World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

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Measuring policy efficacy: A spaciotemporal and predictive analysis of gun legislation in New York city

Michael Mutsa Munanairi *

David D. Reh School of Business, Clarkson University, USA.

World Journal of Advanced Research and Reviews, 2025, 28(02), 1612–1618

Publication history: Received on 08 October 2025; revised on 17 November 2025; accepted on 19 November 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.28.2.3893

Abstract

This study aims to measure the efficacy of gun legislation in New York City by conducting a spatiotemporal and predictive analysis of historical shooting incidents. The research analyzes NYPD data from 2006 to 2023 to identify long-term trends, geographic hotspots, and demographic profiles of victims. Utilizing Tableau for data visualization and forecasting, the methodology involves mapping incident concentrations, analyzing temporal patterns, and projecting future violence rates to establish a benchmark for policy evaluation. Key findings reveal a significant decline in gun incidents following legislative packages in 2007 and 2013, suggesting initial policy success. However, a pronounced surge post-2020 indicates the limitations of existing laws, with violence concentrated in the Bronx and Brooklyn and disproportionately affecting Black males aged 25-44. The predictive forecast does not project a decline but a continuation of elevated violence levels. The study concludes that while legislative frameworks are necessary, they are insufficient alone. A paradigm shift is urgently needed, coupling smart gun regulations with targeted investments to address the underlying socio-economic drivers of violence for a more effective and holistic public safety strategy.

Keywords: Gun Violence; Policy Efficacy; Spatiotemporal Analysis; Predictive Modeling; New York City; NYPD Data; Public Safety

1. Introduction

Gun violence has been a persistent and damaging public health and safety challenge across the United States of America. While New York Police Department (NYPD) and other state organs work rigorously to extinguish this threat, a strategic, futuristic solution requires the use of a data-driven comprehension of the clustering of the shootings, how they are spread over time, the targets or affected demography and possibly predicting where they are likely to occur next. This is essential to enable stage organs to come up with effective polices to curb this threat and assist them as they allocate state resources for this cause. This research will address this by analyzing NYC shooting data to scrutinize the above-mentioned areas of concern and influence effective, target-based, proactive interventions.

1.1. Background of the study

The debate on gun legislation's efficacy is long-standing and multifaceted, characterized by conflicting evidence and evolving perspectives. Early research by [1] set a foundational tone, arguing that the gun laws of that era were too weak to reduce violence. This perspective finds a modern echo in the work of [9], who contends that gun control is inherently ineffective for crime reduction and primarily serves as a mechanism for "people control," positing that armed citizens are a more effective deterrent. Conversely, other research provides evidence supporting legislative intervention. [2], focusing on suicide rates, demonstrated that gun availability significantly increases firearm-related suicides. More directly, [5] analyzed New York's own SAFE Act and concluded it reduced gun incidents, though explicitly noting the need for further research on how such laws function. This call for a deeper, more nuanced understanding is critical. The

* Corresponding author: Michael Mutsa Munanairi

challenge of measuring pure policy impact is compounded by significant non-legislative factors, including a culture of fear and individualism that drives gun ownership [6] and broader societal issues like mental health and media influence [9].

This complex evidential landscape exists within a highly polarized political environment where the morality and efficacy of gun laws are intensely contested [7]. Despite this polarization, surveys indicate significant public support for gun legislation across political groups, including Republicans ([3]; [4]). However, this support must be reconciled with serious equity concerns, as research by [8] reveals that the enforcement of gun laws has historically disproportionately targeted Black communities, though some measures like the SAFE Act may enhance safety without exacerbating disparities. Given these conflicting arguments, methodological limitations in past studies, and the critical need for objective analysis, a new approach is required. This study directly responds to [5] call for deeper investigation by moving beyond traditional methods. It employs a spatiotemporal and predictive analysis of NYC shooting data to cut through the ideological stalemate and provide a data-driven, granular measurement of gun policy efficacy, offering a framework for proactive and equitable resource allocation.

