

# The Effect of ShotSpotter Technology on Police Response Times

Mini Conference

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Michael Topper and Toshio Ferrazares  
University of California, Santa Barbara  
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# Motivation:

## State of Crime in the US:

- Gun violence has increased relative to pre-Covid
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- Costly (~9 million a year)

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## Research Question:

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

# 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 Response Times:

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

# 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
  - Daily level
- Variation: ShotSpotter rollouts

## Main Results:

- Longer dispatch/arrival times:
  - +2.5 minutes in call-to-dispatch
  - +3 minutes in call-to-on-scene
- Lower arrest rates
  - 5% decrease in arrests made

# Contribution:

First economics study to provide causal analysis on ShotSpotter

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## Related Literature:

### ShotSpotter Specific

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

### Police Technology

### Rapid Response

### Gun Control

- Economics:
  - Use ShotSpotter as data for alternative crime/mistrust measure (Carr and Doleac 2018, Ang et. al 2021)
- Non-Economics:
  - No violent crime effect, mixed response time results (Mares and Blackburn 2021)
  - Lower hospital travel time (Goldenberg et al. 2019)
  - Lowered response times (Mazerolle et al. 1998)

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Police Technology

Rapid Response

Gun Control

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

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

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## Related Literature:

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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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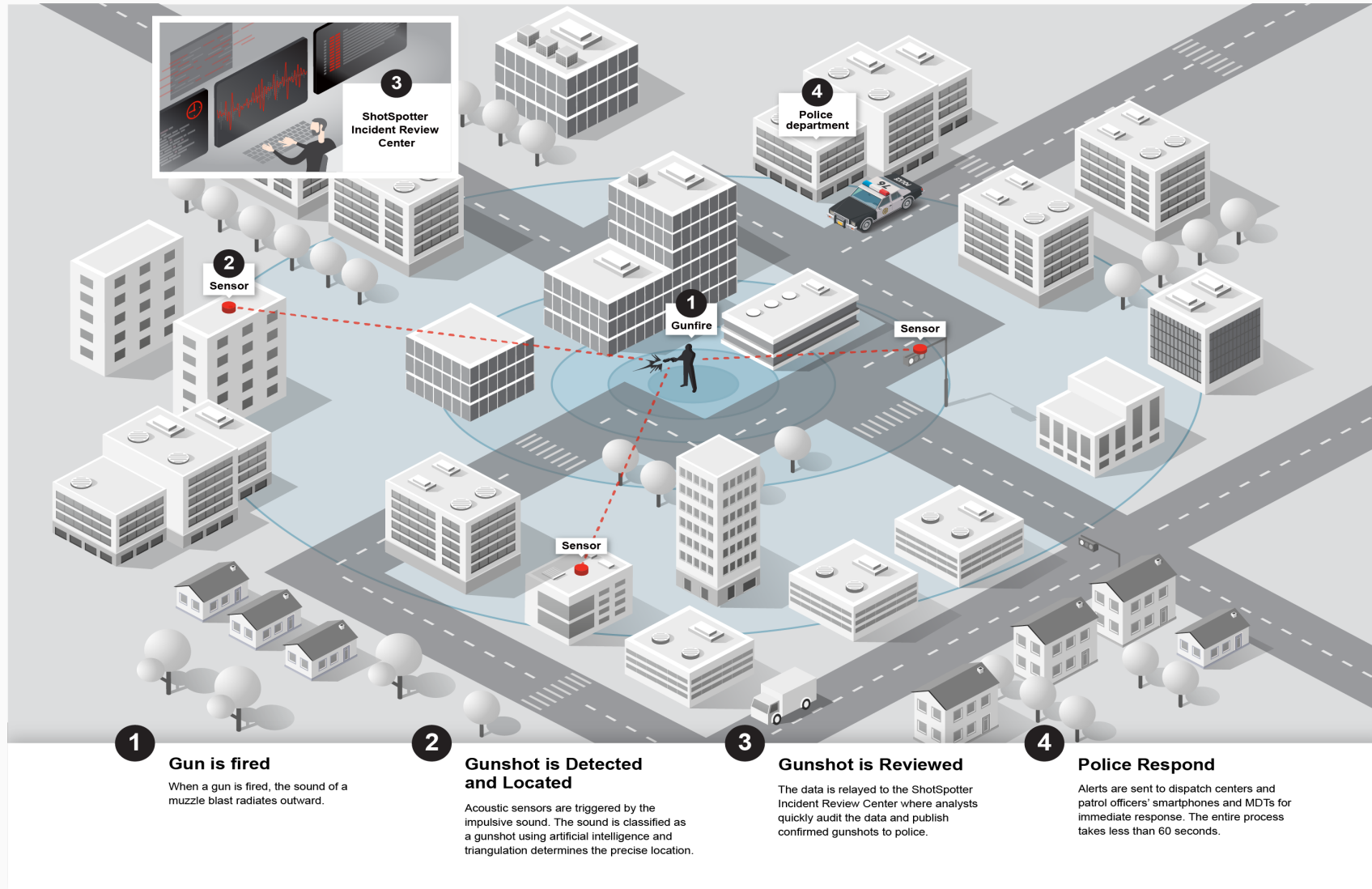
Rapid Response

