Assessing the Impact of Fixed Speed Cameras on Speeding Behavior and Crashes: A Longitudinal Study in New York City

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Speeding is a leading contributor to fatal crashes.

- In 2021, there were **12,330 fatalities** in speeding-related crashes, accounting for **29%** of the total traffic-related deaths for that year.
- Pedestrians struck at 30 MPH are twice as likely to die as pedestrians struck at 25 MPH.
- NYC launch the Automated Speed Enforcement program in 2013, expanded to 750 school zones in 2019 (operated 6AM-10PM) and has **over 2000 cameras** operational as of May 2022 (operated 24/7).

ABSTRACT

This longitudinal study examines the **short- and long-term changes** associated with an automated speed enforcement (ASE) program's expansion from 2019 to 2021 in New York City, including the COVID-19-induced surge on speeding behaviors and the complex nature of high volumes of pedestrians and non-motorized vehicles. Leveraging speeding tickets from 1,821 fixed speed cameras in school zones and crash data, this study employs interrupted time-series, spatial distribution, clustering analysis, and Survival Analysis with a random effect (SARE) to investigate if such a program brings about immediate and/or long-term change in speeding behaviors and crash reduction.

Data and Methods

1. Short-Term Analysis

Through this approach, we evaluate the immediate impact of speed cameras in reducing speeding behavior and intersection-related crashes in the first four months following their installation (first month as baseline).

2. Long-Term Analysis

Used **ARIMA interrupted time-series analysis (ITSA)** to identify whether a specific intervention introduced led to significant changes in the behavior & **K-means clustering with the elbow method**, to assess the effectiveness of the speed cameras over time.

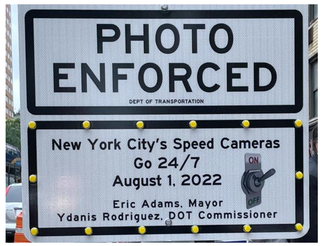
$$y_t = c + \varphi_1 y_{t-1} + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \varepsilon_t$$

3. Crash Analysis: Survival analysis with random effect (SARE)

To properly evaluate the safety effectiveness of the speeding cameras, a before-after analysis approach proposed by Xie et al. (26), named survival analysis with random effect (SARE) approach, is adopted to conduct the before-after crash analysis. SARE Relaxes the requirement for the reference group and can accommodate different start time of the safety treatments across sites.

$$f(t_{ij}|\lambda_{ij}) = \lambda_{ij}\, exp(-\lambda_{ij} t_{ij})$$

$$\log(\lambda_{ij}) = \beta_0 + \beta_T \mathrm{Treatment}_{ij} + \varepsilon_j$$



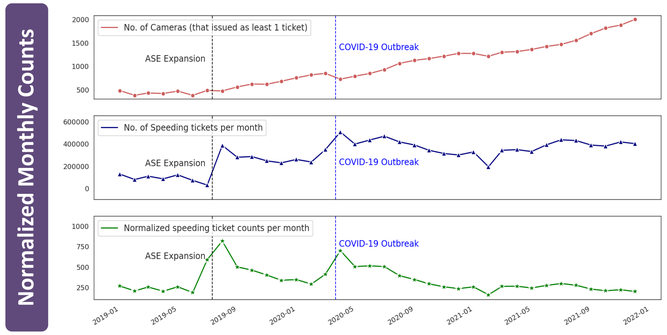
DATA:

1. **School Zone Speeding Tickets**
2. **Reported Motor Vehicle Collisions**

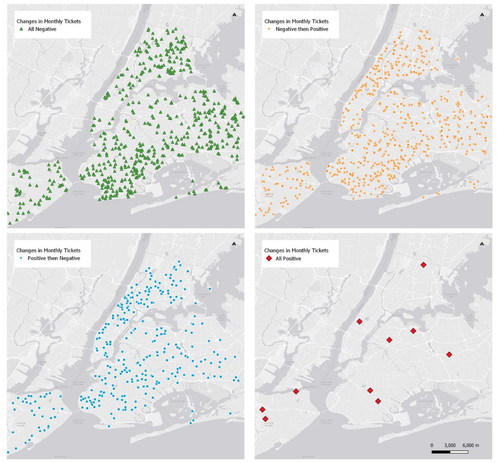
Results and Takeaways

1. Short-term analysis (1800+ cameras, 4-month post-installation)

- Exclude cameras installed 4 months prior to the COVID-19 outbreak.
- Findings show a consistent downward trend over three months, indicating a reduction in speeding tickets post-camera deployment, although the magnitude of the average change also decreased each month, from -18.4% to -0.6%.

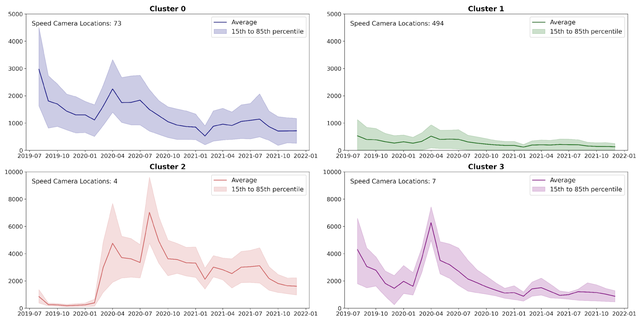


- **All Negative Group (Green)**: 589 cameras (37%).
- **Positive then Negative Group (Blue)**: 333 cameras (21%).
- **Negative then Positive Group (Orange)**: 333 cameras (41%)
- **All Positive Group (red)**: 10 cameras (1%); found mostly on long road segments (800 - 3400 feet), may requiring further validation.



2. Long-term analysis (600+ cameras, 2.5-year after camera installation)

- ITSA found **ASE program expansion**, **Time after ASE program expansion**, and **Time after outbreak of COVID-19** all **Statistically significant.**
- **Clusters 0 and 3** (14%) have been highly effective; **Cluster 1** (85%) also effectively reduced speeding, but with a relatively modest/minor effect**; Clusters 2, and 3** see persistent speeding issues due to COVID-19 impacts by end of 2021.



3. Crash Analysis

SARE estimated treatment effect is -0.142 which corresponds to a 0.867 ($e^{-0.142}$) CMF with a 95% Bayesian Credible Interval (BCI) of [0.842, 0.895].

Estimated parameters of the SARE method

	Mean	Std.	2.5% BCI	97.5% BCI
Intercept	-2.716	0.038	-2.789	-2.645
Treatment Effect	-0.142	0.016	-0.172	-0.111
Dispersion	0.786	0.046	0.699	0.875

4. Takeaways

- **Short-Term Analysis: 93% showed an overall reduction** in tickets in the first 4 months, indicating overall success.
- **Long-Term Analysis:** Over 2.5 years, a **75% reduction** in tickets was observed by end of 2021 post-expansion.
- **Cluster Analysis Insights**: Most cameras effectively curbed speeding **within 6 months of installation**. A few showed no significant reductions and drastic increases during COVID, indicating a need for alternative safety measures.
- **Crash analysis**: Provided statistically significant evidence of a **14% decrease in traffic crashes** following the implementation of speed cameras.

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