1.2. Research objectives

- Spatially analyze data and expose persistent geographic gun-incident hotspots and correlate their behavior with gun-control measures.
- Analyze incident trends and identify anomalies.
- Create a demographic profile of the victims and find out the most affected to inform public health and/or victim services.
- Develop a predictive, statistical model that predicts future shooting risks based on past data, patterns and other indicators.

1.3. Problem Statement

Gun-related violence is a huge public health threat in the United States despite decades of legislative action and academic debate. This is evident specifically in urban centers like New York City. The impact of gun control policies is mired in a deep and polarized conflict, with empirical studies yielding contradictory conclusions as some affirm the crime-reducing impact of specific laws like the SAFE Act [5], while others fundamentally question the premise that restricting firearm access reduces violence. This stalemate is further complicated by critical, non-legislative factors, including socio-cultural drivers, significant equity concerns in enforcement, and strong but disconnected public opinion. Policymakers in NYC are left without a clear, objective, and granular understanding of how, where, and when gun legislation impacts criminal activity. Existing research methodologies have proven insufficient to cut through this complexity, often failing to account for the spatiotemporal dynamics of crime and lacking predictive power. This gap is explicitly acknowledged in the literature, with calls for more sophisticated analysis to build stronger evidence on policy function. Therefore, a critical problem exists, there is a lack of a robust, data-driven framework capable of measuring the spatiotemporal efficacy of gun legislation and predicting its future impact on violence patterns in New York City. This study directly addresses this problem by developing and applying a spatiotemporal and predictive model to determine the true operational impact of gun policies, thereby moving the conversation from ideological contention to empirical, actionable intelligence.

1.4. Purpose of the study

The purpose of this study is to determine the efficacy of gun legislation in New York City by conducting a spatiotemporal and predictive analysis of historical shooting data. This research aims to objectively measure the impact of policies on violence patterns, identify future high-risk areas, and provide a data-driven framework to guide proactive and equitable resource allocation and policy design.

2. Methodology And Materials

The analysis was conducted using a dataset of gun violence incidents provided by the New York City Police Department (NYPD). The dataset, spanning from 2006 to 2024, contains detailed records of each shooting event, encapsulated in the following key variables

- Incident Identifiers: INCIDENT_KEY
- Temporal Variables: OCCUR_DATE, OCCUR_TIME
- Geographical Variables: BORO, PRECINCT, X_COORD_CD, Y_COORD_CD, Latitude, Longitude
- Location Context: LOC_OF_OCCUR_DESC, LOC_CLASSFCTN_DESC, LOCATION_DESC

- Victim Demographics: VIC_AGE_GROUP, VIC_SEX, VIC_RACE
- Perpetrator Demographics: PERP_AGE_GROUP, PERP_SEX, PERP_RACE (noting potential limitations due to unsolved crimes)
- Incident Severity: STATISTICAL_MURDER_FLAG

2.1. Data Processing and Cleaning

Prior to analysis, the dataset underwent a rigorous preprocessing stage within Tableau Prep and Tableau Desktop to ensure data integrity. Removed duplicate entries, corrected misreported dates, and standardized age and sex classifications based on official IDs. Incidents with missing or inconsistent data (e.g., <1% of records) were flagged and excluded.

2.2. Field Standardization

Categorical fields like VIC_AGE_GROUP and VIC_RACE were reviewed for consistency in naming conventions (e.g., ensuring "BLACK" and "BLACK HISPANIC" were distinct categories). The OCCUR_DATE field was used to create a 'Year' dimension to facilitate temporal trend analysis.

2.2.1. Analytical Framework

A multi-pronged analytical approach was employed to assess gun violence patterns and policy efficacy: Analyzed annual incident counts to identify long-term patterns, periods of stability, and significant shifts in violence over time. Investigated the intersection of victim age, sex, and race to identify the most active groups in terms of gun incidents. Mapped incident locations to visualize geographical concentrations and compared trends across major boroughs to identify high-burden areas. Projected future incident rates based on historical data to establish a quantitative benchmark for evaluating the success of future policy interventions.

2.3. Software and Tools

The entire analysis was conducted using the Tableau software suite (Tableau Desktop and Tableau Prep). Tableau was selected for its robust capabilities in data visualization, intuitive drag-and-drop interface for exploratory data analysis, and powerful mapping and forecasting functions

2.4. Data Privacy Considerations

The dataset did not include actual names of person(s) but instead, included reported incidents, descriptions and locations. As such, the people's privacy has been protected.

