Is Crime Displacement Inevitable?
Evidence from Police Crackdowns in Fortaleza, Brazil

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Motivation and Background

- Based on Becker's (1968) model, most of the crime economics literature focuses on the estimation of the "deterrent effect"

  - e.g., Levitt (AER 1997,2002), Di Tella and Schargrodsky (AER 2004), Klick and Tabarrok (J. Law. Econ. 2005), Draca, Machin, and Witt (AER 2011), Chalfin and Mccrary (Restat 2018), among others

- It is already painful to properly establish the causal effect of police on crime due to simultaneity, **and displacement of criminal activities is often ignored**

- Those "more cops, less crime" studies have no words on what exactly extra cops do on the streets

- This study seeks to evaluate one of the most common policing strategies in Brazil: the allocation of blitzes

  - Large-scale intervention: 3,423 blitzes over 2012-2013 (20% of the city treated at least once)

  - Spatio-temporal disaggregation allows the estimation of full impacts, which include direct effects and displacement or diffusion of benefits

- The intervention takes place in a large and growing city in a Developing country

  - Well defined place-based intervention with precise policing assignment that could be replicated in other major cities

Fortaleza-CE, Brazil   *The intervention*   *Blitzes Types*

- Fortaleza is the fifth largest Brazilian city and is the state capital of Ceará, located in the Northeast region of the country

- The city has 120.6 sq mi of territorial area and population around 2.7 million - similar to Houston and Chicago

  - From 2010 to 2020, Fortaleza's population grew by 10%

- Among major Brazilian cities and during the past decade, Fortaleza consistently shows up in the top 5 in terms of homicide rates

	City	State	Region	Homicide Rates 2012	Homicide Rates 2022
1	Salvador	BA	NE	61.6	66.4
2	Macapá	AP	N	36.0	55.8
3	Manaus	AM	N	54.0	55.7
4	Porto Velho	RO	N	40.1	47.6
5	Fortaleza	CE	NE	71.5	45.3
6	Recife	PE	NE	40.2	44.7
7	Aracaju	SE	NE	41.9	41.8
8	Maceió	AL	NE	78.3	41.5
9	Teresina	PI	NE	35.7	40.4
10	Boa Vista	RR	N	27.0	39.2
11	Natal	RN	NE	48.9	36.9
12	Palmas	TO	N	18.5	32.0
13	Porto Alegre	RS	S	36.9	29.0
14	Vitória	ES	SE	38.2	28.5
15	São Luís	MA	NE	52.7	27.2
16	Belém	PA	N	54.1	26.5
17	Rio Branco	AC	N	27.8	25.8
18	João Pessoa	PB	NE	65.1	23.5
19	Rio de Janeiro	RJ	SE	20.6	21.3
20	Curitiba	PR	S	32.7	21.0
21	Campo Grande	MS	CO	21.7	19.8
22	Belo Horizonte	MG	SE	35.0	17.6
23	Goiânia	GO	CO	45.5	16.1
24	São Paulo	SP	SE	16.3	15.4
25	Cuiabá	MT	CO	42.2	15.2
26	Brasília	DF	CO	35.1	13.0
27	Florianópolis	SC	S	14.0	8.9

Source: IPEA and Cerqueira e Bueno (2024).
Brazil has 27 sates and a Federal District (Brasília) grouped into five different geographical regions, i.e. Northeast (NE), North (N), Southeast (SE), Center-West (CO) and South (S).

The Intervention

- A blitz interrupts the flow of vehicles and people through a physical, visual, and audible warning. Police officers proceed with checks and inspections in selected targets

- This sudden increase in policing (5-10 policemen) in a street segment usually lasts between 3 and 6 hours

- The Bureau of Police Operations met every Friday to decide where to allocate blitzes in the following week. That decision was mainly based on the past spatial distribution to create residual deterrence

(a) Blitz with policemen only

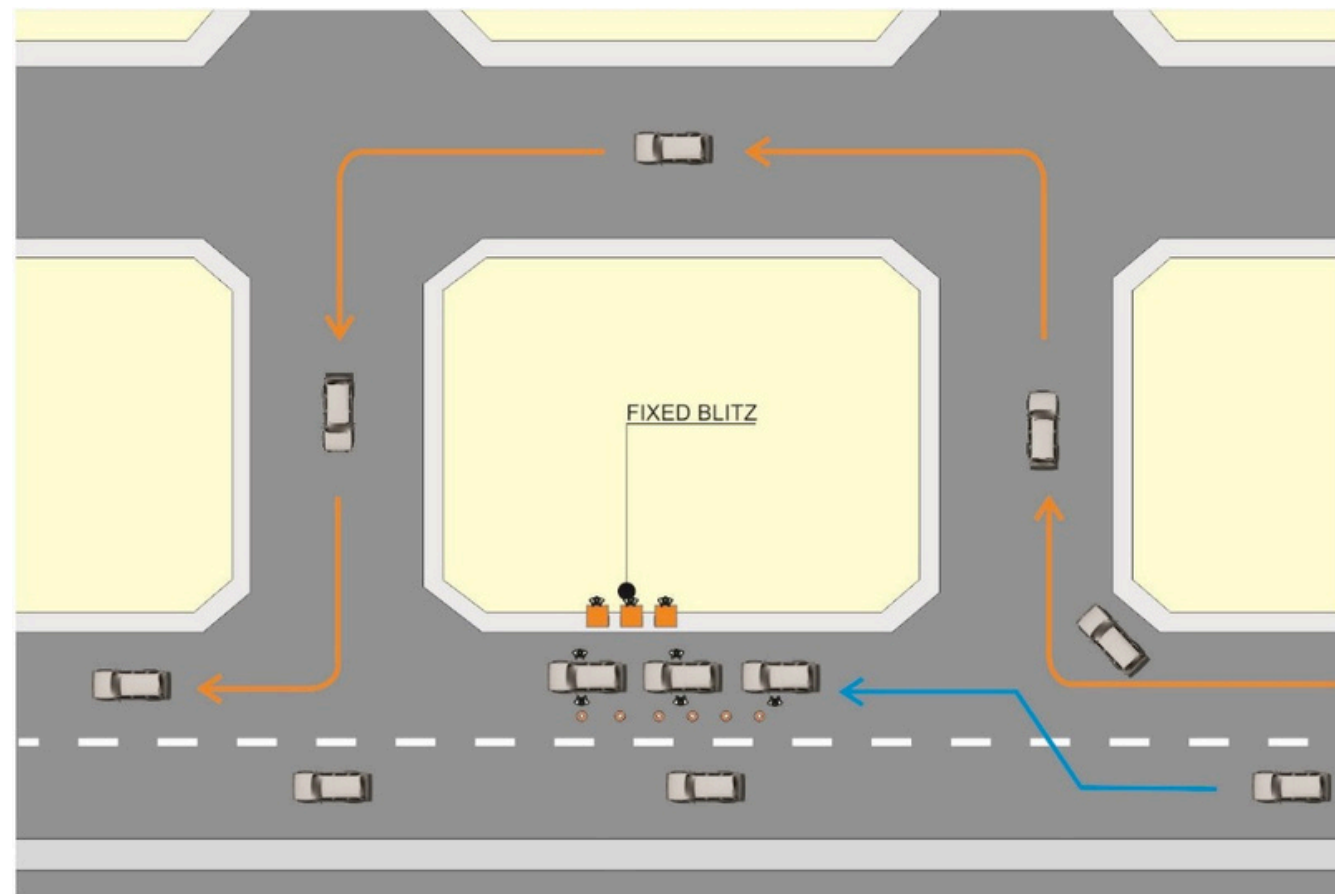(b) Blitz with policemen and transit authorities

