Does Artificial Night Light Deter Crimes as Well as Natural Daylight?

A Test Using Daylight Saving Time(DST)

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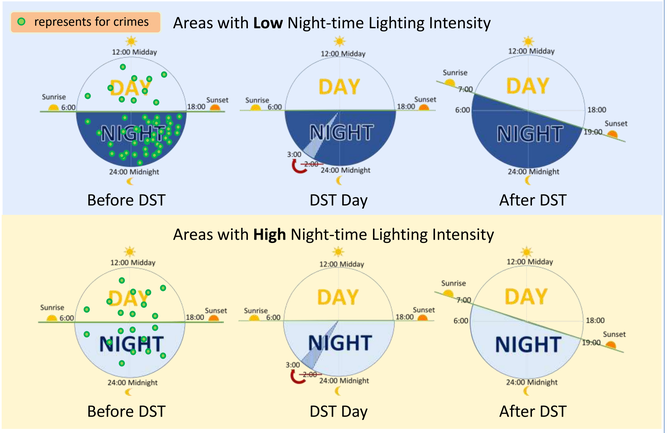
INTRODUCTION

- Criminals prefer to do their work during the darkness. Both of natural daylight and artificial night lights could deter potential offenders by increasing the risk that they will be witnesses or recognized while committing crimes. But, are the two sources of light substitutes in crime deterrence?
- Daylight Saving Time(DST) transition was adapted to be an exogenous shock to daylight by Doleac and Sanders(2015) to study the daylight shifting effect on criminal activities. We further control the night light intensity effect and study the interaction effect of daylight and night light on crimes.
- We predict that when the night light in a place is bright enough, it would 'perfectly' substitute the natural daylight, and there should not be much difference between committing a crime before or after the sun sets for offenders if other conditions stay the same.

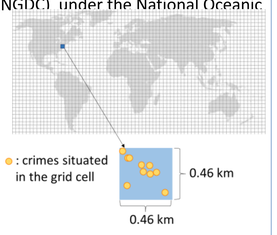
WHAT MAKES THE DIFFERENCE?

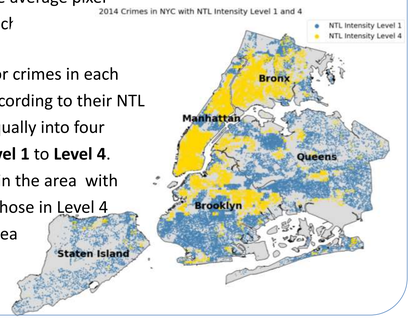


- Noon-to-midnight hours: hours between midday and midnight.
- The number of night-hours falls by **one hour** after DST during noon-to-midnight period(right semicircle of the clock plate).

DATASET

- **Crime Data**: Individual Criminal Records (*date, time, type, geolocation for each offense*)
  - From: New York City Police Department(NYPD) and Chicago Police Department's Citizen law Enforcement Analysis and Reporting system.
- **Nighttime Lighting Intensity(NTL Intensity):** Estimated from the *monthly* satellite images of the night earth(from 2013 to 2018)
  - From the National Geographical Data Center (NGDC) under the National Oceanic and Atmospheric Administration (NOAA)
  - The dataset contains monthly composites with average Day/Night Band(DNB) radiance. We calculate the night-time lighting(NTL) intensity for each crime through situating the latitude and the longitude into pixel coordinates, where the pixel size is 0.004 x 0.004(degree^2)(which is 0.46 x 0.46 km^2 on the earth), and estimate the average pixel brightness of the cell in which located.
- **Four Levels of NTL Intensity:** For crimes in each year, we first sort the crimes according to their NTL intensities, then divide them equally into four groups and label them from **Level 1** to **Level 4**.
  - Crimes in Level 1 occurred in the area with lowest NTL intensity , and those in Level 4 occurred occurred in the area with brighter nights.