Limitations of the study

This study lacks social and economic factors that might influence gun violence. These include income levels, education, religion among other socio-economic demographics. Also, the data included spans only up to 2023, any other incidences after this period have not been considered and as such, should they be significant, further or refined research might need to be undertaken to have updated analysis. Underreporting, there is a possible omission of unreported shootings or even misclassified incidents. The dataset did not have the data for 2024 to 2025; to cater for this, we used past data to predict the levels where we expect the gun incidences to lie within.

3. Findings

This following table shows total demographics in the 4 Boroughs of NYC, namely age and sex.

3.1. Demographics

The 25-44 age group dominates the gun violence incidents in NYC. This age group represents the epicenter of the crisis for both males and females. Furthermore, males (M) are overwhelmingly more involved in gun violence, outnumbering females (F) across every single age group. Gun incident involvement generally decreases as age increases, with 65+ population being the least involved.

This is a trend analysis that shows average gunshot related incidences per year across all the boroughs between 2006 – 2023.

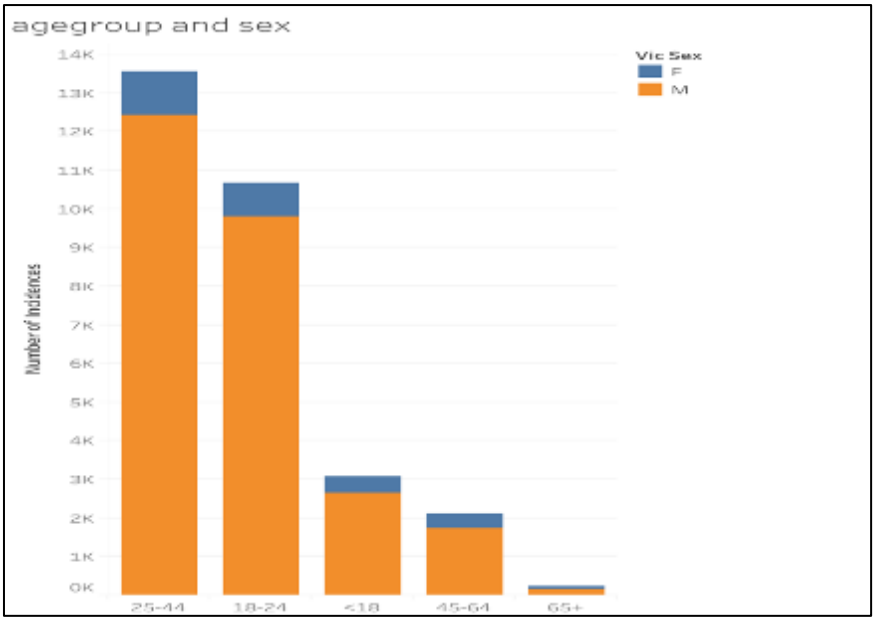

Figure 1 Demographics (Age group and Sex)