Gun Control

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?



# ShotSpotter in Chicago:

## Staggered Rollout

- 12 of 22 police districts in 2017-2018

## High Priority

- Priority 1 (immediate dispatch)
  - Treated similarly to an active shooter
  - ~5% of all Priority 1 dispatches
- Priority 2 (rapid dispatch)
- Priority 3 (routine dispatch)



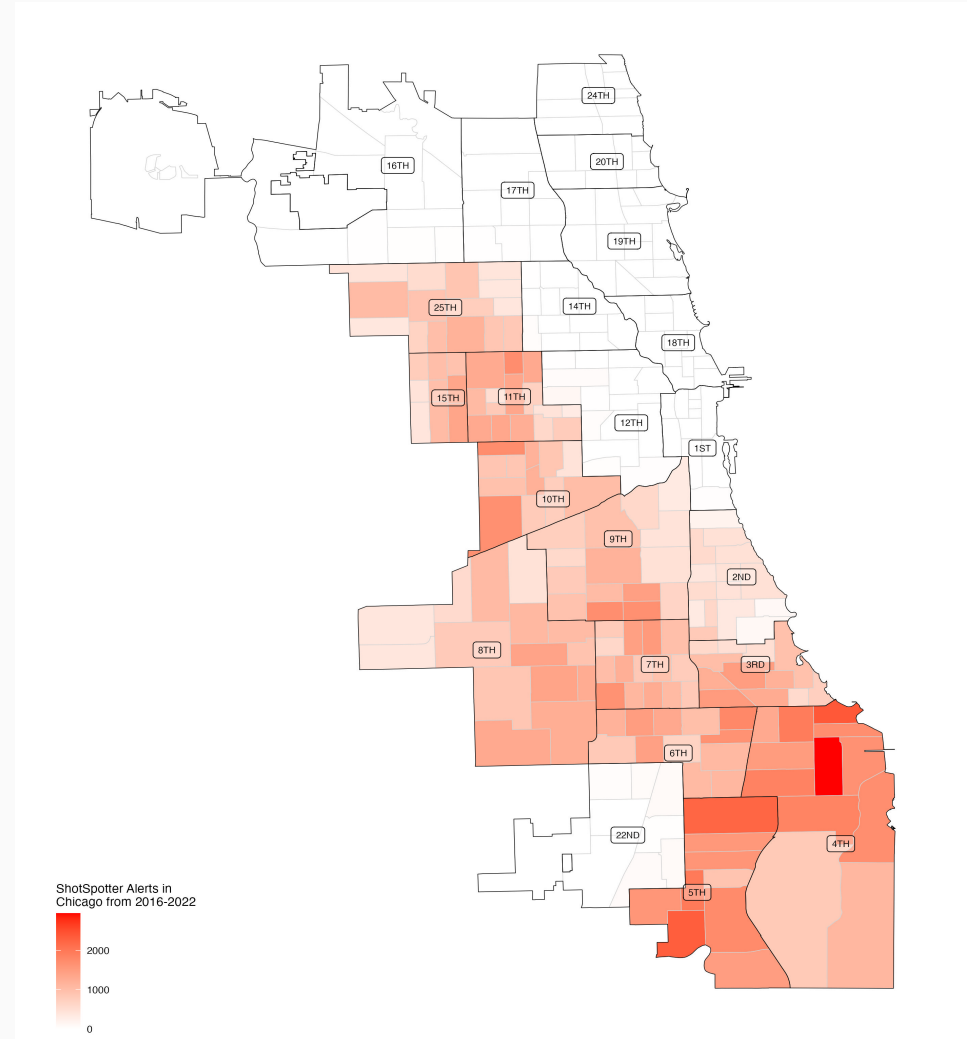
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## Staggered Rollout

