REAP Rede de Economia Aplicada

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Setembro, 2011
Working Paper 003

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Abstract

Mimicking the "Great American Crime Decline" (Zimiring, 2007), violent crime in the state of São Paulo dropped sharply in the 2000s after rising steadily throughout the 1980s and 1990s. This paper evaluates the role of crack cocaine in explaining the aggregate dynamics in violence. Four facts are established. First, the aggregate data show a tight co-movement between the prevalence of crack cocaine and homicides. Second, using city-level apprehension and possession data, I find a strong elasticity of violent crime with respect to crack cocaine after controlling for year, city effects, and many time-varying covariates. I use the estimated elasticity to compute the contribution of crack cocaine to aggregate violence. Crack explains 30% of time series variation in the data. Third, only drug traffic – not drug possession – has an impact on homicides. Finally, I find no impact on property crimes, I find a weaker impact on attempted murder, and, interestingly, I find a weak negative impact on aggravated assault. The theory suggests that both facts – only trafficking matters and crack affects only homicides, not property crime – can be rationalized only if drug-induced crime is driven by systemic violence induced by illegality itself. These results are important for policy because they suggest that violence will not follow legalization of both the possession and the trade of cocaine or crack-cocaine.

KEYWORDS: Crack Epidemic; Violence; Panel Data

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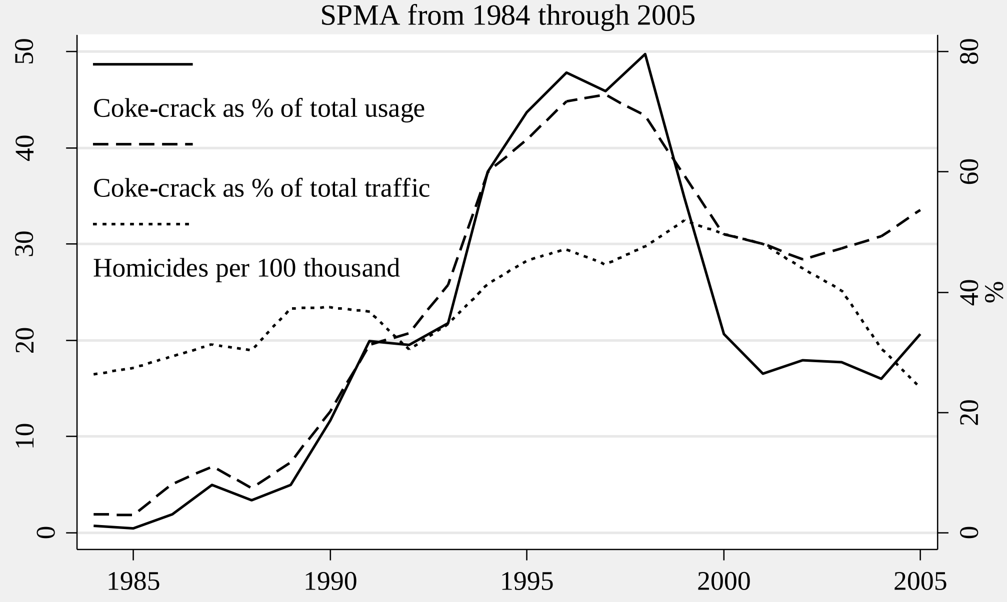
1 INTRODUCTION

The São Paulo Metropolitan Area (SMPA) has received significant attention in the domestic and international media for its sharp swings in homicides during the 1990s and 2000s.[2] Homicides increased steadily over the 1990s, but they fell sharply in the 2000s. There were 24 homicides per 100,000 inhabitants in 2005 in the SPMA, down from the peak of 52 in 1999 and 20% *less* than the level in the early 1990s. In this paper, I investigate the role of a crack epidemic in explaining the swings in violent crime.

Figure 1 depicts three series: 1) homicides per 100,000 inhabitants from 1984 through 2005; 2) cocaine and crack as a percentage of drug traffic violations; and 3) cocaine and crack as a percentage of drug usage/possession charges.[3]

Fig. 1 : Homicides and the Penetration of Cocaine and Crack

SPMA from 1984 through 2005



Source : Secretaria de Estado da Segurança do Estado de São Paulo

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[2] In the 2005-2008 period, the British weekly newspaper *The Economist* reported twice on the murder trends in São Paulo (*Protecting citizens from themselves*, Oct. 20, 2005, and *Not as violent as you thought*, Aug. 21,2008).
[3] The weight of the amount confiscated distinguishes traffic from possession. Small quantities are normally associated with personal consumption, not traffic.

Two facts emerge from Figure 1. First, traffic and possession correlate strongly, with a correlation coefficient of 0.93. Whenever cocaine/crack as a percentage of total traffic increases, so does its usage, suggesting that local market conditions drive drug consumption. A weak co-movement of traffic and usage would suggest that São Paulo was the distribution center for other markets.

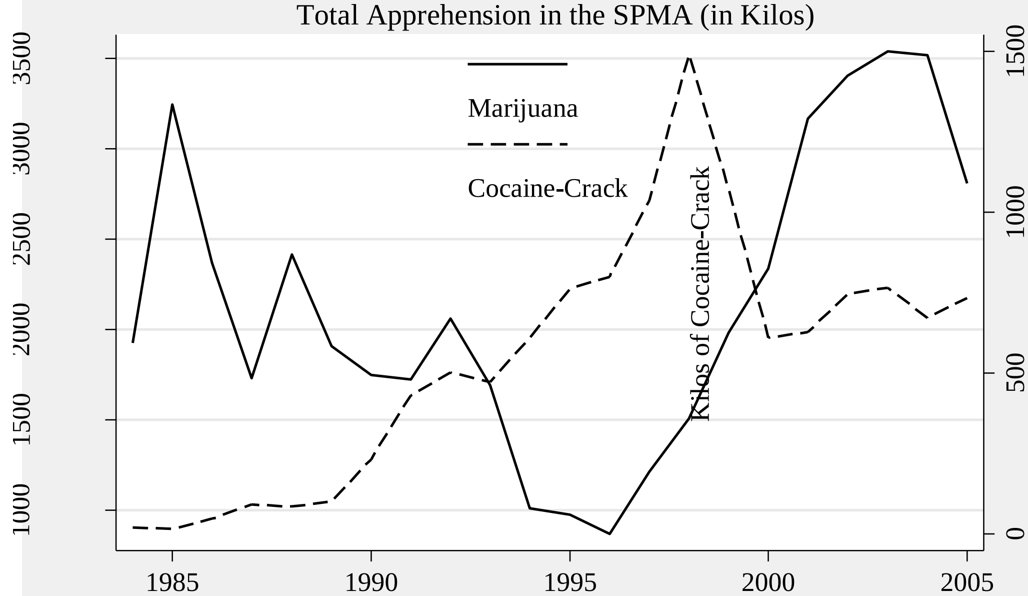
The second fact is the co-movement between homicides and the penetration of crack and cocaine as the drug of choice. Furthermore, all three series grow unabated in the 1990s, peak in the late 1990s, and drop in the 2000s, although the cocaine-crack penetration increases slightly in the last two years of the series. Thus, the raw correlations with aggregate data from the SPMA suggest a relationship between the penetration of cocaine/crack and violent crime. The reminder of the paper attempts to confirm or refute the causality of these correlations.