3.2. Average Gunshots per Year

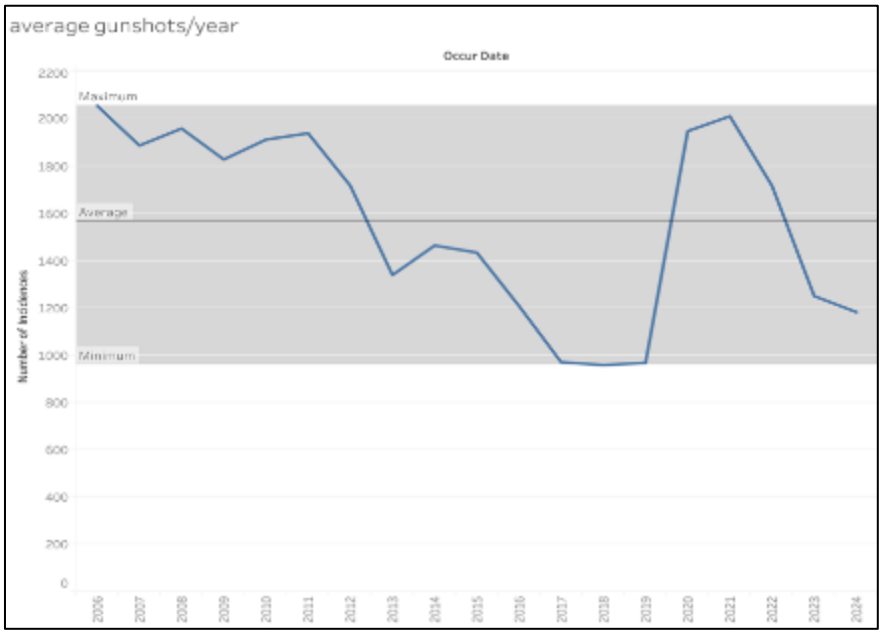

Figure 2 Average Gunshots/Year

The period from roughly 2012 to 2019 shows a relatively stable or even declining trend in the average number of gunshots. This period could represent the "status quo" under the gun legislation and policing strategies that were in effect at the time. It serves as a crucial baseline against which to compare subsequent changes.

3.3. Incident Trends

Fig 3 shows that gun violence is not evenly distributed geographically. The Bronx and Brooklyn are the epicenters of the crisis, consistently reporting the highest number of incidents year after year. While all boroughs saw an increase, the absolute increase was largest in the Bronx and Brooklyn due to their higher baseline.