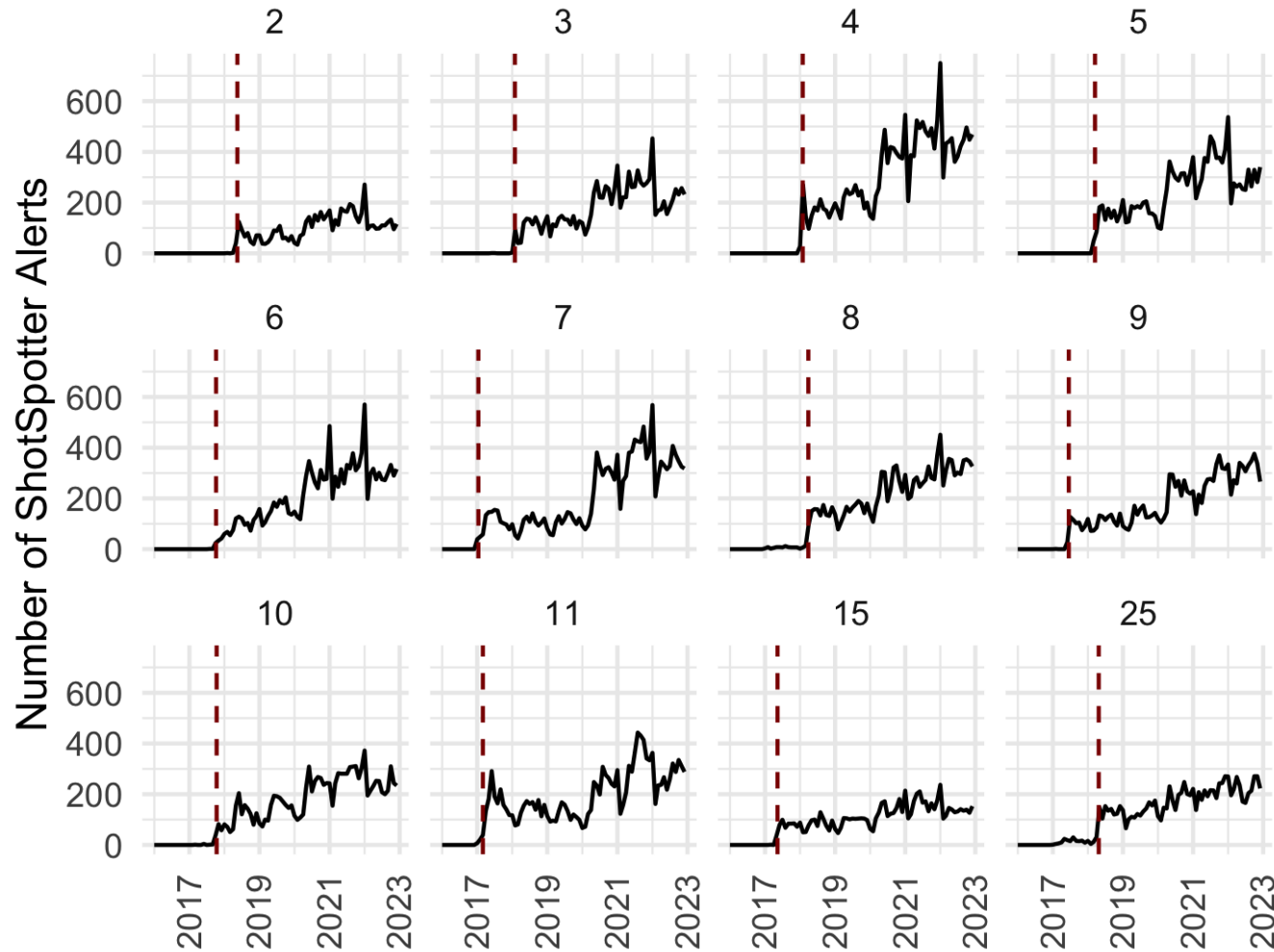
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