Figure 2 depicts the series of possession charges of cocaine-crack and marijuana in levels (kilos). We show only possession because the levels are subject to less contaminated by police activity, especially for cocaine-crack. If constant enforcement is assumed, drug usage did not increase across the board in the 1990s; there was a dramatic increase in cocaine-crack usage but a slight reduction in marijuana usage. Then, in the mid-to-late 1990s, the trends started to reverse. Cocaine and crack usage dropped and marijuana usage increased sharply. Thus, we have two waves: the crack cocaine epidemic in the 1990s, followed by the marijuana age in the 2000s.[4]

[4] Again, the levels of confiscation include both consumption and police enforcement efforts. It may be that police effort varied for different drugs over time. In particular, there is anecdotal evidence that police relaxed the enforcement of possession of light drugs such as marijuana in the mid-2000s, which incidentally explains the large drop in marijuana possession in 2005. Nevertheless, it is hard to rationalize the trends in figure 2 with changes in enforcement, unless enforcement of marijuana was relaxed in the 1990s and then toughened in the 2000s and the opposite was true for cocaine and crack, which is rather far-fetched.

Fig. 2 : Possesion of Coke - Crack and Marijuana (1984 - 2005)

Total Apprehension in the SPMA (in Kilos)



Source : Secretaria de Estado da Segurança do Estado de São Paulo

This paper has seven sections, including this introduction. Section 2 introduces the hypothesis that crack cocaine contributed to the sharp spike in violent crime during the late 1980s in the United States. Section 2 also includes a non-exhaustive review of the literature on drug use and crime. Section 3 briefly provides background on crime and law enforcement in Brazil, with emphasis on drug-fighting policies and enforcement. Section 4 describes the data sources used in the empirical analysis. Section 5 presents the identification strategy and results. Section 6 discusses the results in light of the drug hypothesis in the literature. Section 7 provides the conclusion.

2 THE CRACK HYPOTHESIS AND RELATED LITERATURE

2.1 The Crack Hypothesis

Goldstein (1985) lists three channels through which the drug-violence nexus operates. First, there is a pharmacological relationship. Consumption of psychotropic substances affects behavior, sometimes exacerbating aggressiveness. For example, McClelland et al. (1972), in their classic *The Drinking Man*, compared fantasies of sober and intoxicated men and found that intoxicated men were more likely than sober men to have fantasies involving power and domination. Extensive literature documents the causal impact of alcohol consumption on violent behavior in different settings (see Carpenter (2007), Biderman et al. (2010), Gorman et al. (1998), and Lipsey et al. (1997), among others).

The second channel is an economic relationship: drugs produce crime because users commit crimes to support their habits.

The third channel – the systemic channel – posits that the illegality of drug trade and usage causes criminal behavior. Several mechanisms are operative. Directly, confrontation between traffickers and the police causes violence. Illegality prevents contracts from being enforced through the normal judicial system, thus increasing the value of violence as an enforcing mechanism (Miron and Zwiebel [1995]). Lastly, prohibition may change the competitive dynamics of the industry. For example, the fact that drug trafficking is illegal makes the use of violence relatively attractive as a means to acquire a market share. If a person is engaged in one type of criminal activity (drug trafficking, for example), the marginal cost of the person's engaging in further criminal behavior (killing, for instance) is reduced. In fact, drug cartels and gangs compete mostly through violence – not through prices, as lawful industries do.

The three channels have different implications for how the drug-violence nexus operates for different drugs. For example, the first two channels – pharmacological and economic – apply to all psychotropic substances, but the systemic violence is specific to illicit drugs.

Differences in pharmacology make up for different impacts on behavior. Marijuana and heroin, for example, are depressants, thus abating aggressive behavior. Cocaine and crack, on the other hand, are stimulants that induce aggressiveness (Johnson et al. [2000]). This suggests that, at least theoretically, crack and cocaine have a stronger impact on violence.

Substances also differ in their inducement of economically motivated violence. Different social classes may consume different drugs, for example. In addition, some substances may more severely impair a person's ability to make a living. For example, crack cocaine, because of its extreme addictiveness, is considered to be particularly detrimental to a normal working life (Johnson et al. [2000]).

Within the systemic channel, the industrial organization of drug distribution differs across illicit substances in ways that make crack more conducive to violence. Entry costs and market structure differ for different drugs. In particular, the number of firms supported in equilibrium determines the level of competitiveness in the market and, thus, the level of violence if gangs and cartels use violence as one dimension of competition, as anecdotal evidence suggests. Demand elasticities also differ among drugs. Crack is the most addictive of hard drugs. Johnson et al. (2000) show that this addictiveness manifests itself in "runs" of large amounts of crack consumption. Demand elasticity could then be relatively low, increasing profits and, *ceteris paribus*, inducing more entry. Supply conditions for production, wholesale distribution and retail distribution also differ. The marginal cost of producing crack rocks out of cocaine paste is very low (Johnson et al. [2000]), and margins were very high when crack was introduced in New York City. Johnson et al. (2000) talk about the "crazy money" involved in selling crack: "Crack sales were so lucrative that by 1988 the entire labor force of the illicit drug distribution industry was attracted to it." Large-scale entry into the retail distribution market induced more competition and, consequently, more violence. On the other hand, marijuana, possibly because it is less addictive, had lower margins induced by more elastic demand. In addition, its distribution involved access to a wholesale distributor, increasing entry costs (Johnson et al. [2000]). Heroin retail distribution was also highly concentrated in New York City (Johnson et al. [2000]). All of these factors suggest a more competitive retail market for crack than for marijuana and heroin. Insofar as competitiveness implies violence, one should expect more violence associated with crack and cocaine than with heroin and marijuana.

