The Effect of ShotSpotter Technology on Police Response Times

Mini Conference

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Motivation:

Gun Violence in the US:

- 2021: Most gun fatalies ever (Pew Research Center)
- 2022: 647 mass shootings (Gun Violence Archive)
- All-time high mistrust of police (Washington Post)

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Solution?

- ShotSpotter Technology
  - Gunshot dectection
  - "Colorblind"
- Widespread (150+ cities)
  - Our setting: Chicago
- Costly: $9 million a year

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Research Question:

How does investment in ShotSpotter affect the time allocation of scarce police resources ?

- Priority 1: 911 Call-to-dispatch / Call-to-on-scene

Why do we care about response times?

> “If police can arrive within one minute of the commission of an offense, they are more likely to catch the suspect. Any later and the chances of capture are very small, probably less than one in ten.”- (Baley 1996)

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Support for Reponse Times:

- Lower response times results in:
  - Less likelihood of an injury (DeAngelo et. al. 2023)
  - Higher crime clearance (Blanes i Vidal and Kirchmaier 2018)
- Rapid response most important (College of Policing 2013)
- Enhance community trust

Why would ShotSpotter affect response times?

Police Forces:

- A fixed amount of daily resources

ShotSpotter Resource-Intensive:

- Respond to every alert (Priority 1)
- ~60 ShotSpotter dispatches a day
- ~20 minutes inspecting the scene

Time Wasted?

- Does this time investment come at the expense of other important 911 calls?

Summary of Paper:

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Setting:

- Chicago: 2016-2022
  - Second largest police force
  - Third largest city

Data:

- All 911 dispatches from Chicago
- Merge with:
  - Police shifts
  - Crime/arrest data
  - ShotSpotter alerts

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Empirical Strategy:

- Staggered difference-in-difference
  - Variation: ShotSpotter rollouts across police districts
  - Remove ShotSpotter dispatches

Main Results:

- For other reported crimes:
  - +2.5 minutes in call-to-dispatch
  - +3 minutes in call-to-on-scene
- Lower arrest rates + lower gun victimization

Contribution:

First economics study to provide causal analysis on ShotSpotter

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Related Literature:

ShotSpotter Specific

Police Technology

Rapid Response

Gun Control

We find unintended (increased response times/lower arrest rates) and intended (lower gun violence) outcomes.

- Economics:
  - Use ShotSpotter as data for alternative crime/mistrust measure (Carr and Doleac 2018, Ang et. al 2021)
- Non-Econonomics:
  - Mixed response time results (Mazerolle et al. 1998, Mares and Blackburn 2021)

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We find detrimental consequences of an expensive, resource-intensive, technology.

- Benefits of Police Technology:
  - Body Worn Cameras $\rightarrow$ lower use of force/complaints (Zamoff et al.2021, Braga et al.2022, Ferrazares 2023)
  - Predictable Policing $\rightarrow$ less crime (Mastourbi 2020)
  - Tactical Equipment $\rightarrow$ less crime (Bove and Gavrilova 2017, Harris et al. 2017))

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We identify a determinant of higher response times, and can quantify at a micro-level.

- Effects of Response Times:
  - Less likelihood of an injury (DeAngelo et. al. 2023)
  - Higher crime clearance (Blanes i Vidal and Kirchmaier 2018)

