Big Brother: Good Brother? CCTV Systems and Crime Rates in Medellín-Colombia*

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Abstract

We investigate whether there is any effect on crime rates following the installation of public surveillance cameras in the city of Medellín-Colombia. To do so, we benefit from a quasi-experiment that took place in the installation of 366 cameras from April 2013 through October 2014. We highlight three main findings. First, there is a decline in total crime after the installation of the CCTV system. On average, year on year monthly changes in a total crime index are between 0.004 and 0.012 lower (i.e. between 33.3% and 100% of the average total crime index from January 2011 to October 2014 lower) in a street segment following the installation of one camera. This effect seems to be driven mainly by a decline in property crime. Second, we find no significant effects on apprehensions following the installation of surveillance cameras. These results may suggest the main channel for CCTV systems to deter criminals is through the subjective certainty of punishment. Third, we do not find crime displacement effects after the installation of CCTV systems. Instead, we find diffusion of benefits to the street segments surrounding installation sites when we restrict our sample to high crime places. This diffusion of benefits seems to be driven by a reduction in violent crime.

JEL Classification: H41, K42.

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1 Introduction

The economic approach to crime suggests that potential offenders may be less willing to pursue criminal activities whenever the expected costs of crime rise (Becker, 1968). In this setting, gov-

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ernments willing to increase the costs of crime decide on the allocation of resources among policies that raise the expectations of criminals on how certain or severe their punishment may be.

One such policy is the installation of closed circuit television (CCTV) surveillance cameras. CCTV systems may deter potential offenders from committing crimes trough a number of channels. For instance, the objective certainty of punishment could increase following the installation of surveillance cameras because of a higher probability of apprehension, prosecution or conviction. The subjective certainty of punishment may also increase because of improved perception of surveillance by the authorities. The severity of punishment could rise as well whether camera footage is critical in finding evidence relevant to aggravate sentences. Which channel prevails if CCTV systems work is still an open question in the literature, although survey analysis in European countries suggest that public perception regarding the probability of detecting crimes and catching criminals increases (Charman and Honess, 1992; Ditton, 2000). This points to the relevance of changes in the subjective certainty of punishment.

There is a relative consensus regarding how the effects of CCTV systems on crime rates are context specific, and perceptions about their effectiveness may be influenced by socio demographic or cultural characteristics of the public (Charman and Honess, 1992; Ditton, 2000). Evaluations in European and North American countries have been inconclusive, some finding desired effects on crime rates (Brown, 1995; Skinns, 1998; Armitage et al., 1999; Ditton and Short, 1999; Blixt, 2003; Gill and Spriggs, 2005; Griffiths, 2003), and others undesired effects (Brown, 1995; Winge and Knutsson, 2003; Gill and Spriggs, 2005; Farrington et al., 2007).

In light of several previous studies on the effects of CCTV systems on crime rates, our paper is relevant for a variety of reasons. First, we are able to directly identify the causal effect of surveillance cameras on crime by benefiting from a quasy-experiment in the city of Medellín-Colombia. Second, by using data on apprehensions, we are able to retrieve direct evidence regarding the mechanisms behind any effect on crime rates following the installation of CCTV systems. Finally, to the best of our knowledge this is the first evaluation of the effects of public surveillance cameras on crime in Latin America, a region with homicide rates ten times higher and assault frequencies more than three times higher than Europe and North America (Ortega and Sanguinetti, 2014; UNODC, 2013).

The context of our quasi-experiment and the estimation method are as follows. A group of 366 cameras were installed through a period of 19 months from April 2013 to October 2014. Installation sites were not ranked nor prioritized and the installation procedure relied mainly on operational and bureaucratic decisions. Thus, restricted to these 366 installation sites, from the first month of installation onwards, we have treated groups of places with surveillance cameras and control groups of places without them. These groups change as more cameras are installed. We build a panel data for which the panel variable is the street segment, i.e. a block of street between two corners, and the time variable is the month. We estimate the effects of CCTV systems on crime rates using a specification that parallels the difference-in-difference estimator for multiple time periods, for a case in which the treatment variable is not dichotomous and rather represents the number of active surveillance cameras watching a street segment. Data from crimes and public surveillance cameras is from the National Police of Colombia and the government of Medellín, respectively. Beyond the effects of CCTV systems on crime, we also investigate if there is any effect on apprehensions (i.e. if the prevailing channel for CCTV systems to work is through the subjective certainty of punishment perceived by potential offenders), and whether there are crime displacement effects or rather there is diffusion of benefits to surrounding areas.

