2015/38, González-Val, R.; Marcén, M.: "Regional unemployment, marriage, and divorce"
2015/39, Foremny, D.; Jofre-Monseny, J.; Solé-Ollé, A.: "'Hold that ghost': using notches to identify manipulation of population-based grants"
2015/40, Mancebón, M.J.; Ximénez-de-Embún, D.P.; Mediavilla, M.; Gómez-Sancho, J.M.: "Does educational management model matter? New evidence for Spain by a quasiexperimental approach"
2015/41, Daniele, G.; Geys, B.: "Exposing politicians' ties to criminal organizations: the effects of local government dissolutions on electoral outcomes in Southern Italian municipalities"
2015/42, Ooghe, E.: "Wage policies, employment, and redistributive efficiency"

2016

2016/1, Galletta, S.: "Law enforcement, municipal budgets and spillover effects: evidence from a quasi-experiment in Italy"
2016/2, Flatley, L.; Giulietti, M.; Grossi, L.; Trujillo-Baute, E.; Waterson, M.: "Analysing the potential economic value of energy storage"
2016/3, Calero, J.; Murillo Huertas, I.P.; Raymond Bara, J.L.: "Education, age and skills: an analysis using the PIAAC survey"
2016/4, Costa-Campi, M.T.; Daví-Arderius, D.; Trujillo-Baute, E.: "The economic impact of electricity losses"
2016/5, Falck, O.; Heimisch, A.; Wiederhold, S.: "Returns to ICT skills"
2016/6, Halmenschlager, C.; Mantovani, A.: "On the private and social desirability of mixed bundling in complementary markets with cost savings"
2016/7, Choi, A.; Gil, M.; Mediavilla, M.; Valbuena, J.: "Double toil and trouble: grade retention and academic performance"
2016/8, González-Val, R.: "Historical urban growth in Europe (1300–1800)"
2016/9, Guio, J.; Choi, A.; Escardíbul, J.O.: "Labor markets, academic performance and the risk of school dropout: evidence for Spain"
2016/10, Bianchini, S.; Pellegrino, G.; Tamagni, F.: "Innovation strategies and firm growth"
2016/11, Jofre-Monseny, J.; Silva, J.I.; Vázquez-Grenno, J.: "Local labor market effects of public employment"
2016/12, Sanchez-Vidal, M.: "Small shops for sale! The effects of big-box openings on grocery stores"
2016/13, Costa-Campi, M.T.; García-Quevedo, J.; Martínez-Ros, E.: "What are the determinants of investment in environmental R&D?"
2016/14, **García-López, M.A; Hémet, C.; Viladecans-Marsal, E.:** "Next train to the polycentric city: The effect of railroads on subcenter formation"
2016/15, Matas, A.; Raymond, J.L.; Dominguez, A.: "Changes in fuel economy: An analysis of the Spanish car market"
2016/16, Leme, A.; Escardíbul, J.O.: "The effect of a specialized versus a general upper secondary school curriculum on students' performance and inequality. A difference-in-differences cross country comparison"
2016/17, **Scandurra, R.I.; Calero, J.**: "Modelling adult skills in OECD countries"
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2016/19, Del Rio, P.; Mir-Artigues, P.; Trujillo-Baute, E.: "Analysing the impact of renewable energy regulation on retail electricity prices"
2016/20, Taltavull de la Paz, P.; Juárez, F.; Monllor, P.: "Fuel Poverty: Evidence from housing perspective"
2016/21, Ferraresi, M.; Galmarini, U.; Rizzo, L.; Zanardi, A.: "Switch towards tax centralization in Italy: A wake up for the local political budget cycle"
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2016/23, Daví-Arderius, D.; Sanin, M.E.; Trujillo-Baute, E.: "CO2 content of electricity losses"
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2016/25 Choi, Á.; Gil, M.; Mediavilla, M.; Valbuena, J.: "The evolution of educational inequalities in Spain: Dynamic evidence from repeated cross-sections"
2016/26, Brutti, Z.: "Cities drifting apart: Heterogeneous outcomes of decentralizing public education"
2016/27, Backus, P.; Cubel, M.; Guid, M.; Sánchez-Pages, S.; Lopez Manas, E.: "Gender, competition and performance: evidence from real tournaments"
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2016/30, Di Cosmo, V.; Malaguzzi Valeri, L.: "Wind, storage, interconnection and the cost of electricity"

