

Re-Lighting Detroit's Streets: Impacts on Crime and Traffic Accidents

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Relighting Detroit

Detroit Rising: And then there were streetlights

Detroit's broken streetlights are actually getting fixed.

JC Reindl Detroit Free Press

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Story Highlights

- About 56,000 new streetlights installed - 9,000 more to go.
- Project ahead of schedule.
- Most neighborhoods now have new LED streetlights.
- All lights to be on by end of 2016.

Once an international embarrassment and the worst in the nation, Detroit's street-lighting system has become a bright spot and a bragging point, even inspiring a glitzy national TV campaign by a major bank.

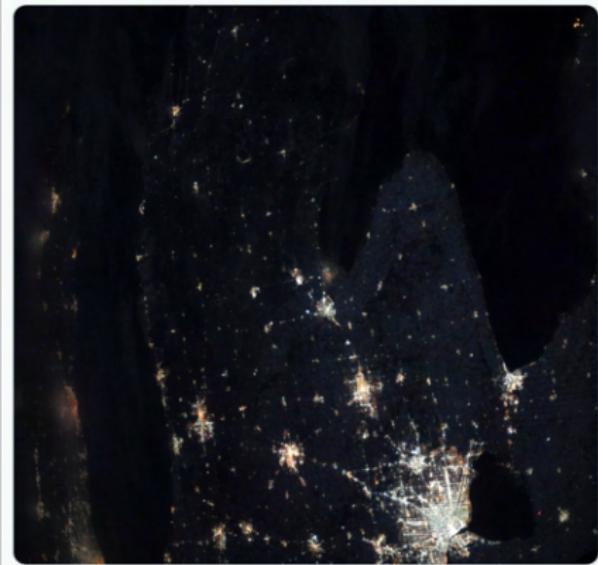
The \$185-million project to overhaul and modernize the vast system is more than 80% done. Workers have installed thousands of new industry standard light-emitting diode (LED) lamps along city streets and across neighborhoods, replacing old and often-broken fixtures.



Christina H Koch

@Astro_Christina

Good evening, Michigan. The mitten waves back, even at night.



6:01 PM · Dec 4, 2019



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Research questions

- 1) Do street lights improve public safety through reductions in crime and traffic accidents?
- 2) If so, do such reductions occur primarily at night with an increase in visibility?
- 3) If so, do such reductions vary with characteristics of the crime or traffic accident?
 - Time of day
 - Street type
 - Type of crime
 - Cause of accident
 - Type of injury
 - Weather conditions

Possible mechanisms

Crime

- Criminal behavior
 - Deterrence effect \implies Crime (night) \downarrow
 - Ability to identify potential targets \implies Crime (night) \uparrow
- Target behavior
 - Ability to avoid dark, high-risk situations \implies Crime (night) \downarrow
 - Additional traffic with perception of safety \implies Crime (night) \uparrow

Traffic Accidents

- Driving behavior
 - Ability to avoid dark, high-risk situations \implies Accidents (night) \downarrow
 - Additional traffic with perception of safety \implies Accidents (night) \uparrow

Ex-ante, the impact of new LED street lights on crime and traffic accidents is ambiguous

Preview of results

Crime

- No significant change in total crime
 - Crime (day) ↓ by about 1.5%
 - Centralized to larger streets (i.e., principal and minor arterial)
- No significant change in street crime
- Crime ↓ around 00:00 (midnight) and 12:00 (noon)
 - Consistent with bunching in time of reporting

Traffic Accidents

- Accidents ↓ by about 0.9%
 - Accidents (day) ↓ by about 0.5%
 - Accidents (night) ↓ by about 0.5%
 - Centralized to larger streets (i.e., principal arterial)

Detroit's Public Lighting Authority (PLA)

The PLA completely overhauled the street light system in Detroit between 2014 and 2017

- January 2014: About 40% of street lights burned out/broken
- February 2014: Begin installation of LED lights
- April 2017: Installation is completed
 - Removed 23,000 old lights
 - Program maintained strict spacing of lights
 - Replaced all remaining lights with LED lights \approx 65,000
 - Became the largest city in US to be completely lit by LED lights