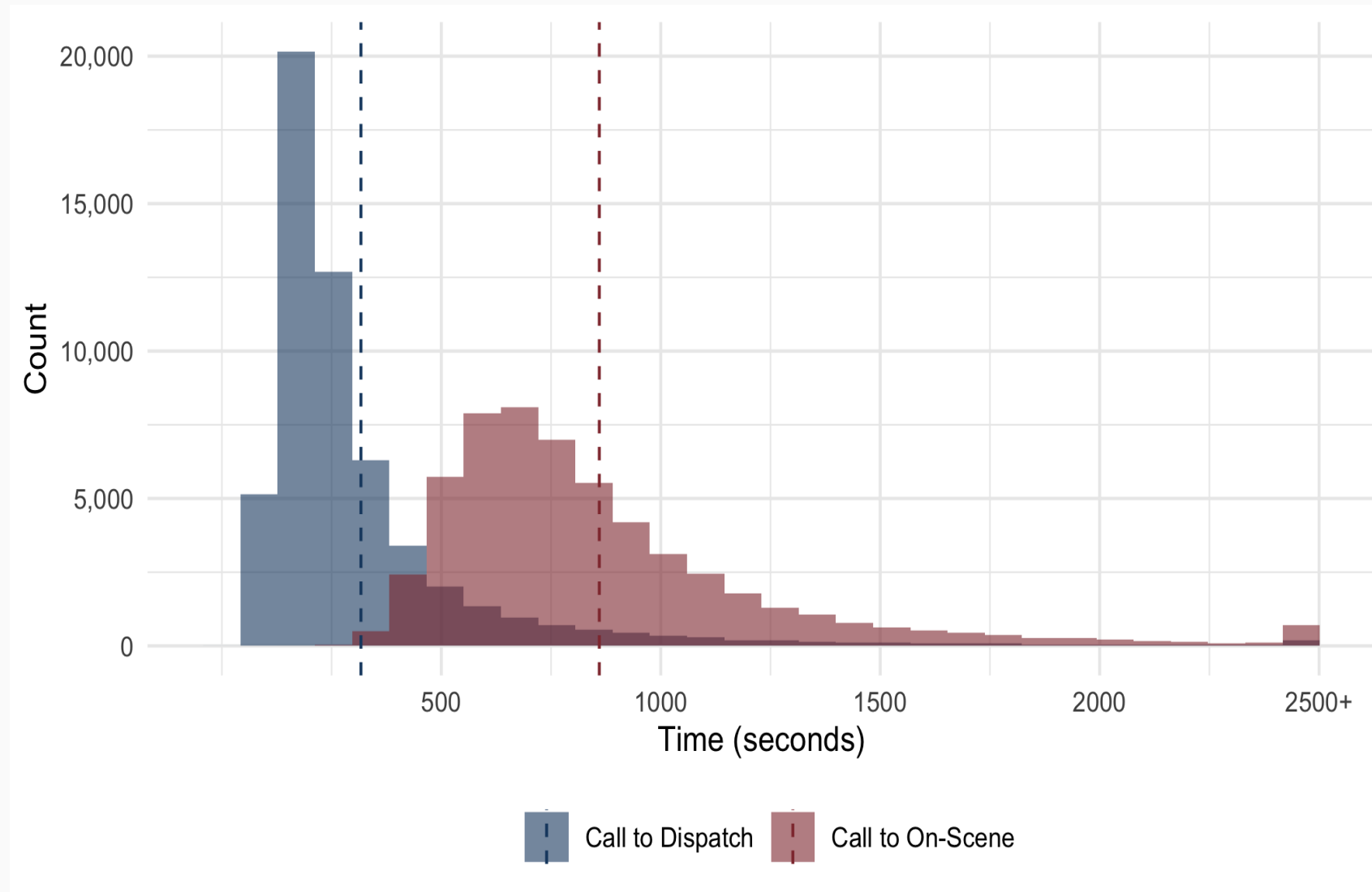