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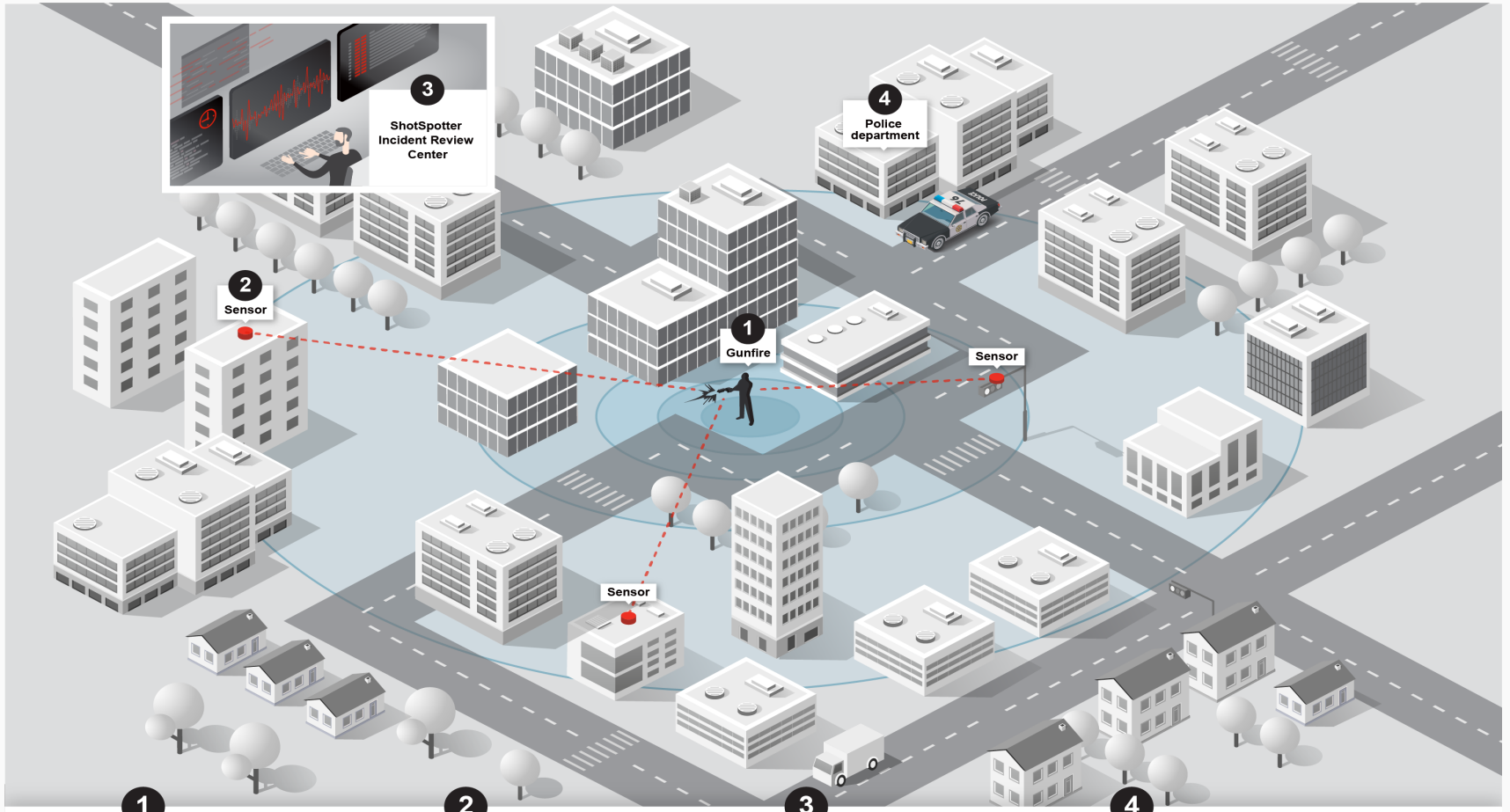
We find evidence of lower gun victimization, linked directly to a police operating procedure.

- Alternative Studies:
  - Gun-access policies (Colmer and Doleac 2022)
  - Direct, personal intervention (Bhatt et al. 2023)

What is ShotSpotter and how does it work?



1 Gun is fired

When a gun is fired, the sound of a muzzle blast radiates outward.

2 Gunshot is Detected and Located

Acoustic sensors are triggered by the impulsive sound. The sound is classified as a gunshot using artificial intelligence and triangulation determines the precise location.

3 Gunshot is Reviewed

The data is relayed to the ShotSpotter Incident Review Center where analysts quickly audit the data and publish confirmed gunshots to police.

4 Police Respond

Alerts are sent to dispatch centers and patrol officers' smartphones and MDTs for immediate response. The entire process takes less than 60 seconds.