40 percent of Detroit's streetlights not working

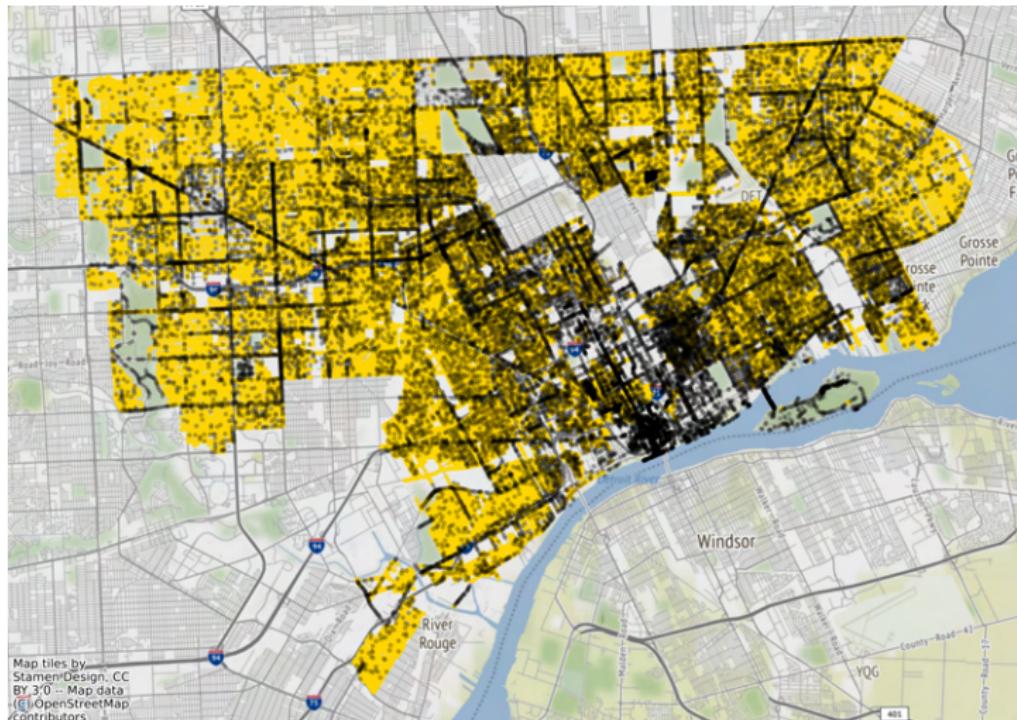


Figure: Gray points are lights not working prior to 2014

Installation of LED lights from 2014 to 2017

Staggered installation of LED lights

The installation of LED lights was done roughly within neighborhoods, working from zip code to zip code

- Precedence given to zip codes further away from the city center

LED lights installed directly after the removal of the old HPS lights

Variation in installation date produces multiple treatment events

- Street A: Receives LED lights in February 2014
- Street B: Receives LED lights in March 2014
- Street C: Receives LED lights in April 2014

Natural experiments: A vs B, A vs C, and B vs C

Data

Lighting Data from the Detroit PLA (2014–2017)

- Old HPS lights
 - Location, status (i.e., broken or working), and wattage
- New LED Lights
 - Installation date, location, and wattage