RD ESTIMATION

Main Regression:

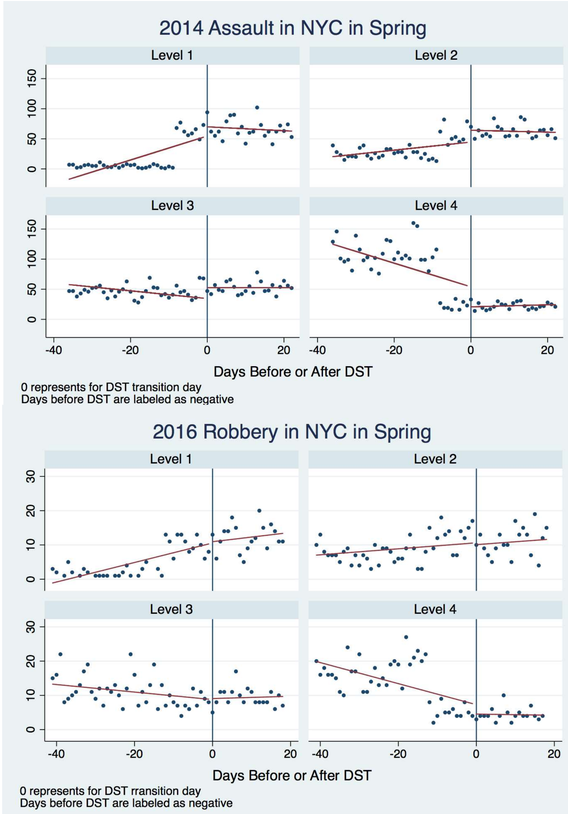
$$\text{Number of Crimes} = \beta_0 + \beta_1 \text{DST} + \beta_2 \text{Day} + \beta_3 \text{DST} \times \text{Day} + w$$

- β_1 is our coefficient of interest, which captures the difference of daily crimes after time-shifting due to DST.
- Day is a running variable with days before and after DST transition, scaled such that the variable is equal to 0 at the first day of DST
- DST is a categorical variable that measures whether the day is before or after the DST transition.
- We run regression discontinuity for **each intensity group** of crimes.

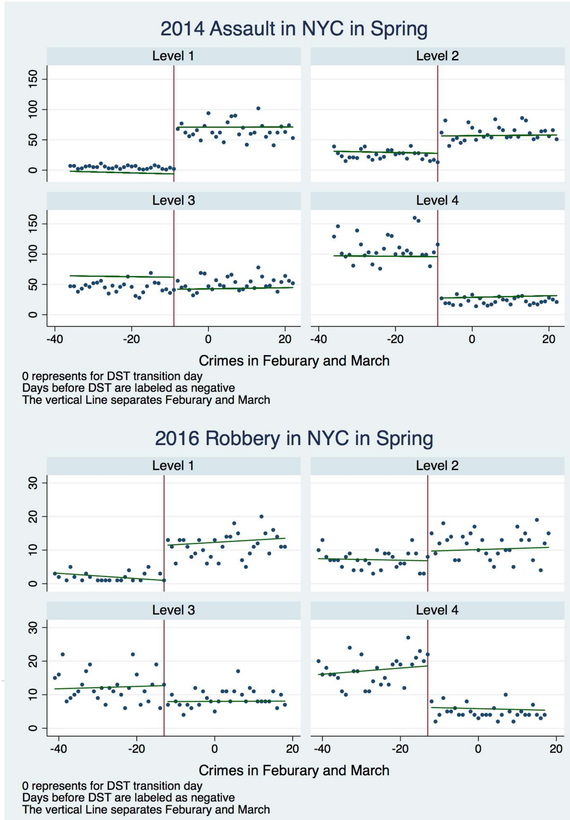
Residual Regression:

$$\text{Number of Crimes} = \beta_0 + \beta_1 \text{Date} + \beta_2 \text{Weather} + \beta_3 \text{Weekday/Not} + \beta_4 \text{Temperature} + \beta_5 \omega$$