Our results suggest that, on average, year on year monthly changes in a total crime index are between 0.004 and 0.012 lower (i.e. between 33.3% and 100% of the average total crime index from January 2011 to October 2014 lower) in a street segment following the installation of one camera. Furthermore, as the sample restricts to street segments with a higher prevalence of crime, the effects grow in magnitude. Results on violent and property crime suggest that changes in total crime are mainly driven by a decrease in property crime. Conditional on the exogeneity of camera installation dates with respect to crime levels, we interpret these effects as causal. Moreover, we find no significant effects on apprehensions following the installation of surveillance cameras. These results may suggest the main channel for CCTV systems to deter criminals is through the subjective certainty of punishment, i.e. improved perception of surveillance. We do not find crime displacement effects after the installation of CCTV systems. Instead, we find diffusion of benefits to the street segments surrounding installation sites when we restrict our sample to high crime places. This diffusion of benefits seems to be driven by a reduction in violent crime.

The remainder of the paper is organized as follows. Section two discusses the economic framework of crime prevention policies. In section three, we introduce the data. Section four presents the empirical strategy and our main identification assumptions. The econometric results and robustness analyses is presented in sections five and six. Section seven concludes.

2 Related literature

The economic approach to crime introduced by Becker (1968) suggests that criminals behave rationally. In this setting, offenders decide to pursue criminal activities whenever they find the expected benefits of committing a crime to be higher than the expected benefits of not doing it. A direct way of decreasing the expected benefits of criminal activities is to increase their expected costs. These costs can be broken down into two components: the certainty and the severity of punishment. In turn, certainty of punishment comprises three aspects: probability of apprehension, probability of prosecution given apprehension, and probability of sentencing by the judiciary given prosecution. None of these aspects are certain. Thus, the problem faced by governments trying to increase the costs of crime is how to efficiently allocate resources among policies that raise the expectations of criminals regarding either the certainty or severity of punishment, or both.

Policies aimed at increasing the expected costs of crime work through two mechanisms: deterrence and incapacitation. The deterrence mechanism is in play whenever a potential offender decides not to incur in criminal activities because she finds the expected costs of crime to be high enough, so that not committing the crime becomes the best alternative. In this case, the crime does not happen. Deterrence can be either specific or general. Specific deterrence happens when a previously punished offender is prevented from committing a crime. General deterrence refers to the case in which potential criminals are deterred because of punishment received by others. The incapacitation mechanism implies that actual punishment takes place and criminals are taken into custody preventing them from committing further crimes. Incapacitation can also be either specific or general. Specific incapacitation happens when a known criminal is imprisoned during her active criminal career. General incapacitation relates to the reduction in the capability of free offenders to incur in criminal activities because of the imprisonment of their associates. Since deterrence actually prevents crimes from taking place, enforcement policies are more effective as long as the deterrence component becomes more relevant (Durlauf and Nagin, 2010).

On a deterrence-based crime prevention approach, the debate on whether resources should be directed at increasing the certainty or severity of punishment has received much attention in the literature. Durlauf and Nagin (2010) present a comprehensive review on this matter. Studies on the effects of variations of the severity of punishment on deterrence have mainly focused on prison sentence length. These studies have found at best, modest deterrent effects of increased sentences ranging from 2% to 4% declines in crime rates in the years following the implementation of such policies (Helland and Tabarrok, 2007; Kessler and Levitt, 1999; Raphael, 2006; Webster et al., 2006; Zimring et al., 2001).[1] Moreover, other studies have found increases in recidivism rates because of longer sentences (Gendreau et al., 1996; Levin, 1971; Song and Lieb, 1993), or serving time in prisons as opposed to less harmful alternatives as electronic monitoring (Di Tella and Schargrodsky, 2013).

On the other hand, there is substantial evidence on the effects that policies intended to increase the certainty of punishment have on deterrence. Most of these studies focus on the deterrent effect of police presence and deployment strategies, that work mainly through the probability of apprehension. Little research is targeted at identifying the deterrent effects of variations on the probability of prosecution given apprehension, or probability of sentencing by the judiciary given prosecution (Durlauf and Nagin, 2010). Results range from about a 3% decrease in total crime following a 10% increase in police presence (Marvell and Moody, 1996; Levitt, 1997), to reductions as high as 75% in vehicle theft (Di Tella and Schargrodsky, 2004), 58% in drug crime events (Weisburd et al., 2006), and 49% in gun crime (Sherman and Rogan, 1995), following deployment strategies as hot spots policing. Policies as increased police presence are mainly focused at raising the objective certainty of punishment. This is, the actual probability of an offender being punished. However, expectations of criminals are not objective, which allows for policies aimed at increasing the subjective beliefs of potential offenders regarding the certainty of punishment. Such policies are associated in the literature with the broken windows hypothesis. This theory was introduced

[1] Larger effects have been found by Kessler and Levitt (1999) five years following the implementation of the policies. However, as more time passes, these effects confound deterrence and incapacitation effects.

by Wilson and Kelling (1982). The idea is that the environment where a potential crime may take place signals enforcement efforts in that particular location. Reductions in crime following order maintenance and environmental interventions as improved lightning and clearance of abandoned buildings, have been found to be as high as a 21.5% decline in the number of police calls (Braga et al., 1999; Braga and Bond, 2008).