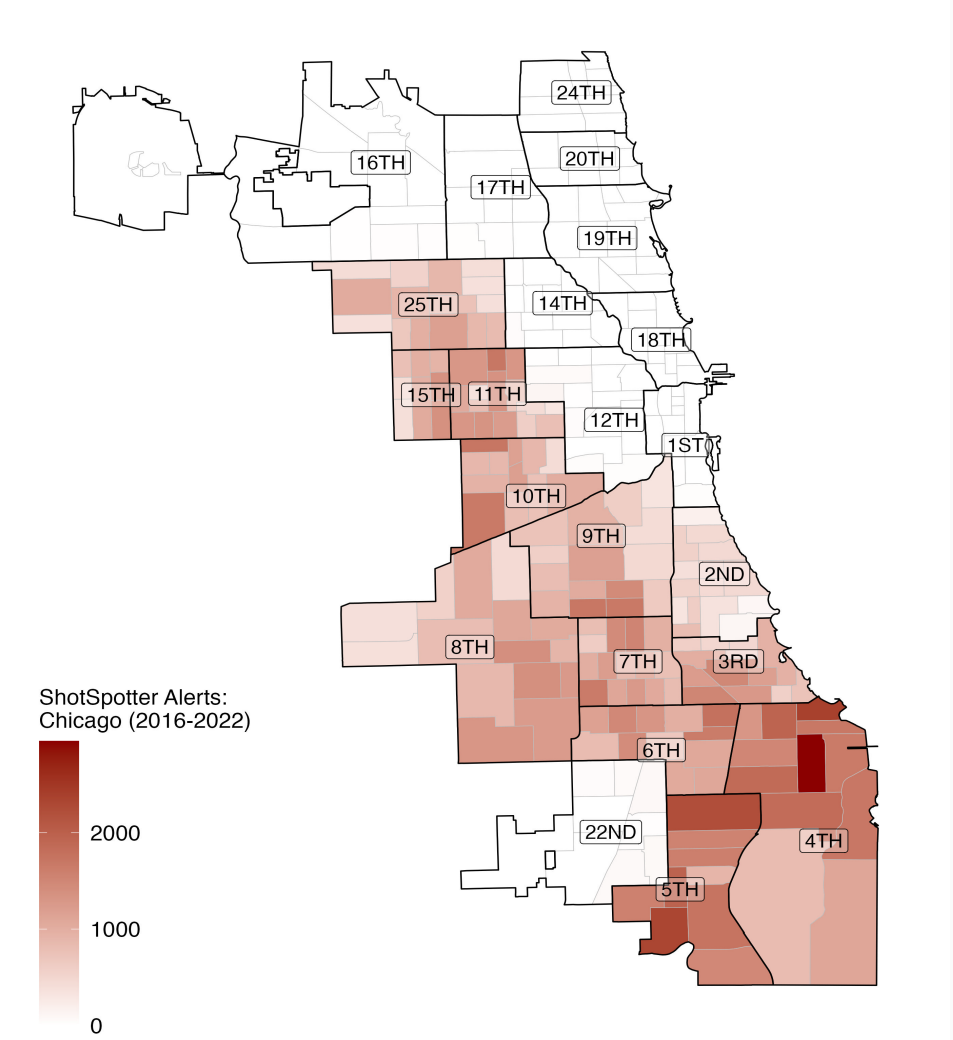
ShotSpotter in Chicago:

Staggered Rollout

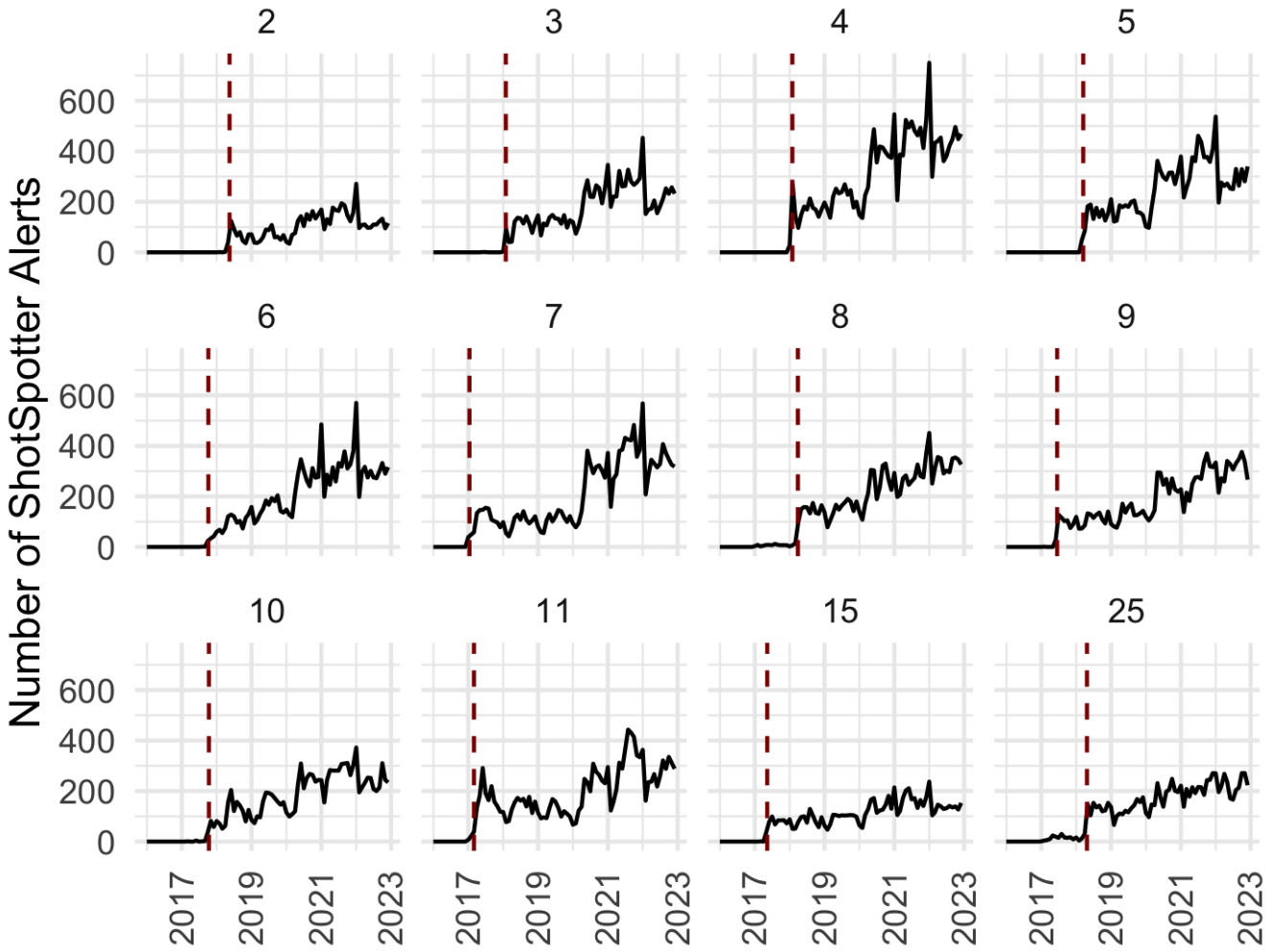
- 12 of 22 police districts in 2017-2018

High Priority

- Priority 1 (immediate dispatch)
  - Active shooter, domestic disturbance
  - ~5% of all Priority 1 dispatches
- Priority 2 (rapid dispatch)
  - Suspicious person, car accident
- Priority 3 (routine dispatch)
  - Noise disturbance, parking violation



ShotSpotter Alert Trends/Averages:



District	Mean Shots
2	3.509
3	6.072
4	10.731
5	8.243
6	7.097
7	6.926
8	7.578
9	6.372
10	6.244
11	6.611
15	3.833
25	5.823