(c) "Stop-and-Frisk" Blitz

(d) Blitz during 2024 Brazilian Carnival

Fixed Operation
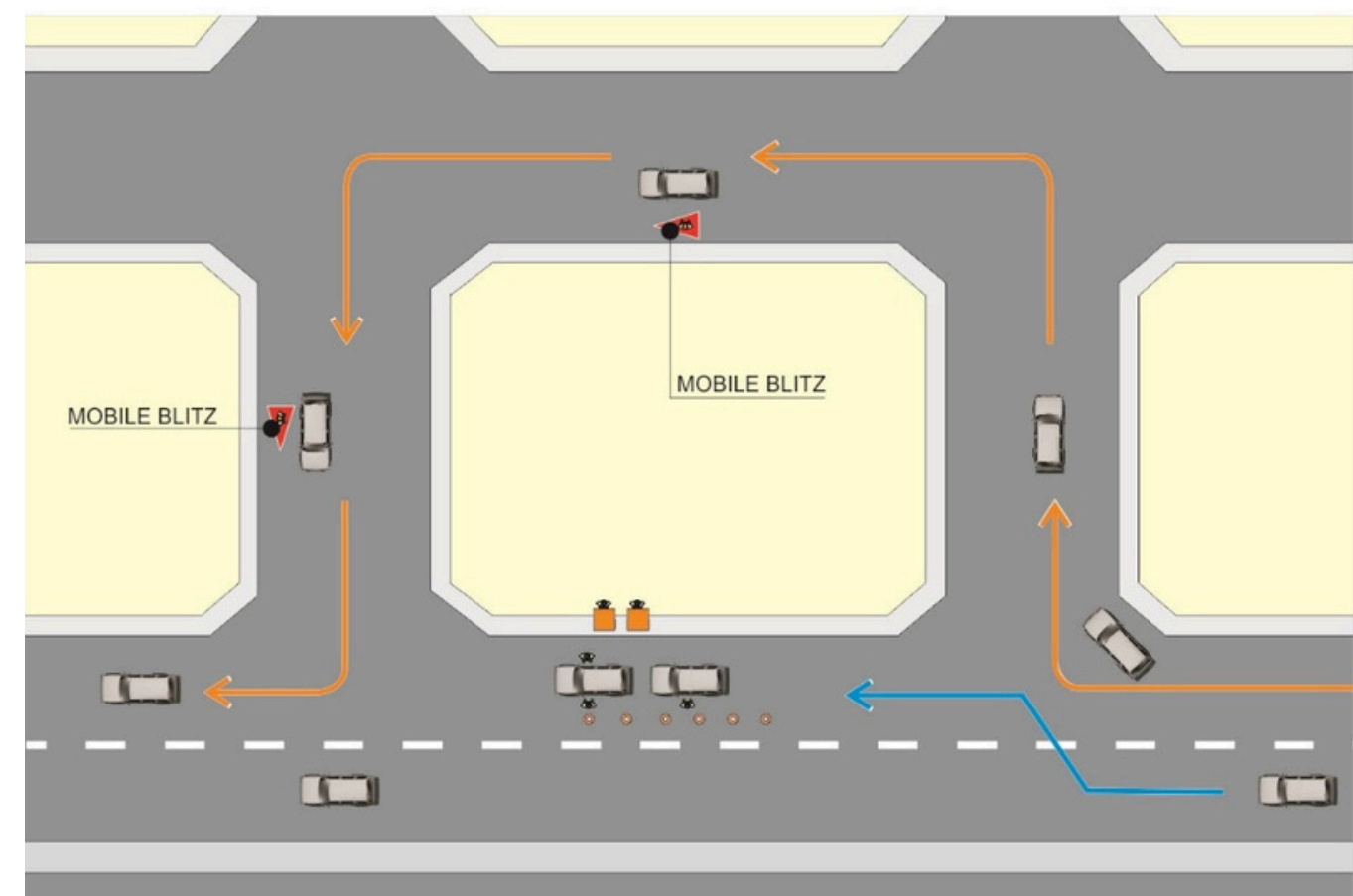

Mobile Operation

Contributions

- **The novelty of our analysis comprises at least 4 dimensions:**

  - Assessing total impacts (direct and indirect) of a well-defined and large-scale police operation

    - Between 2012 and 2013, we identified 3,423 unexpected blitzes - this represents more than 19,000 hours of diligent police work on the streets over two years - and 68,243 violent crimes across street segments of Fortaleza

  - Using as empirical benchmark a combination of 5 disaggregated and precisely measured GPS crime data coupled with PINGs related to police blitzes spatial and time dynamics

  - Estimating the presence of spatial displacement by incorporating inverse distance weight matrices that identify suitable catchment areas that include nearby, intermediate, and distal crime movements

    - We fill Fortaleza's area with a hexagonal spatial grid of 2,526 cells, where each cell has an area of 0.126 km2 (0.049 square miles)

    - To estimate policing spillovers, we build 2,562 by 2,562 spatial weight matrices based on the inverse distance of cells' centroids to each other

  - Measuring temporal displacement or lasting deterrent effects of place-based interventions by exploiting the high frequency of the data using multiple temporal lags

- Fortaleza-CE commonly ranks as one of the most violent cities in the world, with homicide rates close to Cali-COL, St Louis-USA, New Orleans-USA, and Baltimore-USA