The installation of surveillance cameras is an alternative way to increase the expected costs of crime. CCTV systems may cause a deterrent effect on potential offenders through a number of channels. The objective certainty of punishment can rise by means of changes in the probability of apprehension, the probability of prosecution given apprehension, or the probability of sentencing by the judiciary given prosecution. The probability of apprehension increases because of improved surveillance. In turn, the probability of prosecution and sentencing increases because of the possibility to use camera footage as evidence during prosecution and trial. The subjective certainty of punishment may also increase because of improved perception of surveillance by the authorities. Indeed, public perception of the possible uses of CCTV systems is mainly related to an increased probability of catching criminals, scare off potential offenders and make people feel safer because of an improved detection of crimes (Charman and Honess, 1992; Ditton, 2000). A straightforward way to explore the prevailing channel among the objective or subjective certainty of punishment is to look at operational results. This is, whether there is a decline in crime rates following the installation of CCTV systems, but there are no effects on operational results from authorities such as a higher number of apprehensions or drug seizures, the subjective certainty of punishment may be the prevailing channel. The converse is true whenever there are negative effects on crime rates and positive effects on operational results following the implementation of CCTV systems. Furthermore, the severity of punishment could increase whether evidence collected from camera footage results in aggravated sentences. For instance, some judicial systems consider longer prison sentences whenever violence is used in committing a crime. If proof of violence use comes from camera footage, there would be a direct effect on the severity of punishment. In any case, potential effects of CCTV systems on crime rates are context specific and perceptions about their effectiveness may be influenced by socio demographic or cultural characteristics of the public (Charman and Honess, 1992; Ditton, 2000).

Evidence regarding the effects of CCTV systems on crime rates is inconclusive. Welsh and Farrington (2009) present a systematic review of this literature. Aggregate results of interventions in city and town centers suggest a 7% reduction in crime rates following the implementation of CCTV systems, although this effect is not significant. Some evaluations find significant reductions in crime rates ranging from 18% to 57% (Brown, 1995; Skinns, 1998; Armitage et al., 1999; Ditton and Short, 1999; Blixt, 2003; Gill and Spriggs, 2005; Griffiths, 2003). Other studies find significant increases of as high as 24% (Brown, 1995; Winge and Knutsson, 2003; Gill and Spriggs, 2005; Farrington et al., 2007). Two hypotheses are commonly used in assessing increases in crime rates following the installation of CCTV systems in city and town centers. Firstly, it may be that crime reporting rises because of increased recording of crimes. Secondly, CCTV systems could create a false sense of security, which in turn may increase signs of wealth by potential victims. Welsh and Farrington (2009) also present results for CCTV systems used in other urban contexts. Aggregate results for evaluations in public housing and public transport show no significant effects. On the other hand, combined results of evaluations in car parks suggest an average significant reduction of 51% in vehicle crimes. Moreover, all these studies focus on North American or European cities.

3 Data

To study the effects of CCTV systems on crime rates in Medellín-Colombia we use the following data. First, we use the exact dates and installation sites for a group of 366 cameras connected to the CCTV system between April 2013 and October 2014. All cameras can turn 360 degrees horizontally and 270 degrees vertically, have night vision systems and can identify a face within 200 meters. All information regarding cameras and technical facts is from the Information System for Citizen Security of the government of Medellín. Our units of analysis are all street segments within the range of these cameras.[2]

Second, we use monthly data on crimes from the National Police. Crimes are reported with their approximate address and we obtain their geolocation by using geographic information systems.[3] In particular, we use data on homicides, assaults, thefts from person, vehicle thefts, drug traffic and apprehensions. We follow Di Tella and Schargrodsky (2004) and distribute crimes among the nearest street segments whenever they are in or next to a corner. The distribution of these crimes is inversely proportional to their distance to all surrounding street segments. This distribution is intended to account for possible reporting errors on addresses and to accurately distribute crimes reported in corners. Furthermore, in order to gain variance, we follow Mejía et al. (2015) and aggregate crimes by using three indexes: a total crime index built as a weighted average of homicides, assaults, thefts from person and vehicle thefts, using the average sentence (in years) according to the Colombian penal code as weights; a violent crime index built as a weighted average of homicides and assaults; and a property crime index built is a weighted average of thefts from person and vehicle thefts.[4] We also build parallel indexes for apprehensions. In our robustness analyses, we use calls to emergency lines as an alternative measure of crimes. Data on these calls are from the Information System for Citizen Security of the government of Medellín and the National Police.