Estimation Strategy:

Specification (OLS):

$$Y_{d,t} = \beta ShotSpotterEnacted_{d,t} + \gamma_d + \delta_t + \lambda \mathbb{X}_{d,t} + \epsilon_{d,t}$$

Estimation Strategy:

Specification (OLS):

$$Y_{d,t} = \beta ShotSpotterEnacted_{d,t} + \gamma_d + \delta_t + \lambda \mathbb{X}_{d,t} + \epsilon_{d,t}$$

- **Remove all ShotSpotter dispatches**
- $Y_{d,t}$ is an outcome of average **daily** time (in seconds) in police district d in time t
  - 911 Call-to-Dispatch/911 Call-to-On-Scene
- $ShotSpotterEnacted_{d,t}$ is the binary treatment
- γ_d is a police district-specific fixed effect
- δ_t is a day-by-month-by-year fixed effect
- $\mathbb{X}_{d,t}$ is a vector of controls:
  - Officer hours, number of 911 calls (by priority)
- Standard errors clustered by police district
- β - average change in average daily response time

Main Results:

Call-to-Dispatch | Call-to-On-Scene | Arrest Rate | Gun Victimization

	Priority 1		Priority 2	Priority 3
	(1)	(2)	(3)	(4)
ShotSpotter Activated	145.065***	150.687***	152.540**	149.532
	(47.147)	(46.273)	(56.951)	(87.657)
Mean of Dependent Variable	321.128	321.128	435.705	1134.520
Observations	55,792	55,792	55,791	55,792
FE: Day-by-Month-by-Year	X	X	X	X
FE: District	X	X	X	X
Gardner (2021) Robust Estimator		X		
Note:				
* p < 0.1, ** p < 0.05, *** p < 0.01				

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	Priority 1		Priority 2	Priority 3
	(1)	(2)	(3)	(4)
ShotSpotter Activated	199.123***	225.513***	256.031***	169.860
	(57.157)	(51.487)	(71.394)	(100.071)
Mean of Dependent Variable	872.166	872.166	1123.717	2130.285
Observations	55,791	55,791	55,676	55,764
FE: Day-by-Month-by-Year	X	X	X	X
FE: District	X	X	X	X
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	Priority 1		Priority 2	Priority 3
	(1)	(2)	(3)	(4)
ShotSpotter Activated	-0.008***	-0.009***	0.003	0.007**
	(0.002)	(0.003)	(0.004)	(0.003)
Mean of Dependent Variable	0.148	0.148	0.143	0.128
Observations	55,792	55,792	55,791	55,792
FE: Day-by-Month-by-Year	X	X	X	X
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Call-to-Dispatch | Call-to-On-Scene | Arrest Rate | **Gun Victimization**