- Between 2004 and 2015, homicide rates more than double. Many factors contributed to the violence escalation: from a police strike at the end of 2011 to the rise of crime syndicates

- In 2019 the city managed to cut murder rates by more than 50%, compared to the previous year. However, in February 2020, the Military Police went on a general strike again, and the State went back to the top of the murder rates ranking
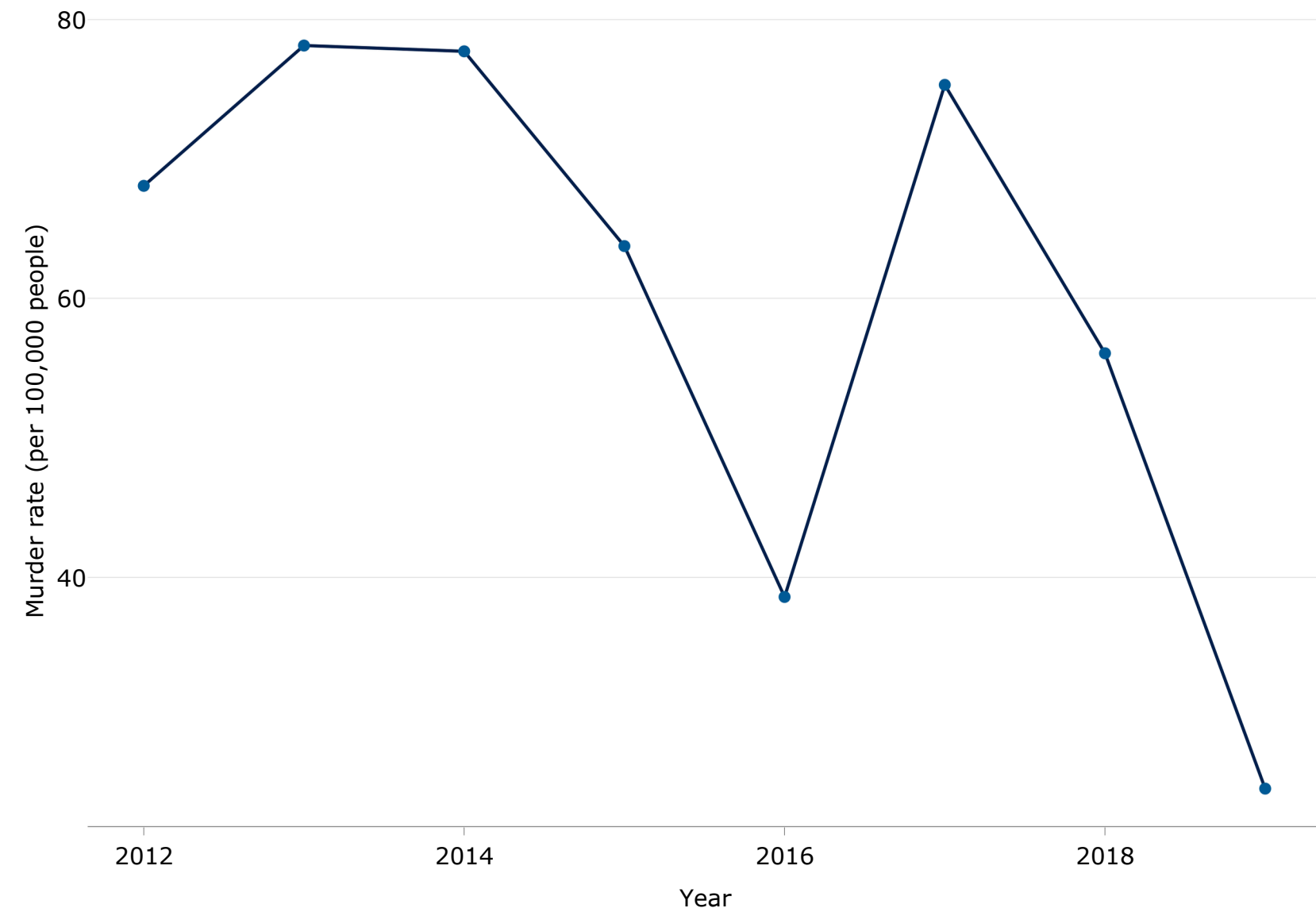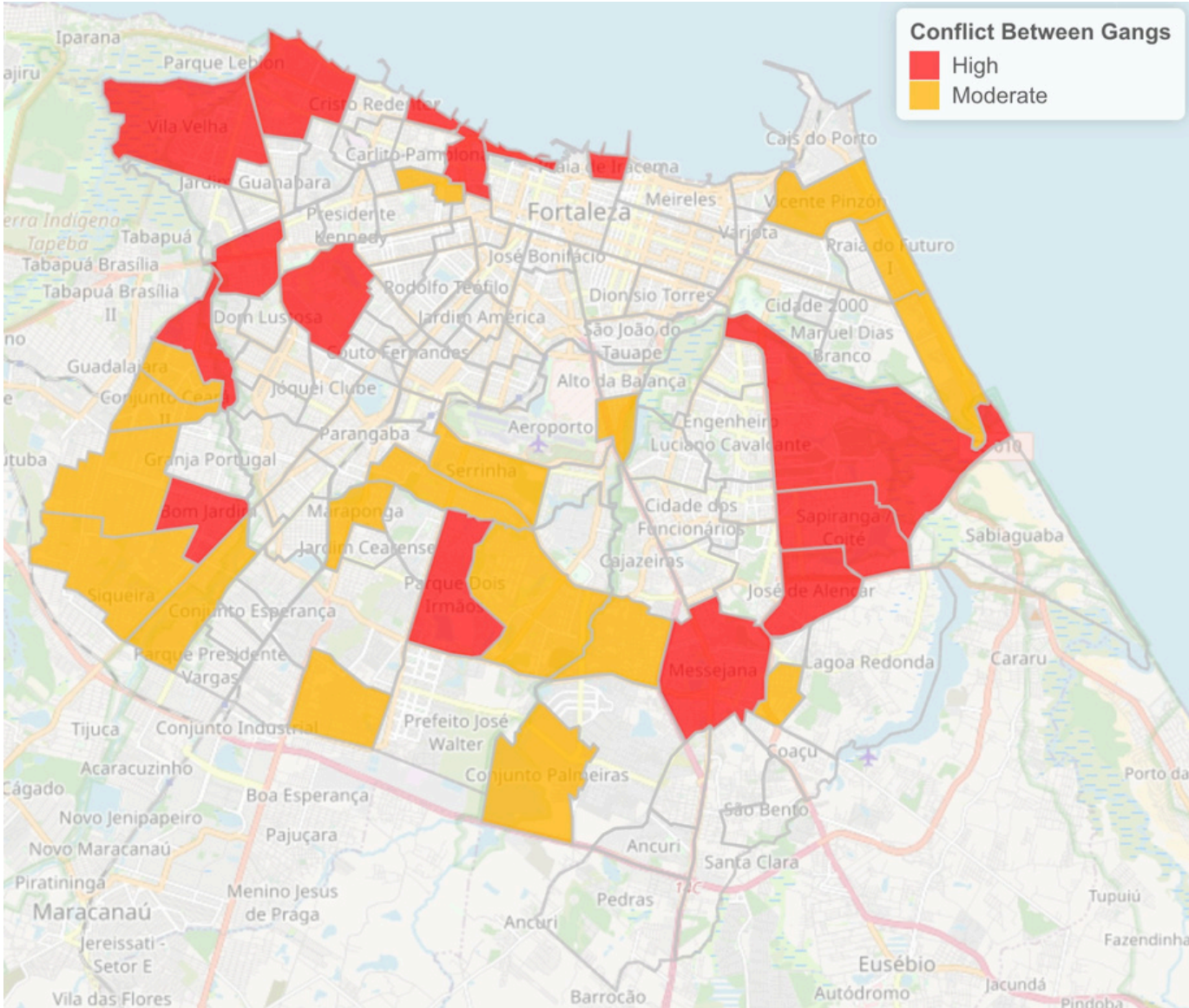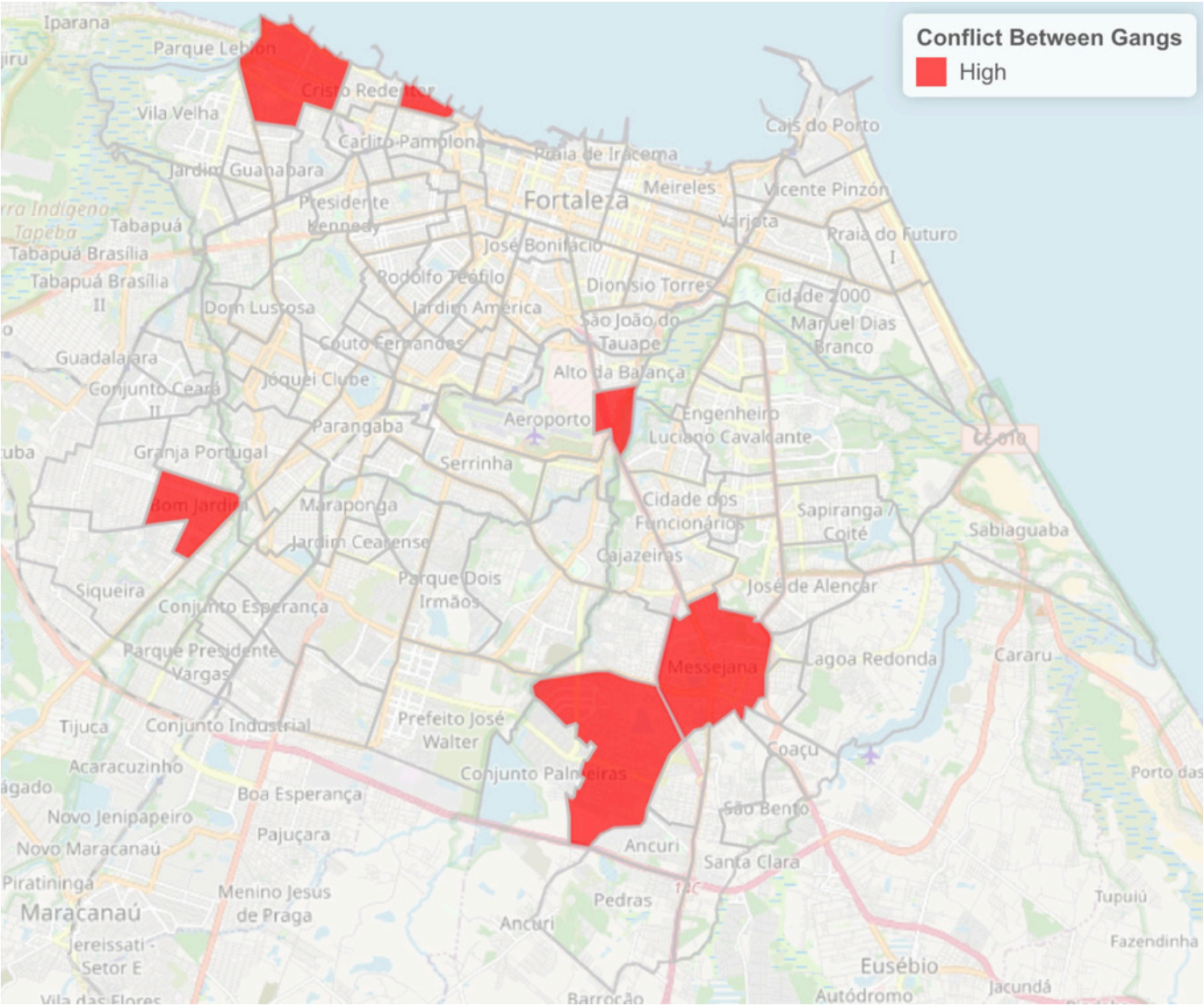
Data and Context