# ShotSpotter Alert Trends/Averages:



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

# Distribution of Outcome Variables:



# Estimation Strategy:

Specification (OLS):

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

# Estimation Strategy:

## Specification (OLS):

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

- $Y_{d,t}$  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
- $\text{ShotSpotter}_{d,t}$  is an indicator variable when ShotSpotter technology is activated in police district  $d$  in time  $t$
- $\gamma_d$  is a police district-specific fixed effect
- $\delta_t$  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

# Main Results:

## Effect on Call-to-Dispatch

## Effect on Call-to-On-Scene

## Effect on Arrest Rate

	Priority 1			Priority 2	Priority 3
	(1)	(2)	(3)	(4)	(5)
ShotSpotter Activated	142.944***	145.065***	143.342***	150.284**	136.856
	(50.035)	(47.147)	(47.086)	(56.958)	(84.475)
Border Activated			11.959	15.664	87.982*
			(29.343)	(38.531)	(48.981)
Mean of Dependent Variable	321.128	321.128	321.128	435.705	1134.520
Observations	55792	55792	55792	55791	55792
FE: Day-by-Month-by-Year	X	X	X	X	X
FE: District	X	X	X	X	X

*Note:*

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

# Main Results:

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Effect on Call-to-On-Scene

Effect on Arrest Rate

	Priority 1			Priority 2	Priority 3
	(1)	(2)	(3)	(4)	(5)
ShotSpotter Activated	201.154***	199.123***	197.026***	246.724***	155.646
	(58.395)	(57.157)	(57.101)	(70.981)	(99.956)
Border Activated			14.564	66.127*	98.844
			(32.708)	(33.988)	(62.111)
Mean of Dependent Variable	872.166	872.166	872.166	1123.717	2130.285
Observations	55791	55791	55791	55676	55764
FE: Day-by-Month-by-Year	X	X	X	X	X
FE: District	X	X	X	X	X

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# Main Results:

Effect on Call-to-Dispatch

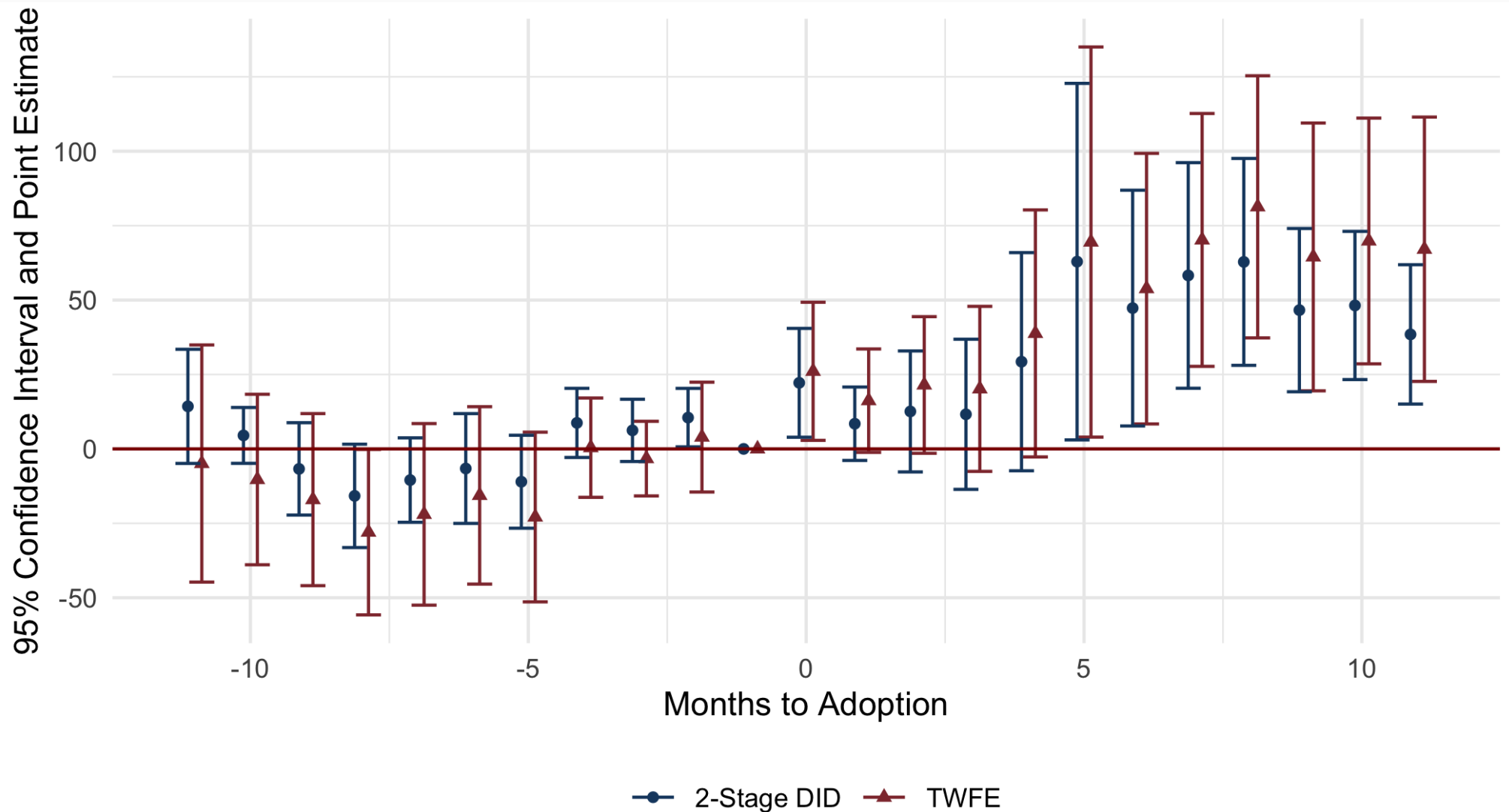
Effect on Call-to-On-Scene

Effect on Arrest Rate

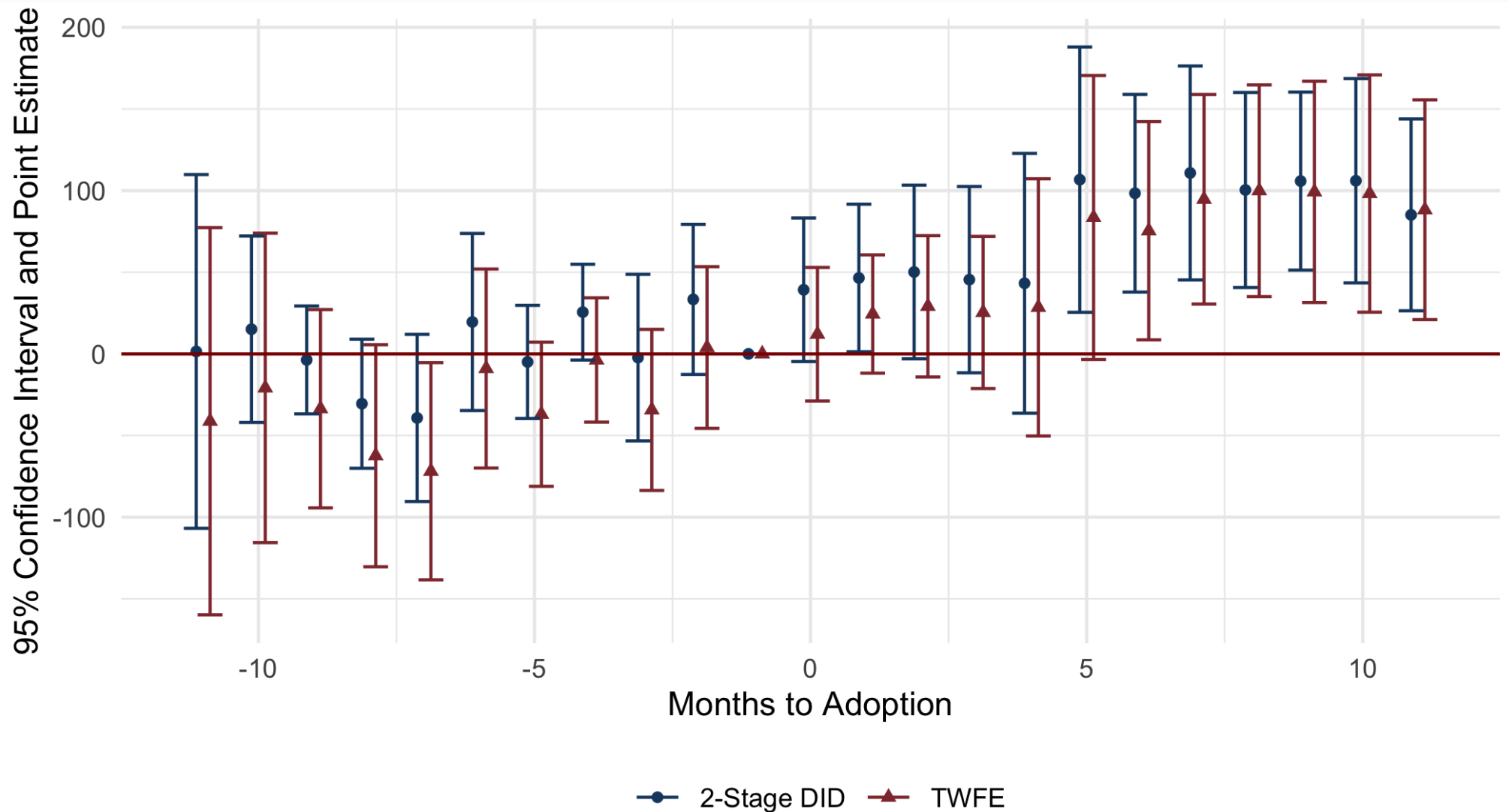
	Priority 1	Priority 2	Priority 3
	(1)	(2)	(3)
ShotSpotter Activated	-0.008***	0.003	0.007**
	(0.002)	(0.004)	(0.003)
Mean of Dependent Variable	0.148	0.143	0.128
Observations	55792	55791	55792
FE: Day-by-Month-by-Year	X	X	X
FE: District	X	X	X
<i>Note:</i>			
* p < 0.1, ** p < 0.05, *** p < 0.01			