2017

2017/1, González Pampillón, N.; Jofre-Monseny, J.; Viladecans-Marsal, E.: "Can urban renewal policies reverse neighborhood ethnic dynamics?"
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2017/5, Solé-Ollé, A.; Viladecans-Marsal, E.: "Housing booms and busts and local fiscal policy"
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2018

2018/1, Boadway, R.; Pestieau, P.: "The tenuous case for an annual wealth tax"
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2018/13, Ayllón, S.; Nollenberger, N.: "The unequal opportunity for skills acquisition during the Great Recession in Europe"
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2018/15, Durán-Cabré, J. M.; Esteller-Moré, A.; Mas-Montserrat, M.; Salvadori, L.: "La brecha fiscal: estudio y aplicación a los impuestos sobre la riqueza"
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2018/17, Garcia-López, M. À.; Moreno-Monroy, A. I.: "Income segregation in monocentric and polycentric cities: does urban form really matter?"
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2018/20, Nerea Gómez-Fernández, Mauro Mediavilla: "Do information and communication technologies (ICT) improve educational outcomes? Evidence for Spain in PISA 2015"
2018/21, Montolio, D.; Taberner, P. A.: "Gender differences under test pressure and their impact on academic performance: a quasi-experimental design"
2018/22, Rice, C.; Vall Castelló, J.: "Hit where it hurts – healthcare access and intimate partner violence"
2018/23, Ramos, R.; Sanromá, E.; Simón, H.: "Wage differentials by bargaining regime in Spain (2002-2014). An analysis using matched employer-employee data"

2019

2019/1, Mediavilla, M.; Mancebón, M. J.; Gómez-Sancho, J. M.; Pires Jiménez, L.: "Bilingual education and school choice: a case study of public secondary schools in the Spanish region of Madrid"
2019/2, Brutti, Z.; Montolio, D.: "Preventing criminal minds: early education access and adult offending behavior"
2019/3, Montalvo, J. G.; Piolatto, A.; Raya, J.: "Transaction-tax evasion in the housing market"
2019/4, Durán-Cabré, J.M.; Esteller-Moré, A.; Mas-Montserrat, M.: "Behavioural responses to the re)introduction of wealth taxes. Evidence from Spain"
2019/5, Garcia-López, M.A.; Jofre-Monseny, J.; Martínez Mazza, R.; Segú, M.: "Do short-term rental platforms affect housing markets? Evidence from Airbnb in Barcelona"
2019/6, Domínguez, M.; Montolio, D.: "Bolstering community ties as a means of reducing crime"
2019/7, García-Quevedo, J.; Massa-Camps, X.: "Why firms invest (or not) in energy efficiency? A review of the econometric evidence"
2019/8, Gómez-Fernández, N.; Mediavilla, M.: "What are the factors that influence the use of ICT in the classroom by teachers? Evidence from a census survey in Madrid"
2019/9, Arribas-Bel, D.; Garcia-López, M.A.; Viladecans-Marsal, E.: "The long-run redistributive power of the net wealth tax"
2019/10, Arribas-Bel, D.; Garcia-López, M.A.; Viladecans-Marsal, E.: "Building(s and) cities: delineating urban areas with a machine learning algorithm"
2019/11, Bordignon, M.; Gamalerio, M.; Slerca, E.; Turati, G.: "Stop invasion! The electoral tipping point in anti-immigrant voting"

2020

2020/01, Daniele, G.; Piolatto, A.; Sas, W.: "Does the winner take it all? Redistributive policies and political extremism"
2020/02, Sanz, C.; Solé-Ollé, A.; Sorribas-Navarro, P.: "Betrayed by the elites: how corruption amplifies the political effects of recessions"
2020/03, Farré, L.; Jofre-Monseny; J., Torrecillas, J.: "Commuting time and the gender gap in labor market participation"
2020/04, Romarri, A.: "Does the internet change attitudes towards immigrants? Evidence from Spain"
2020/05, Magontier, P.: "Does media coverage affect governments'preparation for natural disasters?"
2020/06, McDougal, T.L.; Montolio, D.; Brauer, J.: "Modeling the U.S. firearms market: the effects of civilian stocks, crime, legislation, and armed conflict"
2020/07, Veneri, P.; Comandon, A.; Garcia-López, M.A.; Daams, M.N.: "What do divided cities have in common? An international comparison of income segregation"
2020/08, Piolatto, A.: "'Information doesn't want to be free': informational shocks with anonymous online platforms"
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