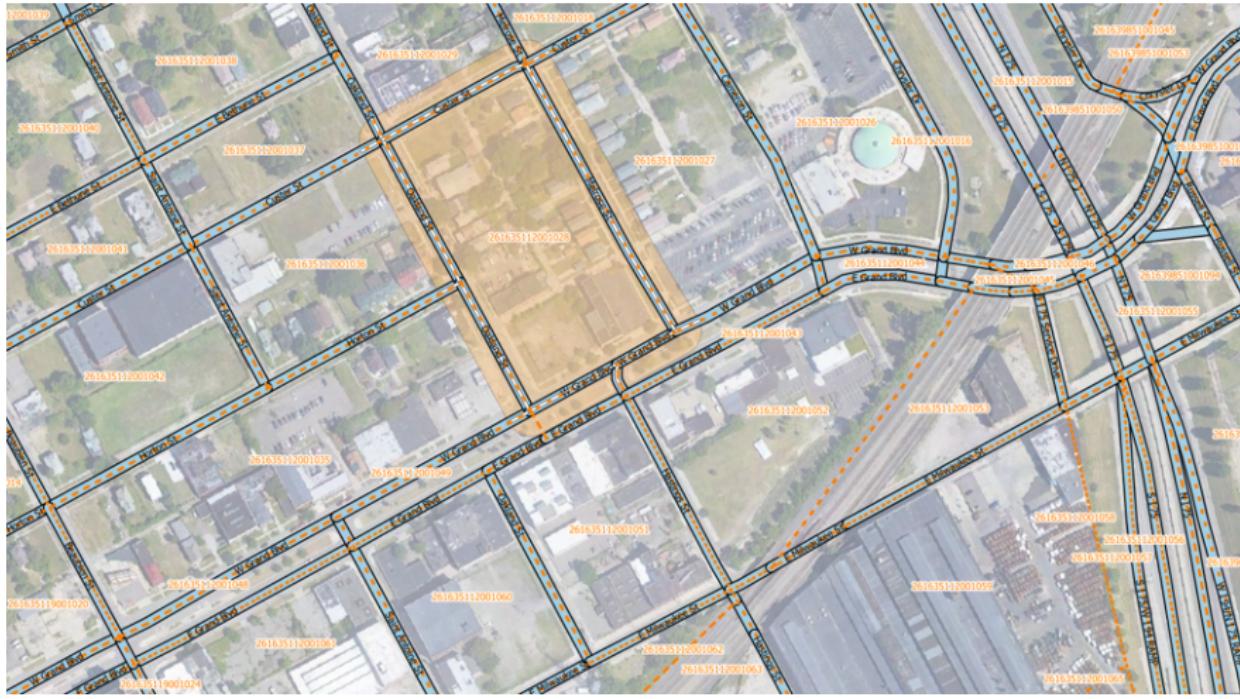
Crime report data from Detroit Police Department (2013–2018)

- Date, time, location, description of crime
 - Semi-anonymous location with coordinates within 180ft of crime

Traffic accidents data from Southeast Michigan Council of Governors (2013–2017)

- Date, time, location, description of accident

Unit of measurement: Street block



Street blocks run between intersections on one side of the street

Match street lights to street blocks



Similarly, crime and traffic accidents are matched to street blocks

Summary statistics - Street blocks

Table 1: Street Blocks by Street Type

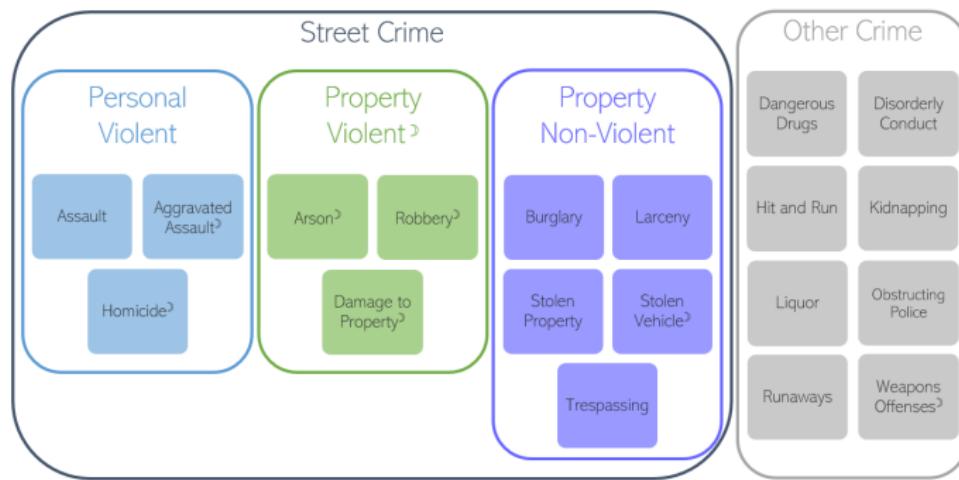
	N	%	% Lights Burnt Out
Principal Arterial	4,416	13.18	49.60
Minor Arterial	4,535	13.54	53.03
Collector	3,467	10.35	51.49
Neighborhood	20,641	61.61	28.59
Non-Certified	442	1.32	52.72
Total	33,501	100.00	37.18