	OLS		Poisson
	(1)	(2)	(3)
ShotSpotter Activated	-0.077**	-0.089**	-0.082
	(0.033)	(0.036)	(0.072)
Mean of Dependent Variable	0.364	0.364	0.365
Observations	56,254	56,254	56,122
FE: Day-by-Month-by-Year	X	X	X
FE: District	X	X	X
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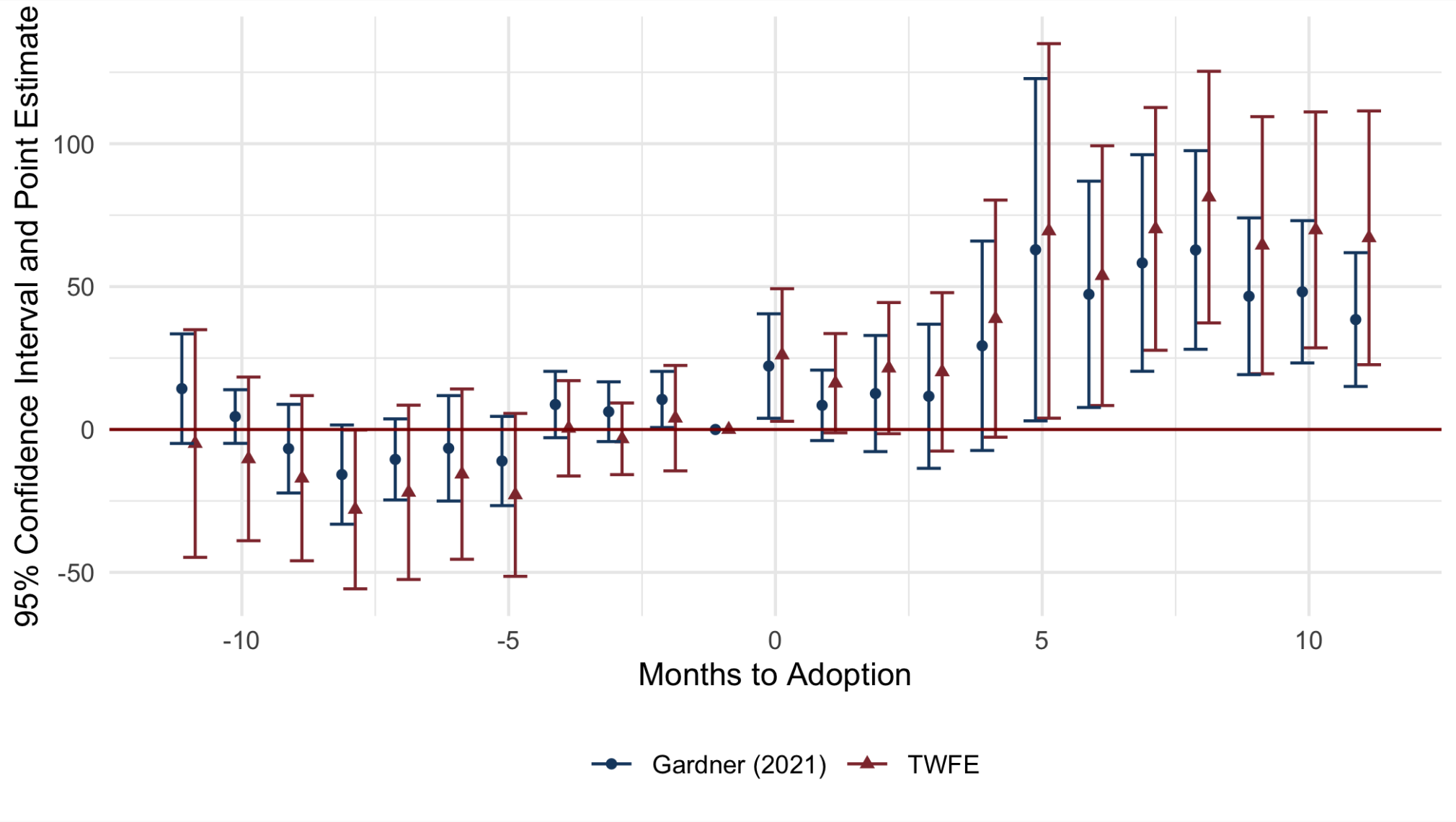
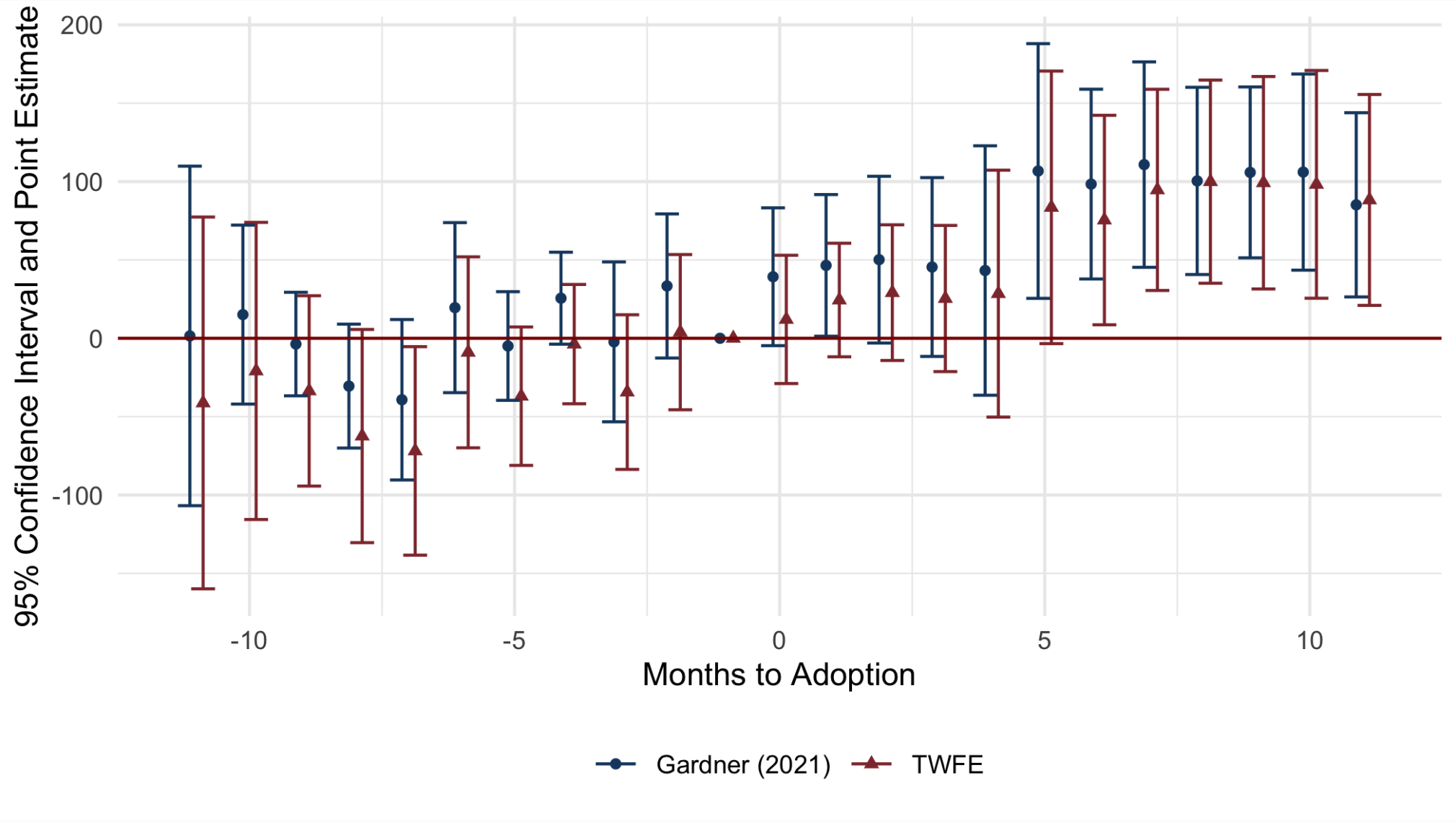
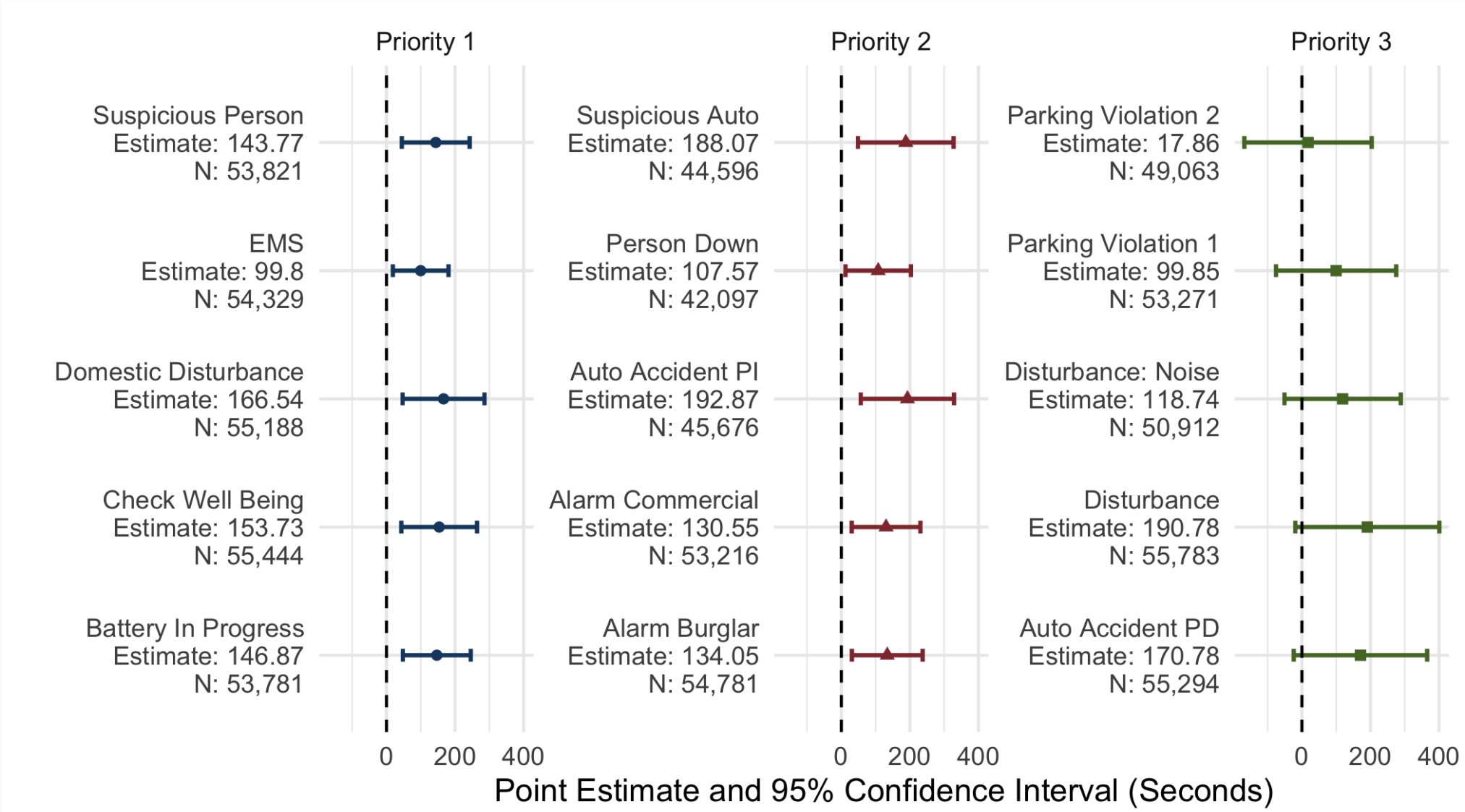
Dynamic Effects: Call to Dispatch (Priority 1)



Dynamic Effects: Call to On-Scene (Priority 1)



Call to Dispatch Times (seconds): Top 5



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Robustness:

- TWFE Robust Estimators
- Sample Selection:
  - Remove 2020 (Covid)
  - Remove never-treated
- Leave-one-out

Heterogeneity:

- Break-downs by:
  - Officer Hours
  - Weekdays/Weekends

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Intensive Margin:

- Alternative Variation: Alerts
  - (RHS): Gunshot alert $\rightarrow$ random event
  - 1 additional alert = +18 seconds to dispatch

Conclusion:

Main Takeaways:

- First causal policy analysis of ShotSpotter:
  - Unintended Consequences:
    - Higher priority 1 response times (omitting ShotSpotter dispatches)
      - Call-to-Dispatch (+2.5 minutes/ 45% increase)
      - Call-to-On-Scene (+3 minutes/ 22% increase)
    - Lower arrest rates for priority 1 (5% decrease)
  - Intended Consequence
    - Lower gun victimization (suggestive evidence)
- For further research:
  - Cost-benefit analysis
  - Other suggestions?