- The State Secretariat of Public Security (SSPDS-CE) shared records of all registered robberies and murders between Jan 1st, 2012 and Dec 21st, 2013. The outcome analyzed is violent crimes, which adds up homicides and robberies

  - Using Google Maps API, we could geolocate 69,243 violent crimes - 3,383 murders, and 65,860 robberies had all the information necessary to get relatively precise coordinates.

- Violent crimes have also a day-time stamp, which we use to aggregate the data into four periods of six hours: morning, afternoon, night and dawn.
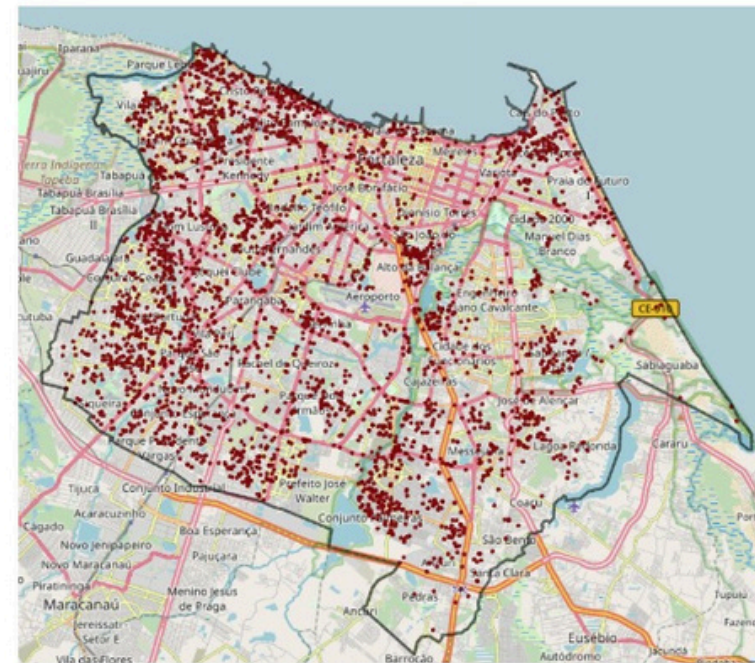

(a) Murders
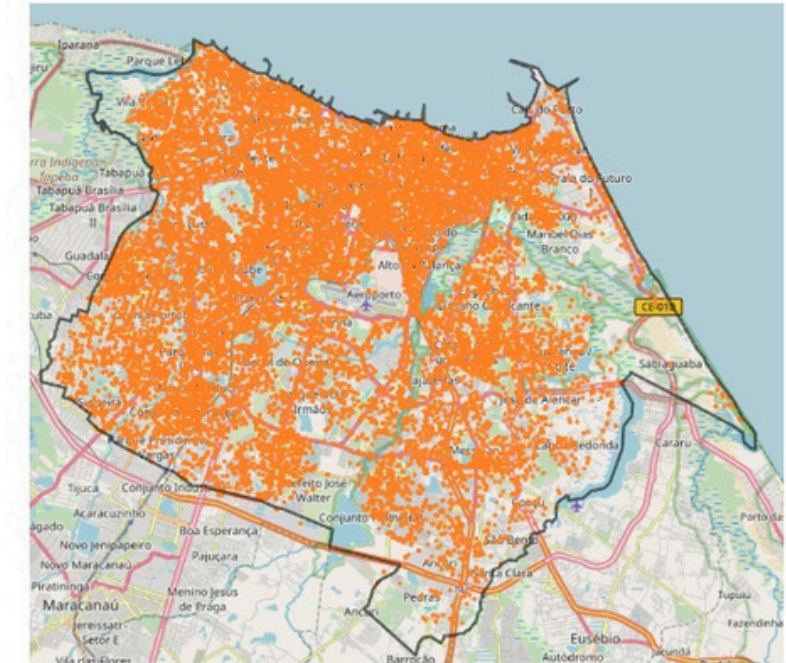
(b) Robberies

8

Data and Context

- The State Secretary of Public Security provided information about the universe of blitzes in Ceara state during 2012 and 2013. The first intervention occurred in January 9th, 2012, and the last in December 15th, 2013.

- Most records have the exact times the blitz started and ended, full street addresses, and numbers of officers and police vehicles allocated. Information about cars and motorcycles stopped and vehicles, weapons, and drugs seized is also available.