Crime classifications

Categorize crime by day and night using local sunrise/sunset times

Additionally, categorize crime by type of crime

- Street crime makes up about 65% of all crime



Summary statistics - Crime

Table 2: Monthly Crime by Street Block

Year	Day	Night	Total	N (Total)
2013				440,086
All Crime	0.6138 (1.5253)	0.4055 (0.9812)	1.0947 (2.3048)	
2014				395,286
All Crime	0.5415 (1.3067)	0.3743 (0.9046)	0.9833 (2.0125)	
2015				403,326
All Crime	0.5428 (1.3149)	0.3917 (0.9503)	1.0033 (2.0521)	
2016				392,724
All Crime	0.5238 (1.2654)	0.3835 (0.9499)	0.9769 (1.9903)	
2017				278,254
All Crime	0.3486 (0.8348)	0.2963 (0.7462)	0.6922 (1.3258)	
2018				277,256
All Crime	0.3478 (0.8232)	0.2933 (0.7339)	0.6897 (1.3192)	
Total				2,186,932
All Crime	0.4864 (1.2111)	0.3574 (0.8845)	0.9067 (1.8789)	
Observations	2,412,072	2,412,072	2,412,072	
Street Blocks	33,501	33,501	33,501	

Summary statistics - Traffic Accidents

Table 3: Monthly Accidents by Street Block

Year		Day	Night	Total	N (Total)
2013	Accidents	0.0545 (0.2589)	0.0253 (0.1672)	0.0862 (0.3357)	34,690
2014	Accidents	0.0548 (0.2608)	0.0246 (0.1655)	0.0858 (0.3403)	34,491
2015	Accidents	0.0649 (0.2865)	0.0287 (0.1778)	0.1014 (0.3707)	40,779
2016	Accidents	0.0620 (0.2809)	0.0272 (0.1749)	0.0971 (0.3643)	39,027
2017	Accidents	0.0619 (0.2796)	0.0264 (0.1711)	0.0954 (0.3599)	38,349
Total					187,336
	Accidents	0.0596 (0.2736)	0.0264 (0.1714)	0.0932 (0.3545)	
Observations		2,010,060	2,010,060	2,010,060	
Street Blocks		33,501	33,501	33,501	

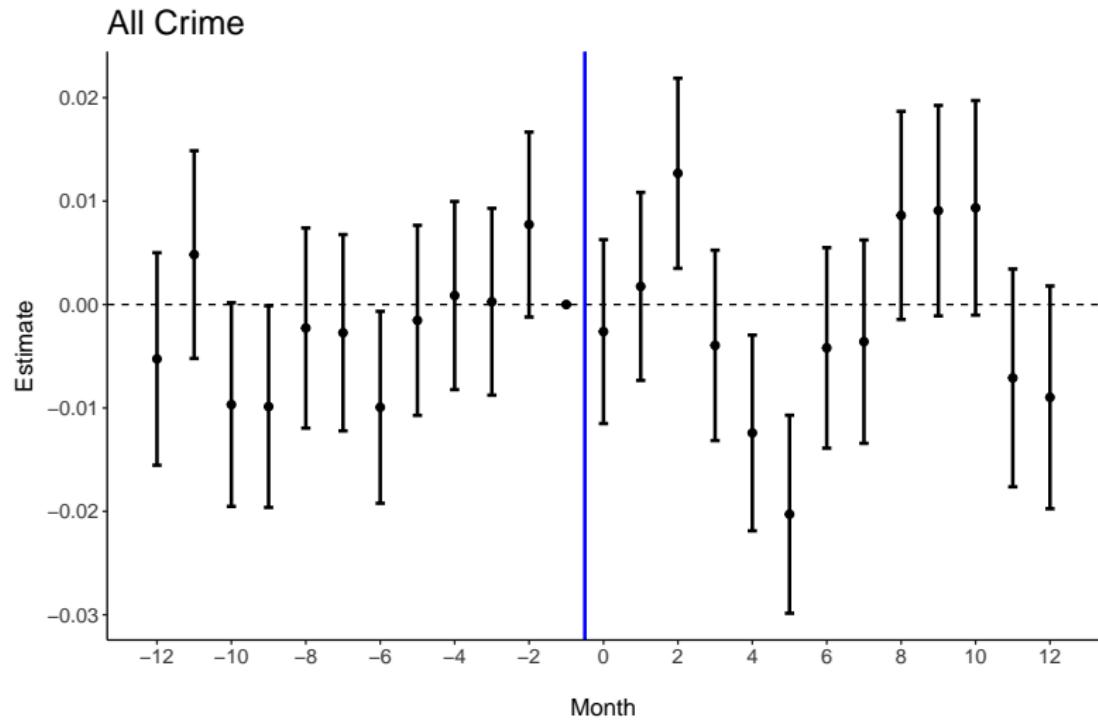
Begin with TWFE event study

$$IHS(Y_{it}) = \alpha_i + \lambda_t + \sum_{k=-12}^{-2} \beta_k^{lead} \mathbf{1}[k = t - g] + \sum_{k=0}^{12} \beta_k^{lag} \mathbf{1}[k = t - g] + \varepsilon_{it}$$

where

- $IHS(Y_{it})$ is the inverse hyperbolic sine of crime (traffic accidents) reports in a street-block-month
- α_i are street block fixed effects
- λ_t are month fixed effects
- g is the first-treatment period of a street block