When demand is inelastic, gangs may choose to compete for turf, which is mainly competition in the violence dimension. Because drug distribution is illegal, the marginal cost of exerting violence is much lower than it is in lawful businesses. Thus, a crucial issue in the industrial organization of drug-induced violence is the own-price elasticity of demand.[5] Although short-term demand for addictive goods should be inelastic, long-run elasticity should be higher (Becker and Murphy [1988]). Estimates vary considerably, but the empirical literature suggests two things. First, demand for different drugs has different elasticities. Second, demand for cocaine seems less elastic than demand for other drugs. DiNardo (1993), for example, finds no effect of cocaine prices on drug usage among high school seniors in the U.S. Chaloupka and Saffer (1995) find higher elasticities than previously thought, but the demand for cocaine is still inelastic. Using individual-level data, participation price elasticity for cocaine is around -0.45, and price elasticity is around -0.90. Heroin has much higher price elasticities (-0.70 and -1.70, respectively). Unfortunately, no estimates are

[5] The ambiguity of the empirical results is not surprising. Besides the normal difficulty in solving simultaneity problems with aggregate data, additional challenges arise when measuring prices of illegal substances.

available for crack cocaine, but given its lower price and extreme addictiveness, it is reasonable to expect the own-price elasticity of crack cocaine to be lower than that of powdered cocaine (Johnston et al. [2000]).[6]

Finally, depending on which channel is operative, the drug-violence nexus operates through drug use, traffic, or possibly both. The pharmacological channel works exclusively through drug use. Even in a city in which all drugs are bought outside the city and brought in for consumption only, violence could arise for pharmacological reasons. Economically induced violence should also operate through drug use because these crimes are committed to support use. Systemic reasons arise because the trade is illegal. Thus, the systemic channel operates through traffic.

In our empirical model, we test the following "crack hypotheses":

- H1: The penetration of crack/cocaine traffic has an impact on both violent and property crime.

- H2: The penetration of crack/cocaine use has an impact on both violent and property crime.

Testing these two hypotheses allows us to 1) test whether the penetration of crack explains violent crime in São Paulo and 2) distinguish between the three non-competing mechanisms.

2.2 Literature Review

This study most closely relates to the extensive literature that explores the youth gangs-drugs-violence nexus. It is beyond the scope of this work to survey this literature exhaustively, but I will present the main results of the literature to position my contribution relative to the literature.[7]

The literature has produced mixed results on the effect of drugs on violence. Corman and Mocan (2000), for example, find only a weak link between drug usage and property crime. The relationship between gang violence and drug use or trafficking is also weak. Fagan (1989) finds that

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[6] There is a relatively large body of literature on the price effects. It is beyond the scope of this work to review this extensively. See Rhodes et al. (2002) for an extensive survey.

[7] Howell and Decker (1999) provide an excellent and exhaustive survey of the literature on the youth gangs-drugs-violence connection.

drug dealing occurs in gangs with both high and low engagement in violent behavior. On the other hand, Hutson et al. (1995) find that, as of the mid-1990s, 43% of all homicides in Los Angeles County were gang-related, although the authors cannot attribute gang violence to drug use or traffic. Scholars find that many adult criminal organizations were formed to distribute crack cocaine in the 1980s in the U.S. (see Taylor [1990], Fagan [1996], Johnson et al. [1990]). Taylor (1989) shows evidence that violence ensued after the introduction of crack cocaine, and this association is apparently linked to the competition for market share in the retail distribution (Fagan [1996]). In summary, the literature using U.S. data provides some weak evidence for the link between drug distribution and gang violence. Furthermore, the introduction of crack cocaine seems to strengthen this link. This is in line with our results, although it should be stressed that the link is not strong and that there is also evidence to the contrary (Huff [1996]).

Regarding Goldstein's three channels, the empirical literature is a little more assertive. Collins (1990) summarizes the available evidence and finds that 1) the pharmacology is at best a second-order channel, 2) some evidence supports the economically induced channel, and 3) little is known about the systemic channel, although it is likely to be first-order by exclusion because the economically induced channel explains little of the overall relationship between drugs and violence.

In this context, I offer several contributions. First, I document the impact of a crack epidemic in a context other than American cities. Second, I show that the type of drug in fashion matters, i.e., crack traffic has an impact on crime, but not aggregate drug traffic. Third, I document the mechanism behind the drug-violence nexus. The three channels have different implications for different types of crime and different types of drug violations. Through the pharmacological and economically induced channels, crack usage causes violence; traffic would affect violence only insofar as it contributes to usage. On the other hand, traffic per se can only affect violence through the systemic channel. We find that only traffic causes violence, not usage, which suggests that the relevant channel is the systemic one. Another source of variation is the type of crime. The economically induced channel implies that drug consumption causes property crime. We show no such result with data from the state of São Paulo. In summary, we provide evidence on the channel by which drugs influence violence. Data from the state of São Paulo favor Goldstein's systemic channel.

This paper's final contribution is in terms of identification. As I explain in detail in Section 5, I adopt a novel way to measure the dynamics of drug possession and traffic. Police report data is contaminated by police activity. Without properly controlling for enforcement, estimates derived from regressing crime on drug traffic/possession are bound to be biased. We circumvent the problem by measuring crack/cocaine not in levels but as a proportion of all drug traffic and possession violations – a strategy not previously used in the literature.

3 CRIME AND LAW ENFORCEMENT IN BRAZIL

Brazil is a federal republic with three layers of government: federal, state and municipal.[8] Law enforcement is primarily the responsibility of state governments. Executive and administrative authority rests in the state-level secretaries of security authorities (the *Secretarias Estaduais de Segurança Pública*), which respond directly to the governor, who allocates the budget to the secretary. The administrative and strategic decisions are made by the state security secretary, who is appointed by the governor. Some strategic decisions are determined by law. For example, by constitutional mandate, the number of policemen in the state of São Paulo must be roughly constant in per capita terms across cities. Enforcement is shared between two organizations that respond to the secretary: the military police, responsible for patrolling and crime prevention, and the civil police, an investigative agency. The commanders of the two police forces are also appointed by the governor. Unlike the U.S., sheriffs in Brazil are not elected but are appointed from among career officers. The institutional structure of state-level police is determined by the federal constitution.

The federal and municipal levels participate in law enforcement, but to a lesser degree. In fact, suppression of drug trafficking is shared between the federal police force – *Polícia Federal*, equivalent to the American FBI –- and the state-level *Secretarias*. The *Polícia Federal*, similar to the FBI, is responsible for dealing with cross-state and international traffic.[9] The state-level police forces work within state borders. Unlike the state-level *Secretarias*, municipal police forces (*Guardas Municipais*) are not mandated by federal law but are the municipality's choice of the municipality. As of 2006, 28% of municipalities in São Paulo state had a municipal police force. Of those police forces, 52% carry firearms and are involved in street-level policing.[10]

[8] The president, governor and mayor are elected by direct ballot.
[9] Other responsibilities include suppressing smuggling, white-collar crime and corruption.
[10] When municipal police forces do not carry firearms, they normally focus on traffic organization duties.