Table 1 presents summary statistics for monthly crime and apprehension levels at the street segment for the period January 2012 through October 2014. Data includes all street segments within the range of cameras installed between April 2013 and October 2014. For instance, street segments in the sample had an average of 0.004 homicides per month. Drug traffic shows higher average levels

[2] Street segments are blocks of streets between two corners.
[3] Specifically, we use a geolocator add-on for ArcGIS.
[4] The idea in using these weights is that average sentences proxy for social costs of crimes.

for apprehension than crimes. This happens because whenever a drug seizure operation takes place, only one crime is reported but all criminals involved are apprehended. For independent crimes and apprehensions measures there is a substantial proportion of observations with zeros. This situation has consequences over statistical power to perform any regression analysis. Therefore, all analysis in the results section will be restricted to total, violent and property crime aggregated data.

[Table 1 goes about here.]

4 Empirical strategy

We investigate the causal impact of CCTV systems on crime rates in Medellín. This is, we want to know whether there was a decline, rise or no effect on crime levels following the installation of public surveillance cameras. In doing so, we have a restricted sample of all street segments within the range of a group of 366 cameras installed between April 2013 and October 2014. To do so, we propose the following empirical model.

$$y_{it} - y_{it-12} = \beta_0 + \beta_1 D_{it} + \sum_{k=1}^{12} \theta_k + \alpha_i + \gamma_t + \epsilon_{it} \quad (1)$$

where i denotes the street segment and t the time period measured in months. y_{it} and y_{it-12} are levels of crime or apprehension, so that $y_{it} - y_{it-12}$ is the change in levels from one year to the other for a specific month. This difference in levels intends to account for the seasonality of crime and to allow for negative values in the outcome variable. D_{it} is a discrete treatment variable that measures the number of connected cameras for street segment i at time t. θ_k is a dummy variable that controls for month fixed effects. α_i refers to street segment specific effects and γ_t for time fixed effects. Conditional on the exogeneity of camera installation dates with respect to crime levels, the coefficient β_1 is identified using an OLS approach. This coefficient measures the effect for a street segment of installing one more camera with coverage over it. This specification parallels the difference-in-difference estimator for multiple time periods, for a case in which the treatment variable is not dichotomous. For each time period, treated segments would be those with surveillance cameras and control segments would be those without cameras. These groups change month by month as more cameras are installed.

Main Identifying Assumption

As of mid 2015, Medellín has 749 cameras connected to a CCTV system aimed at improving security conditions in the city. 383 cameras were already installed by January 1, 2012. An additional group of 366 cameras were connected to the system between April 2013 and October 2014. These cameras are controlled and monitored by the National Police and the Local Government in the Metropolitan Integrated System for Emergencies and Security. Exact dates of installation and selection procedures for the first group of 383 cameras was not documented. On the contrary, information regarding the second group of 366 cameras has been registered in detail. In this case, the installation procedure consisted in three broad stages.

First, the Information System for Citizen Security of the government of Medellín identified 366 potential places for camera installation. Using quantitative data on the amount and location of historical crimes, the location of previously installed cameras and the number of additional cameras available, a geographic information system suggested the exact location for new installations.[5] Of most importance, these places were not ranked nor prioritized. Second, field teams from the National Police and the Local Government made on-site validation visits in order to determine the exact location for new installations. These teams verified whether there were trees, power cables or other operational problems regarding the installation, and validated the exact places of crime concentration in order to control for potential reporting errors in quantitative data. Finally, there was the administrative process for installation and operationalization of each camera. This stage consisted in five activities: i) Requesting of an installation permit from the Planning Office, which must issue a favorable technical concept regarding the provision of most public goods. ii) Requesting of an installation permit from the Transit Authority. This office must review any public goods that use or interfere with traffic infrastructure such as traffic lights and stop or crossing lines. iii) Requesting of an installation permit from the Environmental Authority whenever the process involved cutting off trees or any other environmental concern. iv) Requesting of power and internet connections from local companies. v) After all other activities were finished, requesting of physical installation and final connectivity tests from local contractors.

As our main identification assumption we argue that, conditional on the restricted sample of all street segments within the range of the second group of 366 cameras, timing of the installation is exogenous to crime levels in those places. Put it differently, the setting creates a quasi-experimental design. We rely on two arguments to support this assumption. Firstly, the quantitative selection for all 366 places did not rank nor prioritized any site. Secondly, timing for all permits and logistics necessary to carry out the installations was mainly driven by bureaucratic activities and bottlenecks in each office. Both arguments were emphasized by officials from the government of Medellín in several interviews between November 2014 and June 2015. Table 2 presents OLS regressions between installation month (counting consecutively from April 2013 onwards) and average crime levels for 2011 and 2012 at installation sites. General results show no correlation between crime levels and timing of the installation.