- A total of 3,423 interventions could be geolocated within Fortaleza's boundaries, adding to 19,085 police work, or 27 hours of policing per day.
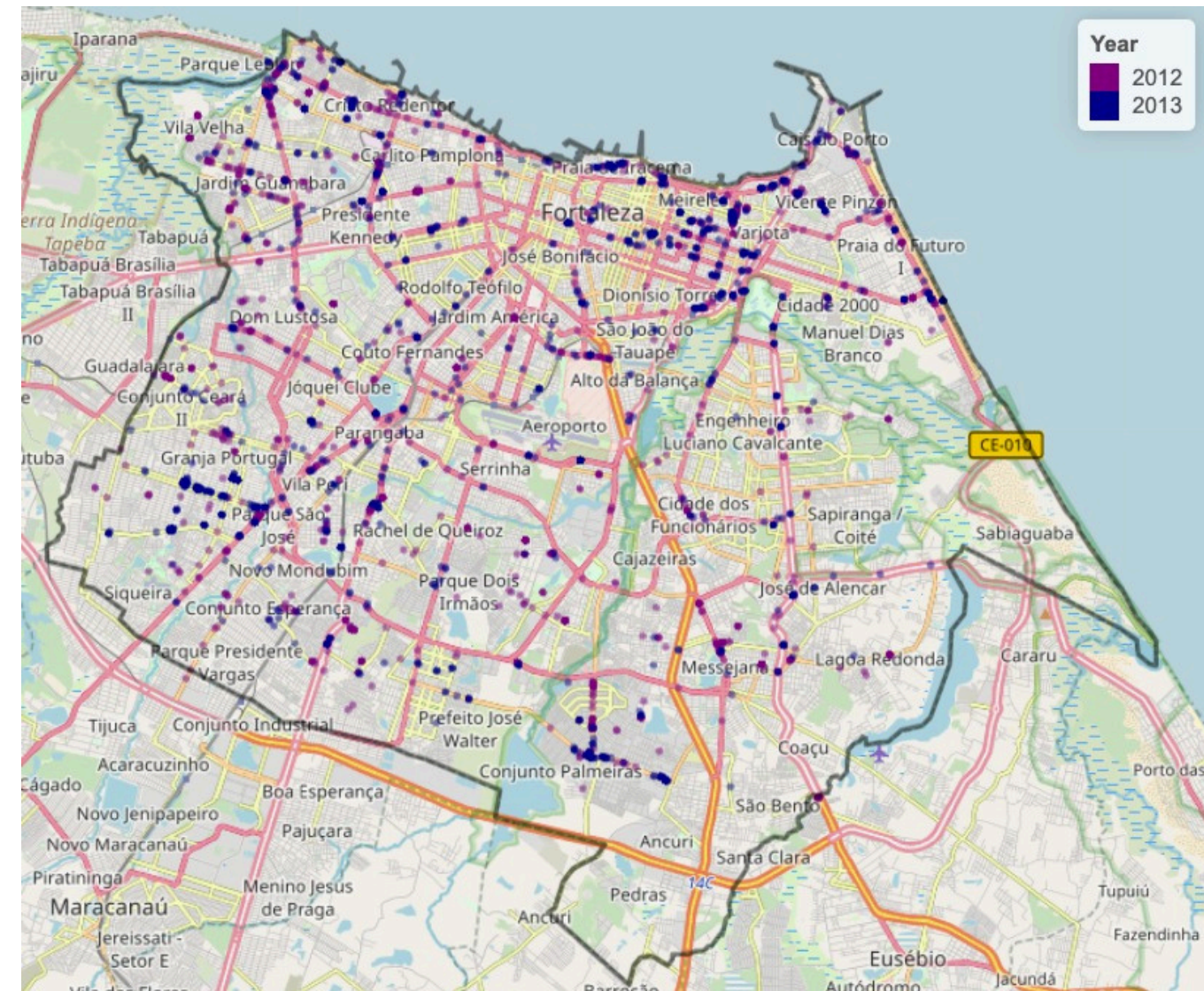
- We fill Fortaleza's area with a hexagonal spatial grid with 2,526 cells, where each cell has an area of 0.126 square km (0.049 square miles), covers around 943 people, on average, and has a very similar size to regular census tracts. We locate both violent crimes and Blitzes within hexagons' boundaries
- In general, cells aggregate 3-6 fragments of street segments, and this high resolution allows the estimation of spatial spillovers and curbs minor measurement errors that naturally arise in georeferenced data
- The days from January 1st, 2012 to December 21th, 2013 are divided into four periods of six hours: morning, afternoon, night and dawn, and a balanced panel with 7,388,808 rows is constructed.
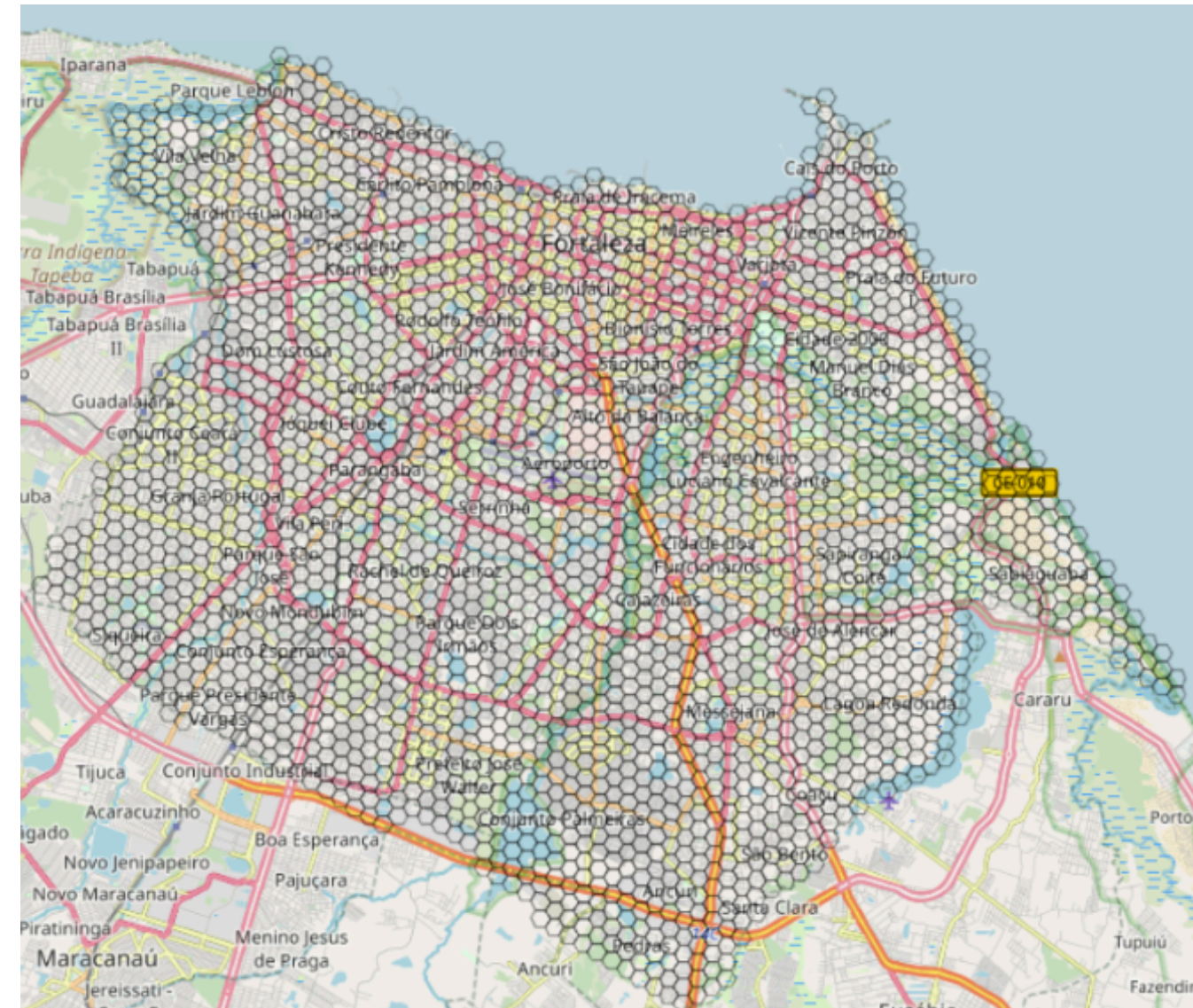
Identification and Estimation

Direct and Indirect Effects | **Modelling Spillovers**

- As mentioned before, it is challenging to disentangle the effect of police on crime. I deal with the simultaneity using police crackdowns that essentially tried to surprise drivers in space and time and do not depend on shocks to crime levels. The reduced-form model that captures the direct effect of the increase in policing on crime:

$$ln(\lambda_{idt}) = \delta Blitz_{idt} + \theta Blitz_{idt}^2 + \rho W Blitz_{idt} + \Gamma lag(Blitz_{idt}, dt - j) + c_{ipw} + \alpha_d + \varepsilon_{idt}$$

- The use of Poisson distribution is justified because the dependent variable $\mathbf{Crime}_{idt}$ is the number of crime occurrences (count variable) measured at cell i and day-time of day dt. $Blitz_{idt}$ refers to the number of hours spent by police officers in cell i at day-time of day dt, $W Blitz_{idt}$ is the weighted average of blitzes hours in the surrounding area of hexagon i at day-time of day dt, and $lag(Blitz_{idt}, dt - j)$ represents the hours of policing work at cell i at day-time of day $dt - j$