The institutional features of police enforcement make it somewhat unlikely that enforcement will respond promptly to city-level changes in drug use and traffic. Decisions are made by state and federal authorities, not at the city level. Of course, state authorities may respond, but deployment of the police force is limited by the constitutional mandate that the number of police officers must be constant per capita across cities.

4 DATA

Our main source of data is the Secretaria de Segurança Pública do Estado de São Paulo. We have two different datasets. One dataset (DS1) is longer, with city-level annual data from 1984 through 2005 for the 37 cities in the São Paulo Metropolitan Area. It includes data on several different types of property and violent crimes. Drug information is based on the number of bookings for drug trafficking and usage. Unfortunately, the information on crack cocaine is bundled with powdered cocaine. We also have a dataset on basic demographics (population, urban population and age distribution) from FUNDAÇÃO SEADE, a state government-sponsored think-tank. The second dataset (DS2) covers all 643 cities in the state of São Paulo from 2001 through 2008. In addition to its wider geographical availability, DS2 has much richer information at the city level. We observe a wider range of crime types (illegal gun possession, for example), the number of arrests, and the number of stolen vehicles recovered, which allow us to construct a measure of police efficiency. In addition, we have information on both powdered and crack cocaine. Unfortunately, no information on drug possession charges is available.

5 EMPIRICAL STRATEGY AND RESULTS

5.1 Identification Strategy

The strategy consists of estimating different versions of the following model:

$$Crime100thd_{it} = \beta_0 + \beta_1 \%CrackTraffic_{it} + \beta_2 \%CrackPossession_{it} + Controls_{it} + \sum_{t=1}^{T} \tau_t YEAR_t + \sum_{i=1}^{I} \iota_i CITY_i + \varepsilon_{it} \quad . \qquad (1)$$

$Crime100thd_{it}$ is the number of occurrences of a certain type of crime per 100,000 inhabitants in city *i* at time *t*. $\%CrackTraffic_{it}$ ($\%CrackPossession_{it}$) is 1) the proportion of crack and cocaine among drug traffic (possession) violations when using DS1 and 2) the proportion of crack among drug traffic violations when using DS2. *YEAR* is a set of year (period) dummies, and CITY is a set of city fixed effects. The inclusion of controls depends on the dataset. Demographics, available in both DS1 and DS2, include the population, the percentage of urban population, and the percentage of the population aged 15-24.

We weight the observations by population. Homicides are a rare occurrence, and observations from small cities have a much higher variance than those from larger cities. Thus, variation from smaller cities should be discounted. To avoid giving more weight to observations in the later part of the sample, the weight is the average population over the sample period. Finally, observations are clustered at the city level. Thus, all estimated standard errors are robust to within-city correlation, an important feature in light of the results of Bertrand et al. (2004).

I take several actions to account for unobserved factors that may affect both crime and crack consumption or trafficking. Identification of the causal effect of crack on crime hinges on these actions.

First, the inclusion of city fixed-effects accounts for all time-invariant heterogeneity across cities. This is important because drug consumption and trading may vary systematically with factors that cause crime, such as the availability of firearms.

Second, aggregate homicides and the penetration of crack cocaine show a strong co-movement (Fig. 1), but the relationship may be spurious. For this reason, we include a year-specific effect to discard all pure-time series variation. After the year and city dummies are included, the variation left for estimating the causal impact is how crack cocaine penetration varied differently in different cities.

Third, I include a wide range of time-varying controls. One important control is the age structure, measured by the percentage of population in the 15-to-24 age bracket. De Mello and Schneider (2010) show that the presence of a large cohort of youth explains 70% of the rise in violence during the 1990s and 50% of the decline in the 2000s. Furthermore, time-varying variation exists at the city-level age structure. Thus, if preferences for drugs were age-specific, the omission of age structure would be a serious impediment to causal interpretation. I also include income when using data from the whole state (DS2). Low income, which causes crime, may change the drug consumption pattern. The remaining demographic controls are population and the percentage of urban population. Finally, I include vehicle robbery per 100,000 inhabitants as a control when using both DS1 and DS2. I do not believe that vehicle robbery/theft causes homicide *per se*. However, it is a good proxy for changes in crime patterns across cities over time. I chose vehicle theft and robbery because it is the only crime variable besides homicides that suffers little from under-reporting.

After including controls and year and city fixed effects, one obstacle to identification remains: police enforcement. With DS2, I can include several measures of enforcement: illegal guns apprehended, number of arrests, income per capita, and police efficiency measured as the rate of recovered stolen vehicles. However, those measures are only indirectly related to enforcement and, arguably, capture its intensity rather imperfectly. This is a problem because I do not observe the amount of drugs consumed or trafficked, but only the amount of apprehensions (possession and traffic), which are contaminated with enforcement. Better policing may both reduce homicides and increase apprehensions. As I argued above, it is unlikely that enforcement changes differently in different cities, but I cannot dismiss this possibility. I mitigate this problem by using crack (or crack cocaine) as a *proportion* of all drug possession and traffic violations. Police enforcement may still contaminate this variable, but it must be that police enforcement not only changes differently across cities but also changes differently for different substances in different cities. It is possible, even likely, that police focus more on substances when they gain a market share. It is, however, very far-fetched that this enforcement changes differently for different drugs in *different cities*.

5.2 Summary Statistics

Table 1 contains descriptive statistics on DS1 and DS2.

Table 1: Descriptive Statistics	Mean		Std Dev		Median	
	DS1[(a)]	DS2[(b)]	DS1[(a)]	DS2[(b)]	DS1[(a)]	DS2[(b)]
Homicides per 100thd inhabitants	38.27	20.27	13.34	15.81	35.80	15.37
Vehicle Robberies per 100thd inhabitants	604.63	446.17	328.57	363.65	542.14	361.89
Robberies and Thefts per 100thd inhabitants[(d)]	1898.33	2189.94	585.74	865.04	1820.81	2239.59
Aggravated Assault per 100thd inhabitants	323.42	431.70	74.06	196.18	308.90	369.66
Attempted Murder per 100thd inhabitants	19.84	19.62	9.82	11.90	17.77	19.60
Robbery followed by Murder per 100thd inhabitants	2.18	0.92	1.04	1.25	2.12	0.62
Drug Trafficking per 100 thousand inhabitants	12.19	30.31	6.88	22.03	11.07	21.41
Crack/Cocaine Traffic[(c)]	0.39	0.05	0.26	0.11	0.45	0.05
Crack/Cocaine Possession	0.21		0.18		0.17	

Source: Secretaria de Segurança do Estado de São Paulo
(a): City-level annual observations for the São Paulo Metropolitan Area from 1984 through 2005
(b): City-level annual observations for the whole state from 2001 through 2008
(c): for DS2 it is only crack, for DS1 it is crack and cocaine
(d): excludes vehichle robbery and theft.
All summary statistics computed using average population as a weight

Several facts arise from Table 1. As expected, the São Paulo Metropolitan Area is much more violent than the whole state, even after weighting observations according to the population.[11] Again not surprisingly, drug trafficking happens more often in the SPMA than in the whole state. Crack and cocaine represent a large fraction of drug traffic, especially in the SPMA. The participation of crack and cocaine in possession is lower than in trafficking. In summary, descriptive statistics suggest that the phenomena of violent crime and drug dealing in the whole state and the SPMA are similar yet different phenomena. This is important for our purposes because it implies that the use of one dataset contains information above and beyond the other dataset.