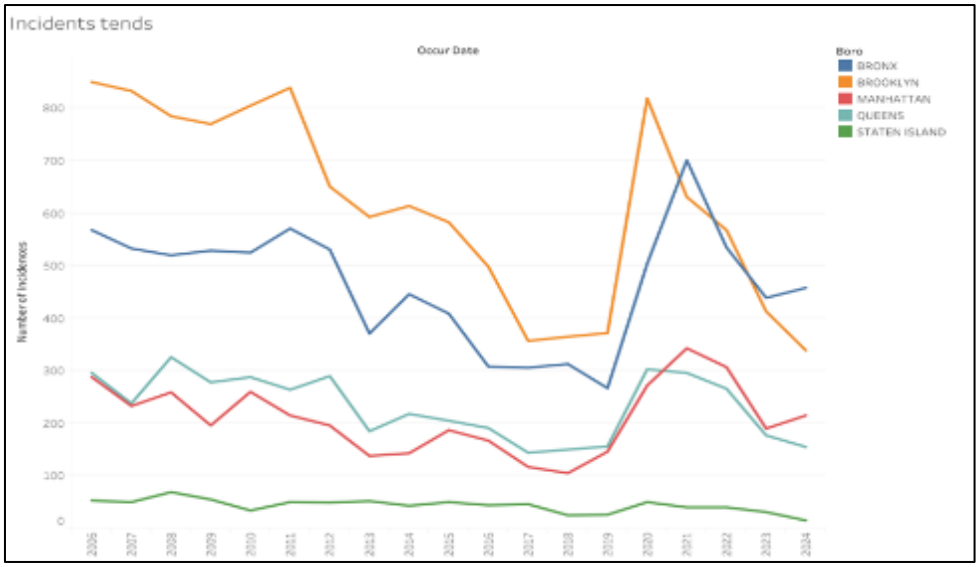

Figure 3 Incident Trends

3.4. Ethnicity

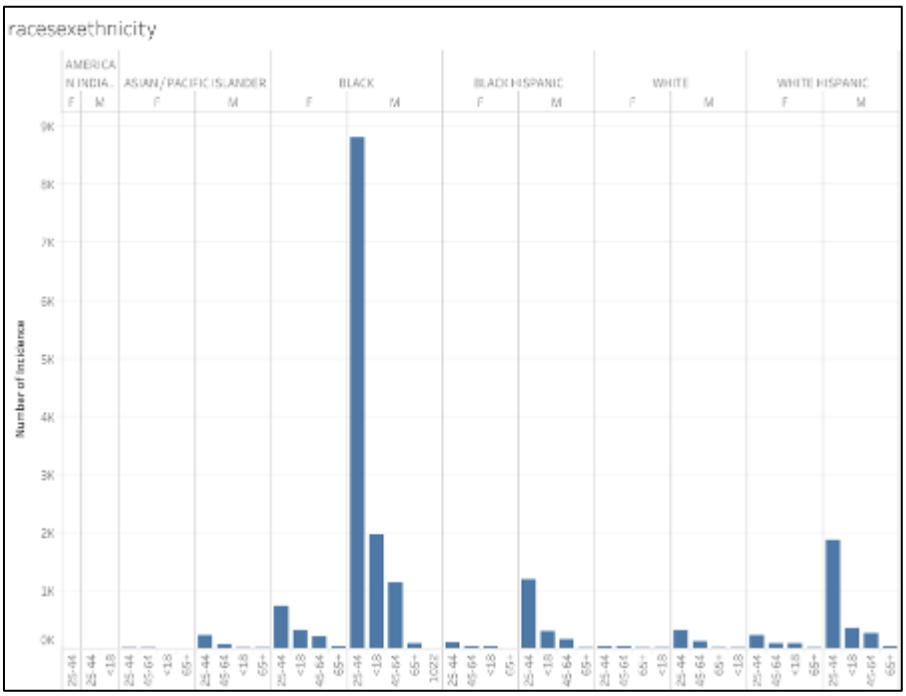

Figure 4 Ethnicity

Fig 4 shows that the highest-risk profile is a Black or Hispanic Male, aged 25-44.

This table indicates the racial profile of gun related incidents in NYC. The data shows that the “black” profile features the most while White, Asian and Hispanic feature less.

3.5. Forecasts

This forecast establishes a critical benchmark. The predicted values for 2025-26 represent what we can expect if current trends continue unchanged. The success of any new or existing policy will be measured against this forecast. If actual data for 2025 falls significantly below this forecasted line, it would be strong evidence of policy efficacy.

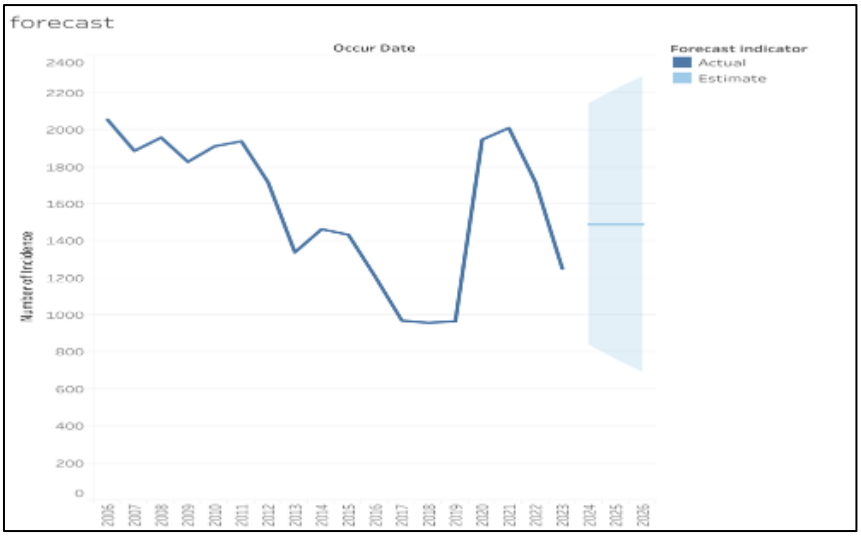

Figure 5 Forecasts

4. Discussion

In 2007, the US Assembly passed a comprehensive gun safety package aimed at tightening existing loopholes in state and federal procedures relating to gun licensing, regulation and other mental health information. From the trend analysis in Fig 2, there is an overall decline in average gun shots/incidences from 2007 to 2019. This trend suggests that this legislation directly addressed the systematic failure that enabled the tragedy to take place. High risk purchases may have been minimized as gun records were now being monitored and risky individuals were now being denied permission to purchase guns.