TWFE event study - All Crime



With heterogeneous treatment effects, these estimates are biased...

The Callaway and Sant'Anna (2020) estimator

The “unconditional” estimator:

$$ATT_{unc}^{ny}(g, t) = \mathbb{E}[Y_t - Y_{g-1} | G_g = 1] - \mathbb{E}[Y_t - Y_{g-1} | D_t = 0]$$

- g indexes street blocks by first treatment month and G_g is a binary variable equal to one if a unit is first treated in period g
- $\mathbb{E}[Y_t - Y_{g-1} | G_g = 1]$ is the difference in outcome Y between period t and the first period before treatment $g - 1$ for treatment cohort g
- $\mathbb{E}[Y_t - Y_{g-1} | D_t = 0]$ is the difference in outcome Y between period t and the first period before treatment $g - 1$ for the not-yet treated street blocks
- Thus, we estimate treatment effects for each treatment cohort g for each time period t

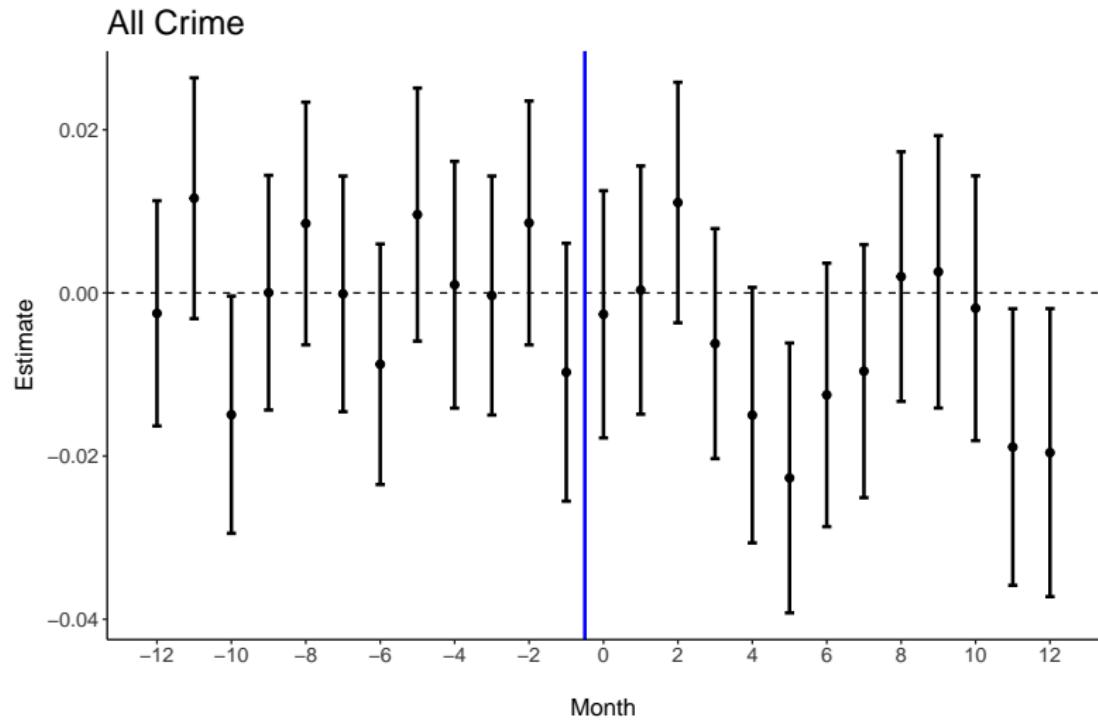
Crime estimates

Table 4: Crime Estimates

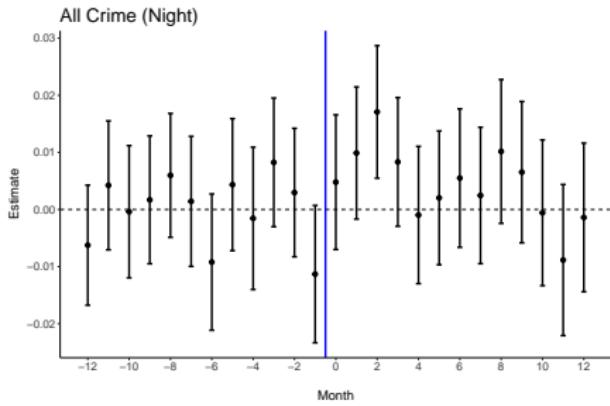
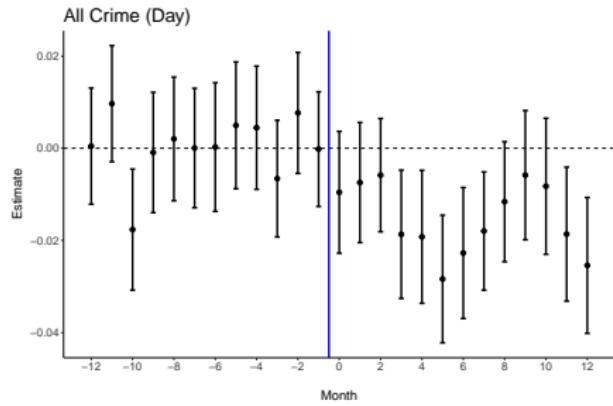
	Day	Night	Total