- Conditional on daily and cell-by-day-of−week-by-time-of-day fixed effects, the allocation of blitzes in a small area (0.126km²) at a given hour of day is treated as good as random and used to identify the causal effect of local police interventions on crime. We rule out simultaneity exploiting the design of the intervention

Direct and Indirect Effects | **Modelling Spillovers**

- The main neighborhood specification considers a spatial weight matrix (W) that is based on the inverse distance of the cells' centroids. Distance cutoffs set the "areas of influence" of the police intervention

- The weights of the W matrix are defined as $wij = \frac{1}{dij}$, where dij is the distance between census tracts i and j

- To capture residual deterrence and temporal displacement, the reduced-form model incorporates part of the history of blitzes with temporal lags of hours spent by police in the past days (distributed lag model)
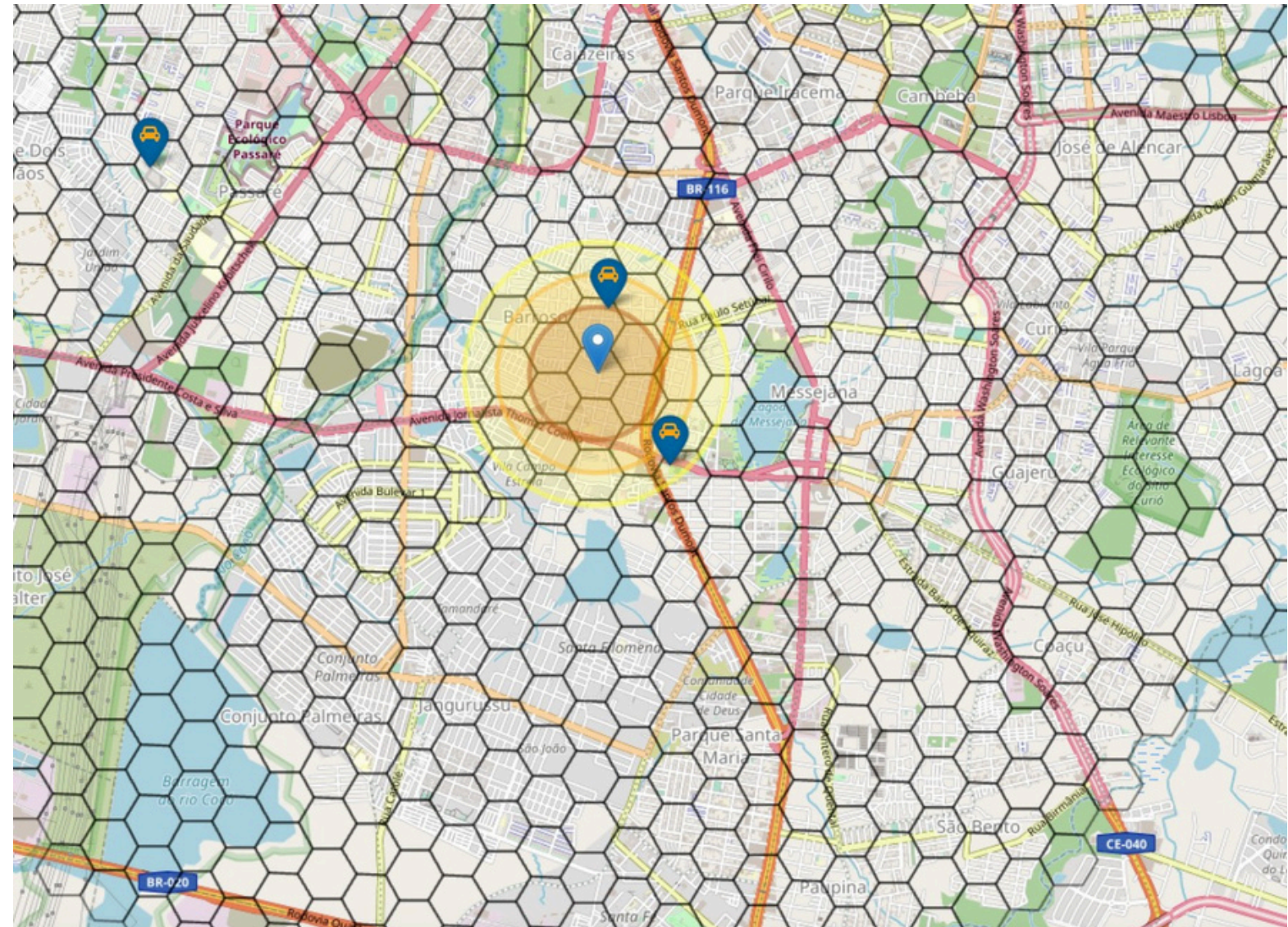
- Blitzes have a meaningful and statistically significant direct effect on violent crime occurrences: **an additional hour spent by this policing assignment causes an average decrease of 21% on daily crime counts in cells at a given 6-hour period of day.**

- **There are diminishing returns of public safety to hours spent by the police in a single area**

- We do not find spatial displacement/diffusion of benefits

- There is a small temporal displacement in the next 6 hours after an intervention, but residual deterrence cancels it in the next 2-3 days

	Dependent Variable: Violent Crimes Occurrences				
	Binary Contiguous (1)	500 meters (2)	750 meters (3)	1 km (4)	1.5 km (5)
Blitz	-0.2814 (0.1360)**	-0.2815 (0.1360)** {0.1271}**	-0.2809 (0.1360)** {0.1305}**	-0.2808 (0.1360)** {0.1221}**	-0.2809 (0.1360)** {0.1376}**
Blitz^2	0.0463 (0.0250)*	0.0463 (0.0250)* {0.0236}*	0.0462 (0.0250)* {0.0240}*	0.0461 (0.0250)* {0.0224}**	0.0461 (0.0250)* {0.0254}*
W Blitz	0.0072 (0.0611)	0.0085 (0.0635) {0.0701}	-0.0413 (0.0885) {0.0924}	-0.0529 (0.1046) {0.1213}	-0.0816 (0.1760) {0.2398}
lag(*Blitz*,1)	0.0638 (0.0295)**	0.0638 (0.0295)** {0.0319}**	0.0639 (0.0295)** {0.0344}*	0.0638 (0.0295)** {0.0341}*	0.0638 (0.0295)** {0.0301}**
lag(*Blitz*,7)	-0.0609 (0.0292)**	-0.0609 (0.0292)** {0.0298}**	-0.0609 (0.0292)** {0.0286}**	-0.0609 (0.0292)** {0.0313}*	-0.0609 (0.0292)** {0.0345}*
lag(*Blitz*,12)	-0.0460 (0.0240)*	-0.0460 (0.0240)* {0.0249}*	-0.0459 (0.0240)* {0.0238}*	-0.0459 (0.0240)* {0.0254}*	-0.0459 (0.0240)* {0.0236}*
Fixed-effects					
Cell-by-time of day-by-day of week	Yes	Yes	Yes	Yes	Yes
Daily	Yes	Yes	Yes	Yes	Yes
Observations	2,608,265	2,608,265	2,608,265	2,608,265	2,608,265
BIC	970,485.1	970,485.1	970,484.9	970,484.8	970,484.9