[Table 2 goes about here.]

[5] Specifically, the SISC office uses Q-GIS, a free and open source geographic information system. It parallels the selection of new points of sale for common businesses, using demand, previously operational points of sale and budget availability for new ones as inputs.

Common Trends Assumption

Whether the common trends assumption is not true, the difference-in-difference estimator is biased. This assumption implies that treated and control groups should have behaved similarly before the surveillance cameras were installed. In our quasi-experiment, all street segments are untreated by March 2013 and treated by October 2014. This implies the common trends assumption needs to be assessed differently. To do so, we estimate equation (1) lagging two and three years all installation dates. Table 3 presents the results. These regressions serve two purposes. First, they imply there were no significant differences between treatment and control groups in the years previous to the installation, i.e. the common trends assumption holds. Second, they are placebo tests implying any differences found using the actual installation dates is not random.

[Table 3 goes about here.]

5 Results

Table 4 presents our main results. The coefficient of our treatment variable is negative and significant in most cases, implying there is a desired effect following the installation of surveillance cameras. These results suggest that, on average, year on year monthly changes in a total crime index are between 0.004 and 0.012 lower (i.e. between 33.3% and 100% of the average total crime index from January 2011 to October 2014 lower) in a street segment following the installation of one camera. As expected, as the sample restricts more to street segments with a higher prevalence of crime, the effects grow in magnitude. Furthermore, year on year monthly changes in property crime are between 0.007 and 0.024 lower (i.e. between 25.9% and 88.9% of the average violent crime index from January 2011 to October 2014 lower) in a street segment following the installation of one camera. For violent crime, only street segments at the 50^{th} superior percentile according to average crime levels for years 2011 and 2012, of those street segments that had any violent crime between May 2013 and April 2014, year on year monthly changes are 0.025 lower (i.e. 625% of the average violent crime index from January 2011 to October 2014 lower) in a street segment following the installation of one camera. Results on violent and property crime suggest that changes in total crime are mainly driven by a decrease in property crime. Conditional on the exogeneity of camera installation dates with respect to crime levels, these effects are causal.

[Table 4 goes about here.]

Effects on Apprehensions

We also investigate whether there is any effect on apprehensions. Table 5 presents the results. For apprehensions on total crime, property crime and violent crime, there are no significant effects following the installation of surveillance cameras. These results may suggest the main channel for

CCTV systems to deter criminals is through the subjective certainty of punishment, i.e. improved perception of surveillance. Any effect on the objective certainty of punishment may have increased apprehensions.

[Table 5 goes about here.]

Crime Displacement or Diffusion of Benefits

Finally, we study whether there is substantial crime displacement or, on the contrary, there is diffusion of benefits to surrounding areas following the installation of surveillance cameras. Table 6 presents the results. Total crime in the three closest street segments surrounding camera installation sites seems to be lower following the installation of surveillance cameras. Furthermore, this effect seems to be driven by a reduction in violent crime, which shows negative and significant effects for both, the three closest and the five closest street segments surrounding installation sites. This diffusion of benefits is relevant in high crime places as the effects are only significant when the sample is restricted to street segments at the 50^{th} superior percentile according to average crime levels for years 2011 and 2012, of those street segments that had any crime between May 2013 and April 2014.

[Table 6 goes about here.]

6 Robustness analyses

There may be several threats to our proposed specification. For instance, effects of surveillance cameras may be random, or correlated to the seasonality on crime rates in previous periods. In this case, results reported in table 3 may also be interpreted as placebo tests for the installation of surveillance cameras. Whether seasonality on crime rates somehow coincided with camera installation months, lagging camera installations two or three years should result in significant and negative coefficients. These placebo tests support our specification.

Also, these effects may be induced by the *ad-hoc* aggregation of crime data per month. Table 7 presents results for crime data aggregated by week and bimester. Coefficients for the treatment variable remain negative and significant for most cases, paralleling our baseline results.

[Table 7 goes about here.]

7 Conclusions

In this paper, we investigate whether there is a decline on crime rates following the installation of surveillance cameras. To do so, we benefit from a quasi-experiment that took place in the installation of 366 cameras from April 2013 through October 2014 in the city of Medellín-Colombia. We highlight three main findings.

First, there is a decline in total crime following after the installation of the CCTV system. On average, year on year monthly changes in a total crime index are between 0.004 and 0.012 lower (i.e. between 33.3% and 100% of the average total crime index from January 2011 to October 2014 lower) in a street segment following the installation of one camera. This effect seems to be driven mainly by a decline in property crime. Second, we find no significant effects on apprehensions following the installation of surveillance cameras. These results may suggest the main channel for CCTV systems to deter criminals is through the subjective certainty of punishment, i.e. improved perception of surveillance. Third, we do not find crime displacement effects after the installation of CCTV systems. Instead, we find diffusion of benefits to the street segments surrounding installation sites when we restrict our sample to high crime places. This diffusion of benefits seems to be driven by a reduction in violent crime. This evidence shed light on contradictory results found in previous studies.