[11] The sample periods are different. If we compute summary statistics using DS1 but restricting the sample to the years 2001 through 2005, the figures are similar.

5.3 Results for the SMPA from 1984 through 2005 (DS1)

Table 2 shows the first set of estimates of model 1 using DS1, which contains data from the SPMA from 1984 through 2005.

Table 2: Estimates from the São Paulo Metropolitan Area

Dependent Variable: Homicides per 100thd inhabitants

	(1)	(2)	(3)	(4)	(5)
Drug Trafficking per 100 thousand inhabitants	**-0.46** **(0.16)*****	**-0.40** **(0.11)*****	**-0.08** **(0.19)**	**-0.08** **(0.17)**	**-0.03** **(0.16)**
Crack and Cocaine/Total (Traffic)	**24.70** **(7.26)*****	**23.23** **(7.25)*****	**3.18** **(2.45)**	**4.29** **(2.60)***	**5.81** **(2.60)****
Crack and Cocaine/Total (Possession)	**3.32** **(5.96)**	**4.51** **(5.57)**	**-0.79** **(3.46)**	**-0.70** **(3.65)**	**1.82** **(3.61)**
City fixed-effects?	No	Yes	Yes	Yes	Yes
Year fixed-effects?	No	No	Yes	Yes	Yes
Demographics?[(a)]	No	No	No	Yes	Yes
Vehicle Robbery/Theft?	No	No	No	No	Yes
R^2	21	57	76	77	77
# Observations	669	669	669	669	669

Source: Secretaria Estadual de Segurança Pública de São Paulo and Fundação SEADE

*** = significant at the 1% level, ** = significant at the 5%, * = significant at the 10%.

In all specifications, observations are weighted according to population. Standard Errors in parentheses are clustered at the city level. Period of Analysis is 1985 through 2005, unless otherwise noted.

(a): Covariates: population, the number of 15-24 year-old males, and urban population.

The model in column (1) includes no controls. Drug traffic violations seem negatively related to violent crime – that is, contrary to expectations, places with more trafficking are less violent. Causal interpretation is not warranted because the measure of drug trafficking is contaminated with the strength of enforcement and may well capture better policing. The coefficients associated with the percentage of drug traffic and possession because of crack and cocaine suggest, in both cases, that crack and cocaine are associated with more homicides. However, only crack and cocaine trafficking is statistically significant. In terms of practical significance, the standard deviation of homicides per 100,000 inhabitants is 13.34, and the standard deviations of the proportion of cocaine/crack in trafficking are 0.26 and 0.18, respectively (see Table 1). Thus, according to the estimates in column 1, an increase of one standard deviation in the penetration of cocaine/crack traffic is associated with an increase of 6.42 homicides per 100,000 inhabitants – nearly half the standard deviation of homicides. The impact of an increase in one standard deviation of cocaine and crack possession is not only statistically insignificant but also much weaker in practice: about 0.80 homicides per 100,000 inhabitants, or 6% of a standard deviation.

One may wonder whether preferences toward cocaine or crack are systematically related to city characteristics, and this may be driving results in column (1). In column (2), I control for all time-invariant unobserved heterogeneity among cities by including city dummies. Results were unchanged, which suggests that the cocaine and crack penetration are not systematically related to city characteristics.

In column (3), we include year dummies. This is quite important because, by sheer coincidence, crack and cocaine may have penetrated (retracted) in a period of rising (reducing) homicides. In other words, the common component among cities may be spurious. Indeed, results change significantly. First, traffic in levels is no longer significant. Second, penetration of cocaine/crack possession no longer has any impact on homicides statistically or practically. Third, the coefficient on the penetration of cocaine/crack traffic is significantly reduced. Although marginally significant in practice (one homicide per 100,000 inhabitants), it is no longer statistically significant at standard levels. One comment is warranted. The inclusion of year dummies discards all common-among-cities pure time-series variation. If the penetration of cocaine/crack in fact causes homicides, the common component is legitimate causal variation. Thus, estimates when discarding pure time-series variation are the most conservative possible.

In columns (4) and (5), we include demographics and vehicle robbery to control for general trends in crime. Traffic in levels and the penetration of cocaine/crack possession are still not significant statistically or practically. Interestingly, when one controls for time-varying heterogeneity among cities, the coefficient on the penetration of cocaine/crack traffic is larger than in column (3), and it is now statistically significant at the 10% level. Using the estimated coefficient in column (5), I find that one standard deviation in the penetration of cocaine/crack traffic causes a 1.51 increase in homicides per 100,000 inhabitants, which is 11% of the standard deviation in homicides. This is a small but non-negligible effect.

Table 3 contains some robustness exercises using DS1.

Table 3: Estimates from the São Paulo Metropolitan Area

Dependent Variable: Homicides per 100thd inhabitants

	City-specific trends[(a)]	Year > 1988	Excluding São Paulo	Excluding São Paulo and Guarulhos	Controls in Levels
	(1)	(2)	(3)	(4)	(5)
Drug Trafficking per 100 thousand inhabitants	**-0.13**	**-0.10**	**-0.04**	**-0.04**	**-0.05**
	(0.24)	**(0.18)**	**(0.18)**	**(0.19)**	**(0.20)**
Crack and Cocaine/Total (Traffic)	**5.95**	**7.08**	**5.18**	**5.69**	**5.48**
	(3.56)*	**(2.90)****	**(2.82)***	**(2.75)****	**(2.80)***
Crack and Cocaine/Total (Possession)	**0.95**	**-0.18**	**1.37**	**0.73**	**1.69**
	(3.65)	**(3.65)**	**(3.76)**	**(3.92)**	**(3.34)**
City fixed-effects?	Yes	Yes	Yes	Yes	Yes
Year fixed-effects?	Yes	Yes	Yes	Yes	Yes
Demographics?[(b)]	Yes	Yes	Yes	Yes	Yes
Vehicle Robbery?	Yes	Yes	Yes	Yes	Yes
R^2	81	78	71	73	78
# Observations	669	542	647	625	669

Source: Secretaria Estadual de Segurança Pública de São Paulo and Fundação SEADE

*** = significant at the 1% level, ** = significant at the 5%, * = significant at the 10%.

In all specifications, observations are weighted according to population. Standard Errors in parentheses are clustered at the city level. Period of Analysis is 1984 through 2005, unless otherwise noted.