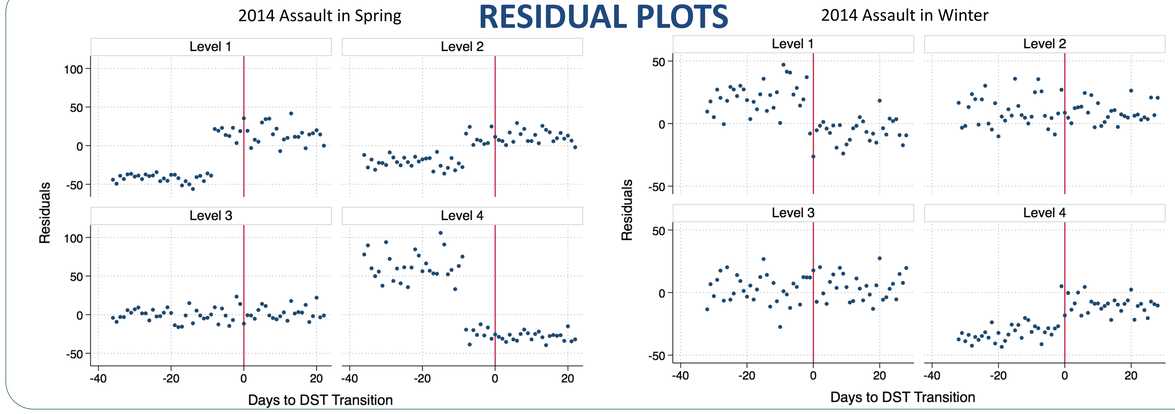
DST AS CUTOFF



FIRST DAY OF MONTH AS CUTOFF



RESIDUAL PLOTS



SUMMARY STATISTICS

Table 1: Number of Daily Crimes the Four Intensity Levels in NYC

Crime Types	Level 1	Level 2	Level 3	Level 4
Arson	1.55 (0.888)	1.37 (0.652)	1.54 (0.894)	1.82 (1.218)
Assault	45.28 (24.682)	49.24 (16.43)	51.21 (11.585)	44.82 (31.497)
Burglary	15.33 (8.746)	13.2 (5.502)	11.84 (4.723)	11.18 (8.943)
Dangerous Drugs	11.24 (8.598)	13.96 (8.465)	20.18 (11.379)	20.1 (18.092)
Dangerous Weapons	6.23 (4.028)	6.9 (3.765)	7.65 (4.19)	7.49 (6.526)
Homicide	1.26 (0.599)	1.19 (0.5)	1.22 (0.722)	1.23 (0.607)
Motor Vehicle Theft	6.69 (3.897)	4.91 (2.432)	3.75 (1.987)	3.12 (2.529)
Offenses against Pubic Order	98.16 (49.352)	89.8 (23.756)	86.44 (16.229)	75.63 (49.394)
Other Category	26.63 (14.103)	25.43 (8.812)	25.25 (7.261)	25.37 (17.027)
Robbery	10.78 (7.378)	11.27 (5.067)	11.19 (4.131)	9.04 (7.001)
Theft	78.55 (41.723)	80.18 (23.263)	79.4 (15.16)	99.82 (44.1)

Year	2013	2014	2015	2016	2017	2018
Total	156612	154966	146858	150062	14577	132024

REGRESSION RESULTS

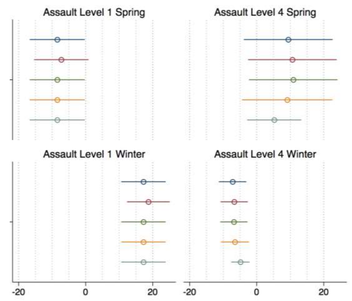
Table 2: The Interaction Effect of Daylight and Nightlight on Crime