Further work in the evaluation of CCTV systems should pursue several issues. For instance, although we find suggestive evidence on the prevailing channel for CCTV systems to work, there is need to specifically disentangle the effects amid the subjective certainty of punishment perceived by potential offenders, the objective certainty of punishment in its components: probability of apprehension, probability of prosecution given apprehension, and probability of conviction given prosecution; and the severity of punishment. Also, there is need to further understand the potential negative effects that CCTV systems may have on the confidence relationship between the state and its citizens.

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Table 1: Summary statistics.

	Mean	S.D.	Min	Max	Obs. with zero
Crimes					
Homicide	0.004	0.045	0.000	2.000	98.8%
Assault	0.007	0.065	0.000	2.000	97.7%
Theft from person	0.022	0.143	0.000	7.690	94.4%
Vehicle theft	0.029	0.129	0.000	4.000	90.9%
Drug traffic	0.059	0.367	0.000	13.145	91.3%
Total crime	0.012	0.044	0.000	1.100	84.2%
Violent crime	0.004	0.040	0.000	1.660	96.7%
Property crime	0.027	0.101	0.000	2.653	86.4%
Apprehensions					
Homicide	0.002	0.034	0.000	2.000	99.5%
Assault	0.005	0.056	0.000	3.997	98.6%
Theft from person	0.013	0.111	0.000	6.114	96.9%
Vehicle theft	0.001	0.027	0.000	2.000	99.5%
Drug traffic	0.063	0.388	0.000	13.395	90.9%
Total apprehensions	0.003	0.025	0.000	1.212	95.0%
Violent crime apprehensions	0.002	0.030	0.000	1.830	98.1%
Property crime apprehensions	0.005	0.042	0.000	2.109	96.4%
Observations		58,412			

Notes: Summary statistics for monthly crime and apprehension levels at the street segment for the period January 2011 through October 2014. Data includes all street segments within the range of cameras installed between April 2013 and October 2014. Average crime and apprehension levels are estimated from geolocated data on crime from the National Police. Total crime is a weighted average of homicides, assaults, thefts from person and vehicle thefts, using the average sentence (in years) according to the Colombian penal code as weights. Violent crime is a weighted average of homicides and assault. Property crime is a weighted average of theft from person and vehicle theft. Aggregated data on crime is weighted using the same rule.

Table 2: OLS regressions between installation month and average crime levels for 2011 and 2012 at installation sites.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Homicide (avg. 2011-2012)	-5.983							
	[5.511]							
Assault (avg. 2011-2012)		-10.215*						
		[5.484]						
Theft from person (avg. 2011-2012)			3.082					
			[2.106]					
Vehicle theft (avg. 2011-2012)				0.109				
				[1.593]				
Drug traffic (avg. 2011-2012)					-0.136			
					[0.290]			
Total crime (avg. 2011-2012)						-1.327		
						[4.859]		
Property crime (avg. 2011-2012)							1.204	
							[2.121]	
Violent crime (avg. 2011-2012)								-8.094
								[6.048]
Neighborhood dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1736	1736	1736	1736	1736	1736	1736	1736
F test	24.225	24.245	24.204	24.200	24.273	24.201	24.238	24.207

Robust standard errors in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variable is installation month counting consecutively from April 2013 onwards. All regressions include a non reported constant. Regressors are average levels of crime for the period prior to installations. Data for installation months is from the Information System for Citizen Security of the government of Medellín. Average crime levels are estimated from geolocated data on crime from the National Police. Construction of aggregate crime data is explained in section 3.

Table 3: Regressions lagging two and three years all installation dates.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Installation dates lagged two years						*Installation dates lagged three years*					
	Total crime Sample 1	Total crime Sample 2	Property crime Sample 1	Property crime Sample 2	Violent crime Sample 1	Violent crime Sample 2	Total crime Sample 1	Total crime Sample 2	Property crime Sample 1	Property crime Sample 2	Violent crime Sample 1	Violent crime Sample 2
Treatment	0.000	0.000	0.000	0.000	0.001	0.003	-0.000	-0.001	-0.002	-0.004	0.001	0.001
	[0.002]	[0.002]	[0.003]	[0.005]	[0.002]	[0.006]	[0.001]	[0.002]	[0.002]	[0.004]	[0.001]	[0.005]
Street segment fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month of year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19704	12576	19704	10956	19704	5340	19704	11664	19704	9804	19704	5196
Groups	1642	1048	1642	913	1642	445	1642	972	1642	817	1642	433
F test	2.029	1.889	4.610	5.034	1.913	2.069	3.565	4.215	4.126	6.387	2.184	2.399
p-value F test	0.024	0.039	0.000	0.000	0.036	0.026	0.000	0.000	0.000	0.000	0.014	0.009