All Crime	-0.0153*	0.0042	-0.0071
	(0.0036)	(0.0031)	(0.0040)
Street Crime	-0.0040	0.0042	0.0014
	(0.0028)	(0.0028)	(0.0036)
Personal Violent	-0.0034	0.0028	0.0000
	(0.0020)	(0.0016)	(0.0022)
Property Violent	0.0035*	0.0012	0.0043*
	(0.0013)	(0.0015)	(0.0020)
Property Nonviolent	-0.0048*	0.0005	-0.0047
	(0.0019)	(0.0019)	(0.0025)

*p<0.05

Crime event study - All Crime



Crime event study - All Crime by day and night



Heterogeneity in crime

Time of day (4-hour blocks) Table

- Crime ↓ during 00:00—03:59 and 12:00—15:59
 - Consistent with bunching in time of reporting (midnight and noon)

Street type Table

- Crime (day) ↓ on larger streets (i.e., principal and minor arterial)
- Crime (night) ↑ on smaller streets (i.e., neighborhood)
- No change in total crime

Type of crime

- Crime ↓ for fraud, homicide, investigations ↘, larceny ↘, liquor, OUIL ↘, solicitation ↘, and **miscellaneous**
- Crime ↑ for aggravated assault ↗, arson ↗, hit and run, kidnapping, obstructing judiciary ↗ and police, robbery, and stolen property