	Level 1					Level 4				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
DST in Spring										
Assault	-8.572* (4.181)	-7.452 (4.140)	-8.035* (4.040)	-7.006 (4.198)	-5.592* (2.597)	9.401 (6.736)	10.63 (6.726)	10.91 (6.714)	9.101 (6.861)	5.217 (4.111)
Burglary	-0.576 (1.429)	-1.157 (1.397)	-1.250 (1.385)	-1.062 (1.434)	0.299 (0.899)	4.233* (1.878)	3.691* (1.857)	3.853* (1.829)	3.508 (1.871)	2.649* (1.224)
Motor Vehicle Theft	0.344 (0.600)	0.288 (0.603)	0.275 (0.603)	0.511 (0.623)	0.298 (0.446)	1.533* (0.624)	1.463* (0.626)	1.463* (0.625)	1.514* (0.651)	0.667 (0.509)
Robbery	-0.576 (0.960)	-0.562 (0.966)	-0.691 (0.956)	-0.557 (0.974)	-0.461 (0.681)	2.185 (1.470)	2.157 (1.477)	2.281 (1.472)	1.846 (1.528)	1.132 (1.067)
Offenses against Pubic Order	-14.22 (8.623)	-14.60 (8.664)	-15.71 (8.370)	-14.26 (8.640)	-9.513 (5.491)	14.55 (10.21)	12.86 (10.21)	13.44 (10.15)	10.51 (10.49)	8.953 (6.690)
DST in Winter										
Assault	17.24*** (3.366)	18.72*** (3.240)	18.28*** (3.155)	19.18*** (3.192)	10.73*** (2.100)	-7.197*** (2.081)	-6.718** (2.067)	-6.817** (2.064)	-6.510** (2.113)	-4.850*** (1.396)
Burglary	6.083*** (1.375)	5.417*** (1.310)	5.323*** (1.302)	5.214*** (1.328)	3.574*** (0.845)	-1.977** (0.716)	-2.304*** (0.687)	-2.325*** (0.687)	-2.254** (0.700)	-1.549** (0.517)
Motor Vehicle Theft	1.929** (0.674)	1.962** (0.677)	1.908** (0.671)	2.034** (0.686)	1.207* (0.515)	-0.0967 (0.164)	-0.104 (0.165)	-0.118 (0.167)	-0.158 (0.170)	-0.0660 (0.237)
Robbery	3.971** (1.219)	3.987** (1.225)	3.885** (1.214)	3.972** (1.249)	2.580** (0.889)	-1.775** (0.614)	-1.821** (0.615)	-1.841** (0.614)	-1.772** (0.635)	-1.477** (0.450)
Offenses against Pubic Order	22.31*** (5.718)	22.10*** (5.743)	21.22*** (5.544)	22.71*** (5.642)	17.80*** (3.759)	-15.38*** (3.121)	-16.38*** (3.067)	-16.52*** (3.063)	-16.85*** (3.154)	-10.34*** (2.073)

Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

For each intensity level, the first column contains the coefficient of DST for the simplest regression with year fixed variable. The second, third and fourth columns contains the same coefficient with weekday effects, temperature and weather effect further controlled respectively. The fifth column contains the same coefficient with regression on crimes occurred during noon-to-midnight period. We run regression separately on crimes occurred near DST in winter and DST in spring.

Coefficient Plot for Assaults in 2014



- For each subplot, from up to bottom, the coefficients of interest for the five regression(simple regression, weekday effect controlled, temperature controlled, weather controlled, and regression on crimes occurred during the noon-to-midnight period) and their confidence intervals are displayed.
- The x-axis represents for the number of crimes changes after DST transition. For example, the number of Assaults increased by around 15 after DST transition in 2014 Winter in areas with **Level 1** NTL Intensity; but it decrease by around 5 to 10 in areas with **Level 4** NTL Intensity.

KEY FINDINGS

- Sudden changes of crime numbers at the beginning of the months in different NTL intensity areas. For example, in low intensity areas, crime frequencies rises significantly right on March 1st; however, in high intensity areas, it drops after entering march.
- During the DST Transition in Winter, the number of crimes drops in low intensity areas and it rises in high intensity areas. However, as DST Transition in Winter occurs each year very close to the beginning of the month, it is ambiguous whether the change is a response to month effect or DST effect.
- Crime rates at the boundaries between other months in different intensity levels are relatively smooth. We observed the sudden change of crimes between February and March is the largest.
- We checked the crimes rates changes at the boundaries between months in the city of Chicago, and we also find the similar pattern.

LITERATURE CITED

Doleac, J. L., and Sanders, N. J., 2015. "Under the Cover of Darkness: How Ambient Light Influences Criminal Activity." Review of Economics and Statistics 97 (5). MIT Press: 1093–1103.