Robust standard errors in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variables are total crime, property crime and violent crime as stated above. We use the fixed effect estimator in all regressions. Columns (1) through (6) have all installation dates lagged two years. Columns (7) through (12) have all installation dates lagged three years. For each regression, data covers one year ranging from May 2011 or May 2010, to April 2012 or April 2011 respectively. Street segments that were in range of any previously installed camera by April 2013 were excluded. Odd columns include the whole sample (Sample 1). Even columns include only street segments for which there was any crime during the time period included in the regression (Sample 2). All regressions include a non reported constant. Data for installation months is from the Information System for Citizen Security of the government of Medellín. Crime levels are estimated from geolocated data on crime from the National Police. Construction of aggregate crime data is explained in section 3.

Table 4: Baseline results.

	(1) Total crime Sample 1	(2) Total crime Sample 2	(3) Total crime Sample 3	(4) Property crime Sample 1	(5) Property crime Sample 2	(6) Property crime Sample 3	(7) Violent crime Sample 1	(8) Violent crime Sample 2	(9) Violent crime Sample 3
Treatment	-0.004**	-0.006**	-0.012**	-0.007*	-0.012**	-0.024*	-0.002	-0.005	-0.025*
	[0.002]	[0.002]	[0.005]	[0.004]	[0.005]	[0.012]	[0.002]	[0.005]	[0.014]
Street segment fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month of year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19704	14292	5208	19704	13056	4584	19704	7284	1632
Groups	1642	1191	434	1642	1088	382	1642	607	136
F test	3.538	4.113	5.463	2.496	3.013	5.139	0.889	0.894	3.899
p-value F test	0.000	0.000	0.000	0.005	0.001	0.000	0.559	0.555	0.000

Robust standard errors in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variables are total crime, property crime and violent crime as stated above. We use the fixed effect estimator in all regressions. For each regression, data covers one year ranging from May 2013 to April 2014. Street segments that were in range of any previously installed camera by April 2013 were excluded. Columns (1), (4) and (7) include the whole sample (Sample 1). Columns (2), (5) and (8) include only street segments for which there was any crime during the time period included in the regression (Sample 2). Columns (3), (6) and (9) include the 50^{th} percentile and above for average crime levels for years 2011 and 2012, using Sample 2 (Sample 3). All regressions include a non reported constant. Data for installation months is from the Information System for Citizen Security of the government of Medellín. Crime levels are estimated from geolocated data on crime from the National Police. Construction of aggregate crime data is explained in section 3.

Table 5: Effects on apprehensions.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Apprehensions in street segment and three closest neighbors						*Apprehensions in street segment and five closest neighbors*					
	Total crime Sample 1	Total crime Sample 2	Property crime Sample 1	Property crime Sample 2	Violent crime Sample 1	Violent crime Sample 2	Total crime Sample 1	Total crime Sample 2	Property crime Sample 1	Property crime Sample 2	Violent crime Sample 1	Violent crime Sample 2
Treatment	0.000	0.001	0.000	0.003	-0.000	0.001	0.000	0.001	0.000	0.002	0.000	0.002
	[0.000]	[0.001]	[0.000]	[0.003]	[0.000]	[0.003]	[0.000]	[0.001]	[0.000]	[0.003]	[0.000]	[0.003]
Street segment fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month of year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	55800	13104	55800	9816	55800	6468	70968	14832	70968	10920	70968	7104
Groups	4650	1092	4650	818	4650	539	5914	1236	5914	910	5914	592
F test	1.912	3.094	1.783	2.871	1.623	3.036	1.915	2.923	1.647	2.301	1.878	3.671
p-value F test	0.033	0.001	0.051	0.001	0.086	0.001	0.033	0.001	0.079	0.010	0.037	0.000

Robust standard errors in brackets

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variables are apprehensions for total crime, property crime and violent crime as stated above. We use the fixed effect estimator in all regressions. For each regression, data covers one year ranging from May 2013 to April 2014. Columns (1) through (6) include apprehensions at each treated street segment and the three closest neighbors. Columns (7) through (12) include apprehensions at each treated street segment and the five closest neighbors. Street segments that were in range of any previously installed camera by April 2013 were excluded. Odd columns include the whole sample (Sample 1). Even columns include only street segments for which there was any crime during the time period included in the regression (Sample 2). All regressions include a non reported constant. Data for installation months is from the Information System for Citizen Security of the government of Medellín. Crime levels are estimated from geolocated data on crime from the National Police. Construction of aggregate crime data is explained in section 3.