(a): One linear time trend per city.

(b): Covariates: population, the number of 15-24 year-old males, and urban population.

Inspection of Figure 1 suggests that the rate of increase in homicides picks up in the late 1980s. For this reason, we discard the early and mid-eighties from the sample. Because of the weighting scheme, the city of São Paulo has a disproportionally large importance (10 million out of São Paulo state's 43 million inhabitants live in São Paulo). Thus, we exclude the city of São Paulo from the sample, and the results are, if anything, stronger (column (2)). We then exclude Guarulhos, the second-largest city in the state, with 1.1 million inhabitants (column (3)). Finally, crime regressions are normally specified with demographic controls as a percentage of the population, a procedure we follow throughout except in column (4), where we use the total population between 15 and 24 years and the total urban population (instead of the proportion of the total population). In all four exercises, results are very similar to results in Table 2. The impact of cocaine traffic is, if anything, stronger. Possession and total traffic have no impact on homicides.

In summary, averaging the estimated coefficients, we conclude that an increase of one standard deviation in the penetration of cocaine/crack in traffic – 0.26 – increases the homicide rate by 1.30 ($\cong 0.26 \times 5$), which represents 9.7% of a standard deviation. Again, I find a small but non-negligible impact.

5.4 Results for the whole state from 2001 through 2008 (DS2)

Table 4 contains the main estimates using the dataset of all cities in the state of São Paulo from 2001 through 2008 (DS2). Although this dataset is richer in general, we have no information on possession, only traffic. On the other hand, I observe crack and cocaine separately.

Table 4: Estimates from the Whole State

Dependent Variable: Homicides per 100thd inhabitants

	(1)	(2)	(3)	(4)	(5)	(6)
Drug Trafficking per 100 thousand inhabitants	**-0.16**	**-0.22**	**0.02**	**0.00**	**0.00**	**0.00**
	(0.06)* **	**(0.08)*** **	**(0.02)**	**(0.01)**	**(0.01)**	**(0.01)**
Crack/Total (Traffic)	**-24.42**	**-2.00**	**11.68**	**5.53**	**4.93**	**4.58**
	(4.04)* **	**(2.68)**	**(3.27)*** **	**(1.73)*** **	**(1.69)*** **	**(1.69)*** **
City fixed-effects?	No	Yes	Yes	Yes	Yes	Yes
Year fixed-effects?	No	No	Yes	Yes	Yes	Yes
Demographics?[(a)]	No	No	No	Yes	Yes	Yes
Vehicle Robbery?	No	No	No	No	Yes	Yes
Additional Controls?[(b)]	No	No	No	No	No	Yes
R^2	9	48	76	83	83	84
# Observations	5088	5088	5088	5088	5088	5088

Source: Secretaria Estadual de Segurança Pública de São Paulo and Fundação SEADE

*** = significant at the 1% level, ** = significant at the 5%, * = significant at the 10%.

In all specifications, observations are weighted according to population. Standard Errors in parentheses are clustered at the city level. Period of Analysis is 2001 through 2007, unless otherwise noted.

(a): Covariates: population, the number of 15-24 year-old males, and urban population.

(b): Additional controls: police efficiency (vehicles recovered/vehicle robberies), guns apprehended per 100 thousand inhabitants, gun possession per 100 thousand inhabitants, income per capita.

The model in column (1) includes neither city nor year fixed effects. The penetration of crack in drug trafficking seems to *reduce* homicide (column (1)). Similar to Table 2, overall traffic seems to reduce homicides. When we include city fixed effects, crack penetration is no longer significant, but overall traffic is still associated with a reduction in homicides (column (2)). When both time and city fixed effects are included, we recover something more similar to the estimates in Table 2, although the impact of crack is much stronger now, at 11.68. When we include demographics and vehicle robbery per 100,000 inhabitants (columns (3) and (4)), we recover estimates very similar to those in Table 2. Inclusion of additional controls not available in DS1 does not change the results meaningfully (column (5)). Averaging the most credible estimates (columns (3) through (5)), we find that an increase of one standard deviation in the penetration of crack in drug traffic (0.11) causes an additional 0.55 homicides per 100,000 inhabitants (5.05 × 0.11), which in the case of DS2 represents 3.7% of the standard deviation of homicides per 100,000 inhabitants. Thus, the impact is similar to the one estimated using data from the SPMA from 1984 through 2005.

Table 5 contains the robustness checks similar to those in Table 3. Again, all results are robust to excluding the largest cities or including demographics in levels.[12]

Table 5: Estimates from the Whole State

Dependent Variable: Homicides per 100thd inhabitants

	Excluding São Paulo	Excluding São Paulo and Campinas	Controls in Levels
	(1)	(2)	(3)
Drug Trafficking per 100 thousand inhabitants	**-0.02** **(0.02)**	**-0.01** **(0.01)**	**0.02** **(0.02)**
Crack/Total (Traffic)	**4.60** **(1.74)****	**4.08** **(1.66)****	**4.77** **(1.72)*****
City fixed-effects?	Yes	Yes	Yes
Year fixed-effects?	Yes	Yes	Yes
Demographics?[(a)]	Yes	Yes	Yes
Vehicle Robbery?	Yes	Yes	Yes
Additional Controls?[(b)]	Yes	Yes	Yes
R^2	78	78	85
# Observations	5080	5072	5088

Source: Secretaria Estadual de Segurança Pública de São Paulo and Fundação SEADE

*** = significant at the 1% level, ** = significant at the 5%, * = significant at the 10%.

In all specifications, observations are weighted according to population. Standard Errors in parentheses are clustered at the city level. Period of Analysis is 2001 through 2008, unless otherwise noted.

(a): Covariates: population, % of of 15-24 year-olds, % urban population and GDP per capita unless otherwise noted

(b): Additional controls: police efficiency (vehicles recovered/vehicle robberies), guns apprehended per 100 thousand inhabitants, gun possession per 100 thousand inhabitants, income per capita.

[12] In the case of the whole state, we exclude the Campinas Metropolitan Region, not Guarulhos, because the Campinas Metropolitan Area is the second-largest in the state.