The NY SAFE Act of 2013 initiated the downward pressure on gun incidents in NYC by creating a stricter regulatory regime. The downward trend noticed (in Fig 3) between 2013 and 2020 was further reinforced and sustained by the 2019 Gun Safety Legislative Package, which provided more targeted, preventative tools to intervene before violence could occur. Together, these laws created a multi-layered legal framework that made it progressively more difficult for firearms to fall into the wrong hands and for potentially violent situations to escalate, directly contributing to the declining trend witnessed in the data. Fig 3 identifies Brooklyn and Bronx as the primary geographic targets for intervention. The dramatic spike around 2020 indicates that the drivers of the surge were city-wide and not confined to a specific area. A key measure of policy efficacy would be to see if post-2020 policies are successful in driving down the numbers in these two critical boroughs. A policy that only reduces violence in lower-incidence boroughs like Staten Island or Manhattan while the Bronx and Brooklyn remain elevated would be of limited overall success. Financial resources, police patrols, violence interruption programs, and social services aimed at reducing gun violence must be disproportionately concentrated in the Bronx and Brooklyn to have the greatest city-wide impact.

Despite the previous downward trend, data from 2022 indicates a concerning rise in gun incidents according to Fig 2. This is despite the introduction of the Concealed Carry Improvement Act. The average number of gunshots remains significantly elevated in 2021, 2022, and 2023 compared to the pre-2020 baseline. This suggests that the factors causing the surge were not temporary but have had a lasting impact. This reversal is likely attributable to a confluence of powerful, external factors that emerged in the post-pandemic period. These include the profound social and economic disruptions of COVID-19, persistent challenges in policing and criminal justice, and the continued proliferation of illegal firearms, particularly ghost guns, which bypass all background check systems. This underscores that the existing legislative framework, while robust in regulating legal gun ownership, shows critical inefficiencies in addressing the deeply rooted social drivers of violence and the evolving challenges of the illegal firearms market.

Fig 5 tries to forecast gun related incidences based on past data. The forecast does not predict a decline but instead projects a continuation of the post-2020 plateau of high violence. This is a powerful finding that suggests the factors driving the surge are now embedded and will not resolve on their own. It underscores the urgent need for effective policy action to disrupt this trend. The primary value of a forecast is to enable policymakers to move from a reactive to a proactive stance. Fig 1 indicates that the most dominant race, with regards to gun violence in NYC, are black males of the 25-44 age group. These are arguably the most active individuals in society. This is quite an alarming statistic, considering that the opportunity cost here would be beneficial productivity from the same individuals that would

benefit the state and the nation. There haven't been age specific gun laws as of late, as most gun laws take a holistic approach and are laid out and executed equally to all citizens regardless of age. From Fig 3, we can determine that the most affected Boroughs are Brooklyn and Bronx. There is a need to analyze the demographics and other social factors related to these to have a deeper understanding on why they stand out in such a negative statistic.

5. Conclusion

In conclusion, while legislative action from 2007 to 2019 created a necessary regulatory framework that contributed to a decline in gun incidents, its limitations are now clear. The post-2022 resurgence in violence, concentrated heavily among Black males aged 25-44, reveals that laws alone cannot address the root causes of this crisis. The profound loss of productivity and potential from this key demographic underscores an urgent need for a paradigm shift. Effective long-term safety requires coupling smart gun regulations with targeted investments to tackle the underlying socio-economic disparities that fuel violence, moving beyond a one-size-fits-all legal approach to a more holistic, community-focused strategy.

Compliance with ethical standards

Acknowledgments

I wish to express my profound gratitude to the individuals whose unwavering support made this research possible. My sincere thanks go to my cousin for her invaluable emotional and educational support. Her insights as a fellow Data Science student at Clarkson University were a constant source of encouragement. I am eternally grateful to my wife, Ishah Nyapimbi, for her endless patience, understanding, and steadfast belief in my work. Her strength provided the foundation upon which I could build.

Statement of informed consent

The data used in this study were obtained from open-access datasets available on the internet. Participants were not required to provide informed consent because these datasets did not contain identifiable personal information.

Disclosure of conflict of interest

The author, Mr. Michael Mutsa Munanairi, confirms that there is no competing interest with the manuscript or publication, nor any institution or products mentioned in the manuscript or publication.

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