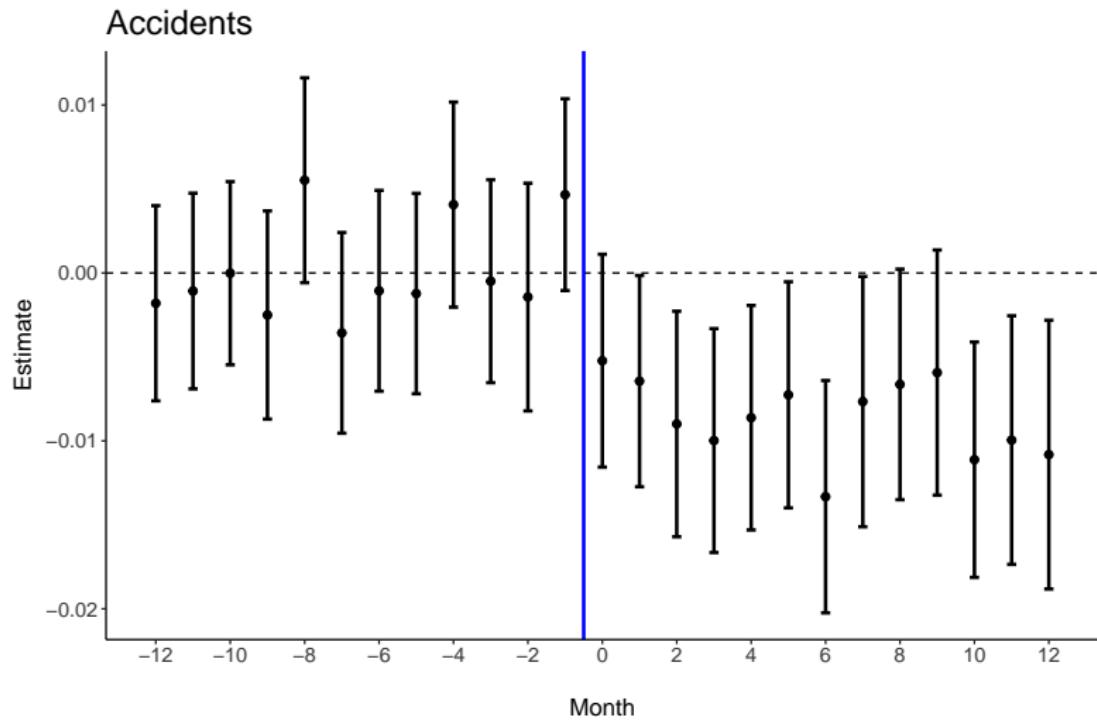
Traffic accidents estimates

Table 5: Accidents Estimates

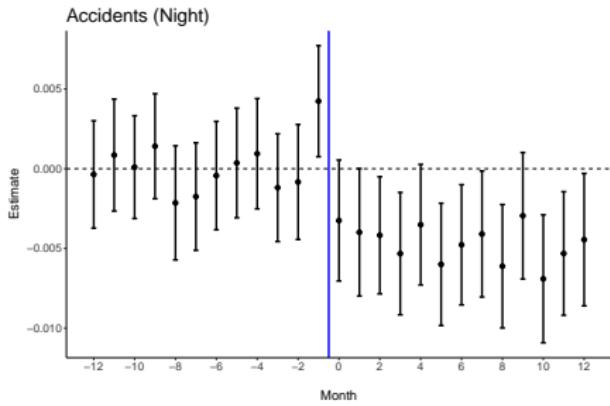
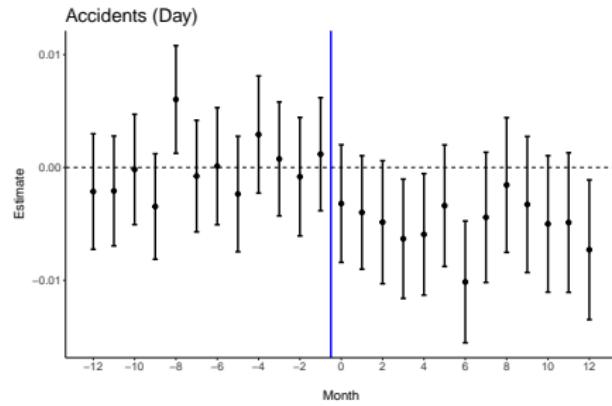
	Day	Night	Total
Accidents	-0.0049* (0.0014)	-0.0047* (0.0010)	-0.0088* (0.0017)

*p<0.05

Traffic accidents event study



Traffic accidents event study by day and night



Heterogeneity in traffic accidents

Time of day (4-hour blocks) [Table](#)

- Accidents ↓ for all 4-hour blocks between 08:00 and 23:59

Street type [Table](#)

- Accidents ↓ on principal arterial streets only

Cause of accident [Table](#)

- Accidents ↓ caused by hit and run, intersection, older driver, and younger driver

Type of injury [Table](#)

- Accidents ↓ in non-injury cases only

Weather conditions [Table](#)

- Accidents ↓ in dry conditions only

Conclusions and future work

Not enough evidence to support the hypothesis that street lights reduce crime:

- 1.5% reduction in *day* crime and no change in *night* crime

Some evidence to support the hypothesis that street lights reduce traffic accidents:

- 0.5% reduction in *day* accidents and a 0.5% reduction in *night* accidents

Mechanisms are unclear because both accidents and crimes are equilibrium outcomes.