5.5 Other crimes

I now present the impact of crack penetration on other crime categories. These categories serve two purposes. First, they may serve as a falsification test. They are informative regarding the mechanisms that drive the relationship between crack cocaine and crime. Several authors have stated that the crack epidemic in the late 1980s and its abatement in the 1990s cannot explain the breadth of the crime increase and decline (Zimiring [2007], Rosenfeld [2004]). Zimiring offers the reason:

> *One problem is that the crack/gun violence influence should not cause all varieties of crime to go up and then decline. Thus, Rosenfeld concludes that the crack hypothesis "says nothing about the drop in property crime rates or the long-term decline in violence among adults"…[Rosenfeld] is making a limited but important point – that there are many elements of the 1990s decline that the proliferation and the abatement of drug markets in big cities did not cause. What, after all, should be the impact of variations in crack cocaine markets on rates of auto theft, rape, or robbery?*

If one accepts this theoretical assertion, then one should find no impact of crack on property crime, for example.

There are, however, theoretical reasons to believe that drugs in general, and crack in particular, could have an impact "on rates of auto theft, rape or robbery." The pharmacological channel suggests that the mental impairment by drug use may lead to all types of violent behavior (Goldstein [1985]), including rape. In fact, previous empirical research has established a relationship between alcohol consumption and violent behavior (Carpenter [2007], Biderman et al. [2010], Gorman et al. [1998], and Lipsey et al. [1997]). In fact, pharmacological misbehavior is one of the main justifications for the illegality of drugs. Through the economically induced crime channel, drug use should increase property crime to support the addiction (Goldstein [1985]). Whether the pharmacological and economically induced channels are relevant in practice is an empirical question, and measuring the impact of crack-cocaine on different crime categories is informative about which channel is operative.

Tables 6 and 7 contain estimates of the effect of trafficking and crack penetration on other crimes using data from the SPMA and the whole state, respectively. The general message is that neither traffic in general nor the penetration of crack has a consistent impact on any other crime category. Traffic has a statistically significant and positive impact only on assaults (column [1]), and only using data from the SPMA. Point estimates indicate that the penetration of crack reduces assaults, which could suggest an increase in lethality. The impact is statistically significant only when data for the whole state is used (Table 7, column [1]). In both cases, the impact is not significant in practice.[13] When using DS1, crack penetration *reduces* vehicle theft and robbery, but the effect is not significant in practice. The category in which one gets closest to finding an impact is attempted murder. When using DS2, I find a significant effect of crack penetration on attempted murder, which is in line with the effect on homicides (column [2]). Multiplying the estimate coefficient (3.67) by the standard deviation of crack penetration (0.11) yields 0.40, which is roughly 4% of the standard deviation of attempted murder per 100,000 inhabitants, a small but non-negligible impact (see Table 1). I also find an impact on property crime when using DS2. However, the effect is smaller than the impact on homicides. A one standard deviation increase in the penetration of crack causes 31.72 additional property crimes (122.89 times 0.26). This represents less than 4% of the standard deviation of property crimes. I find no impact on the remaining crime categories (vehicle theft and robbery and robbery followed by murder, in columns (4) and (5), respectively).

[13] We consider the case of DS2 because the estimated coefficient on assaults per 100,000 inhabitants is statistically significant. The standard deviation of crack penetration is 0.05. Multiplying this figure by the estimated coefficient on assaults (-30.50) yields a reduction of -1.52 assaults per 100,000 inhabitants (see Table 7). The standard deviation of assaults per 100,000 inhabitants when using DS2 is 196.18. Thus, the impact of an increase of one standard deviation in crack penetration reduces assaults per 100,000 inhabitants by less than 0.8% of its standard deviation.

Table 6: Other Crimes in the São Paulo Metropolian Area, 1984 through 2005

Dependent Variable: Crime per 100thd inhabitants

	Aggravated Assault	Attempeted Murder	Property Crime[c]	Vechicle Theft/Robbery	Robbery followed by Murder
	(1)	(2)	(3)	(4)	(5)
Drug Trafficking per 100 thousand inhabitants	**2.61**	**0.11**	**2.40**	**-4.85**	**0.02**
	(1.16)**	**(0.08)**	**(2.92)**	**(2.91)**	**(0.01)***
Crack and Cocaine/Total (Traffic)	**-27.92**	**2.39**	**-40.98**	**-40.90**	**0.46**
	(20.31)	**(2.96)**	**(50.62)**	**(47.49)***	**(0.40)**
Crack and Cocaine/Total (Possession)	**-25.84**	**0.20**	**35.75**	**-25.76**	**-0.52**
	(23.89)	**(3.63)**	**(56.20)**	**(34.87)**	**(0.39)**
City fixed-effects?	Yes	Yes	Yes	Yes	Yes
Year fixed-effects?	Yes	Yes	Yes	Yes	Yes
Demographics?[a]	Yes	Yes	Yes	Yes	Yes
Crime control?[b]	Yes	Yes	Yes	Yes	Yes
R^2	66	72	95	93	49
# Observations	669	669	669	669	669

Source: Secretaria Estadual de Segurança Pública de São Paulo and Fundação SEADE

*** = significant at the 1% level, ** = significant at the 5%, * = significant at the 10%.

In all specifications, observations are weighted according to population. Standard Errors in parentheses are clustered at the city level. Period of Analysis is 1984 through 2005, unless otherwise noted.

(a): Covariates: population, the number of 15-24 year-old males, and urban population.

(b): Vehicle theft and robbery per 100 thousand inhabitants, except when Vehicle theft and robbery is the dependent variable in which case it is property crime excluding vehicle theft and robbery per 100 thousand inhabitants.

(c): Excludes vehicle theft and robbery

Table 7, Other Crime in the Whole State, 2001 through 2008

Dependent Variable: Crime per 100thd inhabitants

	Aggravated Assault	Attempeted Murder	Property Crime[(c)]	Vechicle Theft/Robbery	Robbery followed by Murder
	(1)	(2)	(3)	(4)	(5)
Drug Trafficking per 100 thousand inhabitants	**-0.13**	**-0.03**	**-0.68**	**0.06**	**0.00**
	(0.18)	**(0.02)**	**(0.78)**	**(0.11)**	**(0.01)**
Crack/Total (Traffic)	**-30.50**	**3.67**	**122.89**	**14.53**	**0.64**
	(14.99)**	**(0.001)*****	**(63.48)***	**(8.97)**	**(0.73)**
City fixed-effects?	Yes	Yes	Yes	Yes	Yes
Year fixed-effects?	Yes	Yes	Yes	Yes	Yes
Demographics?[(a)]	Yes	Yes	Yes	Yes	Yes
Crime control?[(b)]	Yes	Yes	Yes	Yes	Yes
Additional Controls?[(d)]	Yes	Yes	Yes	Yes	Yes
R^2	89	69	93	99	29
# Observations	5088	5088	5088	5088	5088

Source: Secretaria Estadual de Segurança Pública de São Paulo and Fundação SEADE

*** = significant at the 1% level, ** = significant at the 5%, * = significant at the 10%.

In all specifications, observations are weighted according to population. Standard Errors in parentheses are clustered at the city level. Period of Analysis is 2001 through 2008, unless otherwise noted.