Clustered (cell) standard-errors in parentheses, and Conley's standard-errors in brackets (500-1500 meters, according to the distance cutoffs of weight matrices). Note: temporal lags up to 16 day-time of day periods (4 days from an intervention) are included, but only statistically significant ones are shown. ***: 0.01, **: 0.05, *: 0.1

- To partially disentangle deterrence and incapacitation, we explore the information about the number of vehicles seized during the operation. If incapacitation is the main channel through which blitzes reduce violent crime occurrences, we would see larger effects for blitzes that seize more vehicles, which is not the case

- We also explore blitzes characteristics such as number of policemen involved, as well as blitz type (i.e., mobile vs fixed). One can see in the table that there is no significant direct impact of additional officers assigned to a blitz on crime, and mobile blitzes increase the direct deterrent effects by 11%, but this impact is not statistically significant.

Dependent Variable: Violent Crime Occurrences			
	1 km (1)	1 km (2)	1 km (3)
Blitz	-0.491 (0.161)** {0.164}**	-0.485 (0.204)** {0.195}**	-0.309 (0.136)** {0.137}**
Vehicles Seizure	0.195 (0.1151) {0.127}		
Blitz:Vehicles Seizure	-0.003 (0.032) {0.165}		
Policemen		0.166 (0.120) {0.111}	
Blitz:Policemen		0.002 (0.045) {0.050}	
Motorcycles			0.722 (0.529) {0.506}
Blitz:Motorcycles			-0.114 (0.089) {0.088}
Fixed-effects			
Cell x TOD x DOW	Yes	Yes	Yes
Day	Yes	Yes	Yes
Observations	2,608,265	2,608,265	2,608,265
BIC	970,514.4	970,988.3	970,971.7

*Clustered (cell) standard errors in parentheses, and Conley's standard errors in brackets (1000 meters, according to the distance cutoff of the weight matrix). Note: temporal lags up to 16 day-time of day periods (4 days from an intervention) are included, but only statistically significant ones are shown. ***: 0.01, **: 0.05, *: 0.1*

Robustness

- To assess the robustness of the results to the cells' size, we construct a panel with a higher resolution, keeping the same time division (721 days, each with 4 periods) **but dividing the city into 17,544 hexagons of 0.0179 square km** - a balanced panel with 50,596,896 observations.
- Direct effects are greater: an additional hour of police blitzes decreases violent crime occurrences by 35.5%, on average. We observe the same pattern of diminishing returns of policing hours to public safety, no spatial displacement to nearby areas, and very little residual deterrence after two days of an operation.

| | Dependent Variable: Violent Crime Occurrences | | | |
| | 500 meters | 750 meters | 1 km | 1.5 km |
	(1)	(2)	(3)	(4)
$Blitz$	-0.5242	-0.5243	-0.5241	-0.5242
	(0.2587)**	(0.2587)**	(0.2586)**	(0.2587)**
	{0.2178}**	{0.2217}**	{0.2194}**	{0.2159}**
$Blitz^2$	0.0853	0.0854	0.0853	0.0853
	(0.0469)*	(0.0469)*	(0.0469)*	(0.0469)*
	{0.0388}**	{0.0394}**	{0.0389}**	{0.0385}**
$W\,Blitz$	-0.1888	-0.1724	-0.4651	-0.6030
	(0.3662)	(0.5557)	(0.7327)	(1.050)
	{0.4044}	{0.6206}	{0.7964}	{1.2748}
$\mathrm{lag}(Blitz,7)$	-0.0844	-0.0844	-0.0844	-0.0844
	(0.0442)*	(0.0442)*	(0.0442)*	(0.0442)*
	{0.0444}*	{0.0422}**	{0.0406}**	{0.0413}**
Fixed-effects				
Cell x TOD x DOW	Yes	Yes	Yes	Yes
Day	Yes	Yes	Yes	Yes
Observations	3,958,707	3,958,707	3,958,707	3,958,707
BIC	1,244,904.6	1,244,904.9	1,244,904.5	1,244,904.6

*Clustered (cell) standard-errors in parentheses, and Conley's standard-errors in brackets (500 to 1500 meters, spherical distances, according to the distance cutoffs of weight matrices). Note: temporal lags up to 16 day-time of day periods (4 days from an intervention) are included, but only statistically significant ones are shown. ***: 0.01, **: 0.05, *: 0.1. TOD is the time-of-day and DOW represents the day-of-week.*

Cost-Benefit Analysis

- An average intervention consists of 2 vehicles and 6policemen, and on any given day there are 5 blitzes. Individual yearly salaries are around R$ 50,000, and a police vehicle costs R$ 150,000,000. Hence, 30 officers and 10 vehicles are needed to perform these daily policing assignments over the year and the total costs for two years of interventions are approximately **R$ 6 million (US$ 3.2 million)**

- Between 2012 and 2013, we estimate that **blitzes prevented 66 violent crimes**, approximately. Based on the values of statistical life and statistical robbery, this policing assignment generated **R$ 4.31 million (US$ 2.3 million) in public safety** improvements. Besides, our data shows that **R$ 13.74 million (US$ 7.4 million) were collected in fines distributed to drivers.** Finally, there are uncovered potential benefits of reducing traffic fatalities through drunk driving crackdowns.
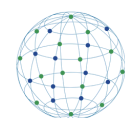
Social Benefits and Revenues	R$ Million
Public Safety	4.31
Collected Fines	13.74

Operational Costs	R$ Million
Vehicles	1.5
Salaries	4.5

Takeaways

- In two years, this policing assignment generated R$ 4.31 million (US$ 2.3 million) in public safety improvement. Besides, R$ 13.74 million (US$ 7.4 million) was collected in fines distributed to drivers, and there are uncovered potential benefits of reducing traffic fatalities through drunk driving crackdowns

- We do not find any sort of displacement of this highly visible policing assignment

- The intermittent design of the intervention produces uncertainty that might be useful to minimize temporal and spatial displacement of crime

Thanks!