- Possible shifting of foot and vehicle traffic from day to night
 - Future work will use cell phone location data to study supply side

Crime estimates by time of day

Table 6: Crime Estimates: Time of Day

Crime	-0.0068 (0.0040)
Crime: 00:00-03:59	-0.0052* (0.0022)
Crime: 04:00-07:59	0.0029 (0.0016)
Crime: 08:00-11:59	-0.0034 (0.0023)
Crime: 12:00-15:59	-0.0098* (0.0025)
Crime: 16:00-19:59	-0.0035 (0.0025)
Crime: 20:00-23:59	0.0022 (0.0023)

*p<0.05

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Crime estimates by street type

Table 7: Crime Estimates: Street Type

	Day	Night	Total
Crime	-0.0153* (0.0036)	0.0042 (0.0031)	-0.0071 (0.0040)
Crime: Principal Arterial	-0.0233* (0.0105)	-0.0012 (0.0097)	-0.0157 (0.0107)
Crime: Minor Arterial	-0.0240* (0.0095)	0.0022 (0.0084)	-0.0101 (0.0105)
Crime: Collector	-0.0159 (0.0097)	-0.0124 (0.0088)	-0.0173 (0.0114)
Crime: Neighborhood	-0.0080 (0.0048)	0.0103* (0.0043)	0.0019 (0.0058)
Crime: Non-certified	-0.0028 (0.0260)	-0.0027 (0.0225)	0.0131 (0.0295)

*p<0.05

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Traffic accidents estimates by time of day

Table 8: Accidents Estimates: Time of Day

Accidents	-0.0088*
	(0.0018)
Accidents: 00:00-03:59	-0.0007
	(0.0006)
Accidents: 04:00-07:59	-0.0005
	(0.0005)
Accidents: 08:00-11:59	-0.0018*
	(0.0008)
Accidents: 12:00-15:59	-0.0023*
	(0.0009)
Accidents: 16:00-19:59	-0.0027*
	(0.0001)
Accidents: 20:00-23:59	-0.0023*
	(0.0007)

*p<0.05

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Traffic accidents estimates by street type

Table 9: Accidents Estimates: Street Type

	Day	Night	Total
Accidents	-0.0049* (0.0014)	-0.0047* (0.0010)	-0.0088* (0.0017)
Accidents: Principal Arterial	-0.0057 (0.0061)	-0.0180* (0.0046)	-0.0218* (0.0070)
Accidents: Minor Arterial	-0.0029 (0.0054)	-0.0061 (0.0035)	-0.0079 (0.0061)
Accidents: Collector	-0.0001 (0.0048)	-0.0019 (0.0032)	-0.0001 (0.0057)
Accidents: Neighborhood	-0.0016 (0.0014)	0.0003 (0.0010)	-0.0011 (0.0017)
Accidents: Non-certified	-0.0001 (0.0064)	0.0008 (0.0050)	0.0016 (0.0071)

*p<0.05

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Traffic accidents estimates by cause

Table 10: Accidents Estimates: Cause

Alcohol	0.0006*	(0.0002)			
Bicycle	-0.0003	(0.0002)	Motorcycle	-0.0001	(0.0002)
Deer	0.0000	(0.0000)	Older Driver	-0.0032*	(0.0007)
Distracted Driver	0.0001	(0.0001)	Pedestrian	-0.0003	(0.0003)
Drugs	0.0003*	(0.0001)	Run Red Light	0.0001	(0.0005)
Hit and Run	-0.0046*	(0.0011)	School Bus	0.0002	(0.0001)
Intersection	-0.0061*	(0.0014)	Train	0.0000	(0.0000)
Lane Departed	-0.0001	(0.0005)	Young Driver	-0.0023*	(0.0010)

*p<0.05

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Traffic accidents estimates by type of injury

Table 11: Accidents Estimates: Type of Injury

Accidents	-0.0086*
	(0.0018)
No Injury	-0.0079*
	(0.0015)
Injury	-0.0015
	(0.0010)
Injury (Fatal)	0.0000
	(0.0001)
Injury (Serious)	0.0001
	(0.0002)
Injury (Minor)	-0.0003
	(0.0004)
Injury (Possible)	-0.0016
	(0.0009)

*p<0.05

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Traffic accidents estimates by weather conditions

Table 12: Accidents Estimates: Weather

Accidents	-0.0086*
	(0.0018)
Dry	-0.0101*
	(0.0016)
Not Dry	0.0014
	(0.0010)
Not Dry (Wet)	0.0005
	(0.0007)
Not Dry (Icy)	0.0005
	(0.0005)
Not Dry (Snowy)	0.0006
	(0.0004)

*p<0.05

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