(a): Covariates: population, the number of 15-24 year-old males, and urban population.

(b): Vehicle theft and robbery per 100 thousand inhabitants, except when Vehicle theft and robbery is the dependent variable in which case it is property crime excluding vehicle theft and robbery per 100 thousand inhabitants.

(c): Excludes vehicle theft and robbery

6 DISCUSSION

6.1 Source of variation in crack penetration

The results show three things:

1) For violent crime, the specific psychotropic substance matters more than the drug traffic itself. The amount of traffic dealing has no robust impact on homicides.
2) The penetration of crack (or crack and cocaine) increases homicides and, to lesser extent, attempted homicides. No systematic effect is found on assault and property crime (general, vehicle theft and robbery, or robbery followed by murder).
3) The main mechanism is traffic, not possession.

For the longer-term dynamics of violence in the São Paulo Metropolitan Area, I use our estimates to assess how much the increase and subsequent reduction in homicides result from the crack cocaine epidemic. From 1984 to its peak in 1997-1998, the penetration of crack cocaine increased steadily from 3% to 72%. My main estimates (Table 2, column [5]), when multiplied by the 69% increase, predict that homicides should increase by 4 homicides per 100,000 inhabitants. In fact, they increased by much more: from 27 to 52 homicides per 100,000 inhabitants. As for the reduction, crack also matches the trend but explains it less quantitatively. In summary, the crack cocaine epidemic did, in fact, contribute to the aggregate large changes in violence in the SPMA, but the contribution is small. Thus, it was a contributing factor to the perfect storm of the 1990s and to the tranquility of the 2000s. This pattern is in line with the one found by Johnson et al. (2000) for New York City in the 1980-1990 period.

The estimates of the impact of crack penetration on homicides should be viewed as a lower boundary of the real impact. The reason stems from the inclusion of year dummies, which are necessary to ensure that spurious, non-stationary time-series variation does not drive results (see below). However, including year dummies requires that we discard the component of crack penetration that is common among cities in the state of São Paulo. If crack indeed causes homicides, as we argued above and again below, then at least part of the common component is legitimate variation to estimate the causal impact of crack on homicides. What is unknown is which part. Thus, the safe route involves excluding all pure time-series variation.

The results suggest that among Goldstein's (1985) three channels through which drugs cause violence, the *systemic channel* is most prominent. First, the absence of any systematic impact on categories other than property crime suggests that the *economically induced channel* is not of first-order importance. More importantly, if the *psychopharmacological* and *economically induced channels* were operative, I would find an impact of crack possession on homicides. Using data from the SPMA, I can distinguish the impact of crack/cocaine use from crack/cocaine traffic. Only traffic has a systematic impact on homicides. The absence of any effect from drug usage on crime is in line with previous literature (Corman and Mocan [2000], for example).

Rates of incidence of some crime categories are notoriously unstable. Thus, the failure to establish some connections may result from noise. However, homicides – where I find a systematic impact – are not the less noisy category. Using the standard deviation/mean ratio, the least noisy category is assaults, followed by robberies and thefts (general) and vehicle robberies and theft. Thus, it is unlikely that the lack of results in other categories results purely from noise.

Do estimates establish a causal relationship? An unequivocal affirmative answer demands experimental data. In our setting, experiments are unfeasible. Thus, credibility must be judged by the non-experimental data yardstick. There are three major obstacles. First, time-series variation resulting from non-stationarity series may produce spurious results (see Figure 1). Second, enforcement affects the measure of drug prevalence and violence. Third, unobserved factors may affect both the incidence of crack and homicides.

The first challenge – non-stationarity – is fully dealt with by the inclusion of year dummies.

The second challenge plagues most studies that use police report data. The literature relating the possession of firearms and violence are illustrative because arms apprehended are contaminated by enforcement (see Lott and Mustard [1997], Ludwig [1998], Donohue and Levitt [1998]). The literature normally attempts to solve this problem by finding a good proxy of variable of interest. Duggan (2001) uses the circulation of specialized gun magazines. I use a strategy that is novel in the literature, to the best of my knowledge. Instead of searching for creative proxies, I use the penetration of crack (or crack and cocaine) – crack as the proportion of total violations. This measure considerably mitigates the "enforcement" problem because it must be that enforcement changes differently in different cities for different drugs in a way that coincides with movements in homicides. In other words, this is possible but far-fetched. In addition, I must emphasize that the inclusion of at least three different measures of the intensity of enforcement helps in mitigating the problem.[14]

The third problem is inherent to non-experimental data. A researcher cannot be completely confident that he or she has accounted for all potential factors that may affect both drug consumption and homicides. My strategy is simply to include as many controls as possible. Chief among them are city dummies, which control for all time-invariant unobserved heterogeneity across cities. Other time-varying covariates are income per capita, the percentage of males aged 15-24, population, the percentage of urban population, enforcement variables (see footnote 12), and vehicle theft and robbery per 100,000 inhabitants. This last variable is quite important because it controls for general city-specific trends in criminality.

[14] When using DS2, I include the number of prisons and the number of guns apprehended (both per 100,000 inhabitants), which somehow proxy for the intensity of enforcement. In addition, vehicles recovered as a proportion of vehicles stolen proxy for police efficiency.

7 CONCLUSION

Crack cocaine plays a role in the explaining the dynamics of homicides in São Paulo over the 1990 and 2000 decades. The crack epidemic matches movements in homicides qualitatively. Using the lower bound of the impact, crack cocaine explains some 20% of the increase in homicides during the 1990s and about 15% of the reduction in the 2000s. Thus, there is a crack-violence nexus, although the impact of crack traffic on violence is small.

More importantly, estimates indicate that the most important channel is the systemic channel. This result has important implications for policy. In the case of São Paulo, violence is derived from illegality itself, not from impairment or the necessity of sustaining habitual crime. My results suggest that a large spike in violent crime should not be expected after legalization, even if consumption rises; illegal possession (for consumption) is not associated with an increase in violence. In this case, legalization becomes, *ceteris paribus*, a more attractive option.

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