Table 6: Crime displacement or diffusion of benefits.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
					Three closest neighbors									*Five closest neighbors*				
	Total crime Sm. 1	Total crime Sm. 2	Total crime Sm. 3	Prop. crime Sm. 1	Prop. crime Sm. 2	Prop. crime Sm. 3	Vio. crime Sm. 1	Vio. crime Sm. 2	Vio. crime Sm. 3	Total crime Sm. 1	Total crime Sm. 2	Total crime Sm. 3	Prop. crime Sm. 1	Prop. crime Sm. 2	Prop. crime Sm. 3	Vio. crime Sm. 1	Vio. crime Sm. 2	Vio. crime Sm. 3
Treatment	-0.001	-0.001	-0.006**	-0.000	-0.001	-0.011	-0.001	-0.003	-0.024***	-0.000	-0.000	-0.001	0.000	0.001	0.001	-0.000	-0.002	-0.015*
	[0.000]	[0.001]	[0.003]	[0.001]	[0.003]	[0.008]	[0.000]	[0.002]	[0.008]	[0.000]	[0.001]	[0.002]	[0.001]	[0.002]	[0.005]	[0.000]	[0.002]	[0.008]
Street segment f.e.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month of year f.e.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	60144	26760	8004	60144	22152	6540	60144	11076	1968	82188	36624	10572	82188	30168	8484	82188	15156	2688
Groups	5012	2230	667	5012	1846	545	5012	923	164	6849	3052	881	6849	2514	707	6849	1263	224
F test	4.337	5.698	6.305	4.451	6.459	8.909	1.722	2.235	12.767	4.456	5.778	6.527	5.393	7.946	13.515	1.282	1.611	9.494
p-value F test	0.000	0.000	0.000	0.000	0.000	0.000	0.062	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.229	0.090	0.000

Robust standard errors in brackets
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variables are total crime, property crime and violent crime as stated above. We use the fixed effect estimator in all regressions. For each regression, data covers one year ranging from May 2013 to April 2014. Columns (1) through (9) include crime at the three closest non treated street segments for each treated one. Columns (10) through (18) include crime at the three closest non treated street segments for each treated one. Street segments that were in range of any previously installed camera by April 2013 were excluded. Columns (1), (4), (7), (10), (13) and (16) include the whole sample (Sample 1). Columns (2), (5), (8), (11), (14) and (17) include only street segments for which there was any crime during the time period included in the regression (Sample 2). Columns (3), (6), (9), (11), (15) and (18) include the 50^{th} percentile and above for average crime levels for years 2011 and 2012, using Sample 2 (Sample 3). All regressions include a non reported constant. Data for installation months is from the Information System for Citizen Security of the government of Medellín. Crime levels are estimated from geolocated data on crime from the National Police. Construction of aggregate crime data is explained in section 3.

Table 7: Robustness analyses. Crimes aggregated by week and bimester

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Crimes aggregated by week						*Crimes aggregated by bimester*					
	Total crime	Total crime	Property crime	Property crime	Violent crime	Violent crime	Total crime	Total crime	Property crime	Property crime	Violent crime	Violent crime
	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
Treatment	-0.001*	-0.001**	-0.002*	-0.003**	-0.000	-0.000	-0.006	-0.008*	-0.016*	-0.027**	-0.001	0.000
	[0.000]	[0.000]	[0.001]	[0.001]	[0.000]	[0.001]	[0.004]	[0.005]	[0.009]	[0.013]	[0.004]	[0.010]
Street segment fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week or bimester fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	129955	91798	129955	83898	129955	45504	9852	7146	9852	6528	9852	3642
Groups	1645	1162	1645	1062	1645	576	1642	1191	1642	1088	1642	607
F test	2.553	3.475	3.020	3.778	2.291	4.860	3.328	3.741	3.499	4.198	0.968	0.792
p-value F test	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.002	0.003	0.001	0.448	0.578

Robust standard errors in brackets
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variables are total crime, property crime and violent crime as stated above. We use the fixed effect estimator in all regressions. For each regression, data covers one year ranging from May 2013 to April 2014. Columns (1) through (6) aggregate crime data by week. Columns (7) through (12) aggregate crime data by bimester. Street segments that were in range of any previously installed camera by April 2013 were excluded. Odd columns include the whole sample (Sample 1). Even columns include only street segments for which there was any crime during the time period included in the regression (Sample 2). All regressions include a non reported constant. Data for installation months is from the Information System for Citizen Security of the government of Medellín. Crime levels are estimated from geolocated data on crime from the National Police. Construction of aggregate crime data is explained in section 3.