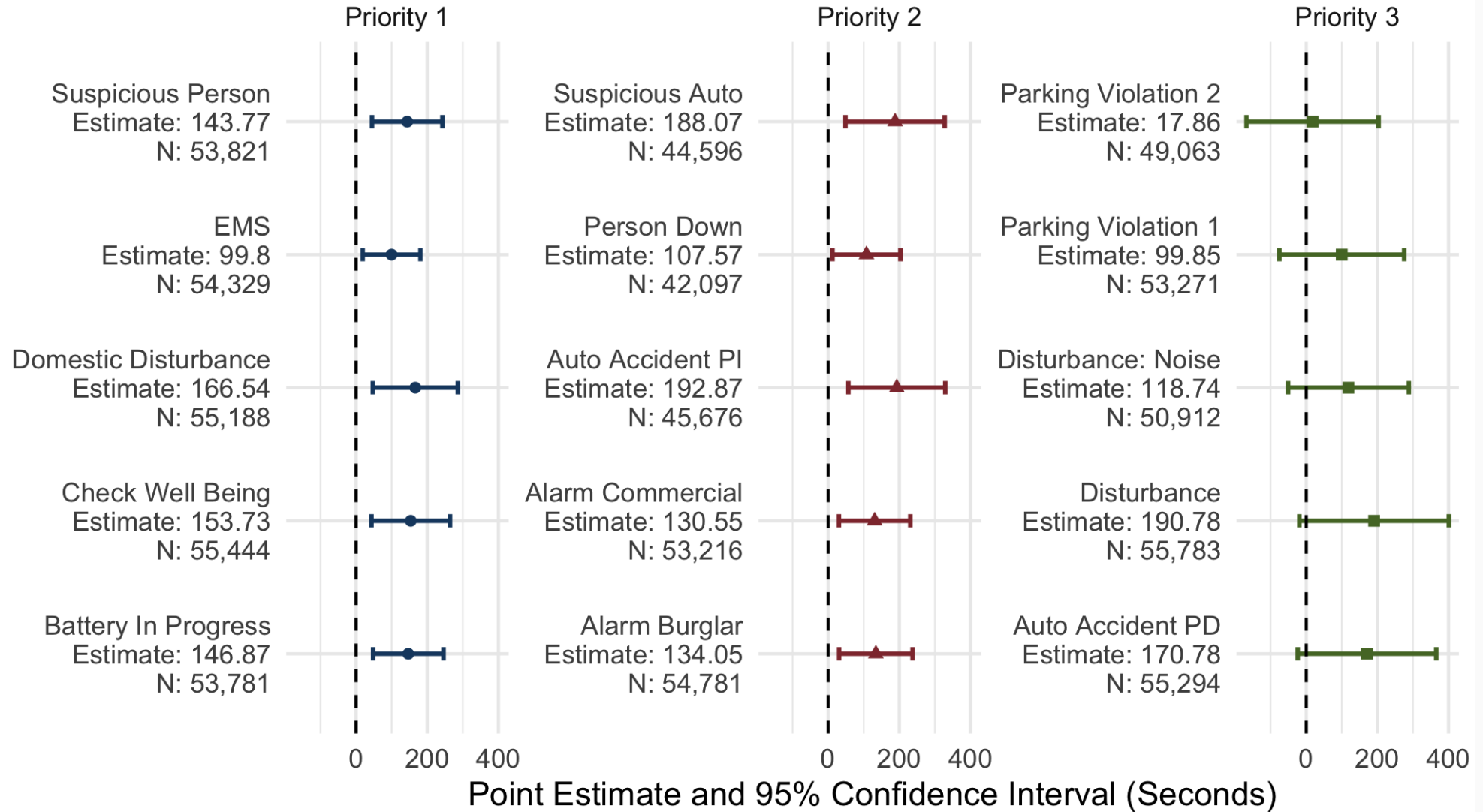
# Dynamic Effects: Call to Dispatch (Priority 1)



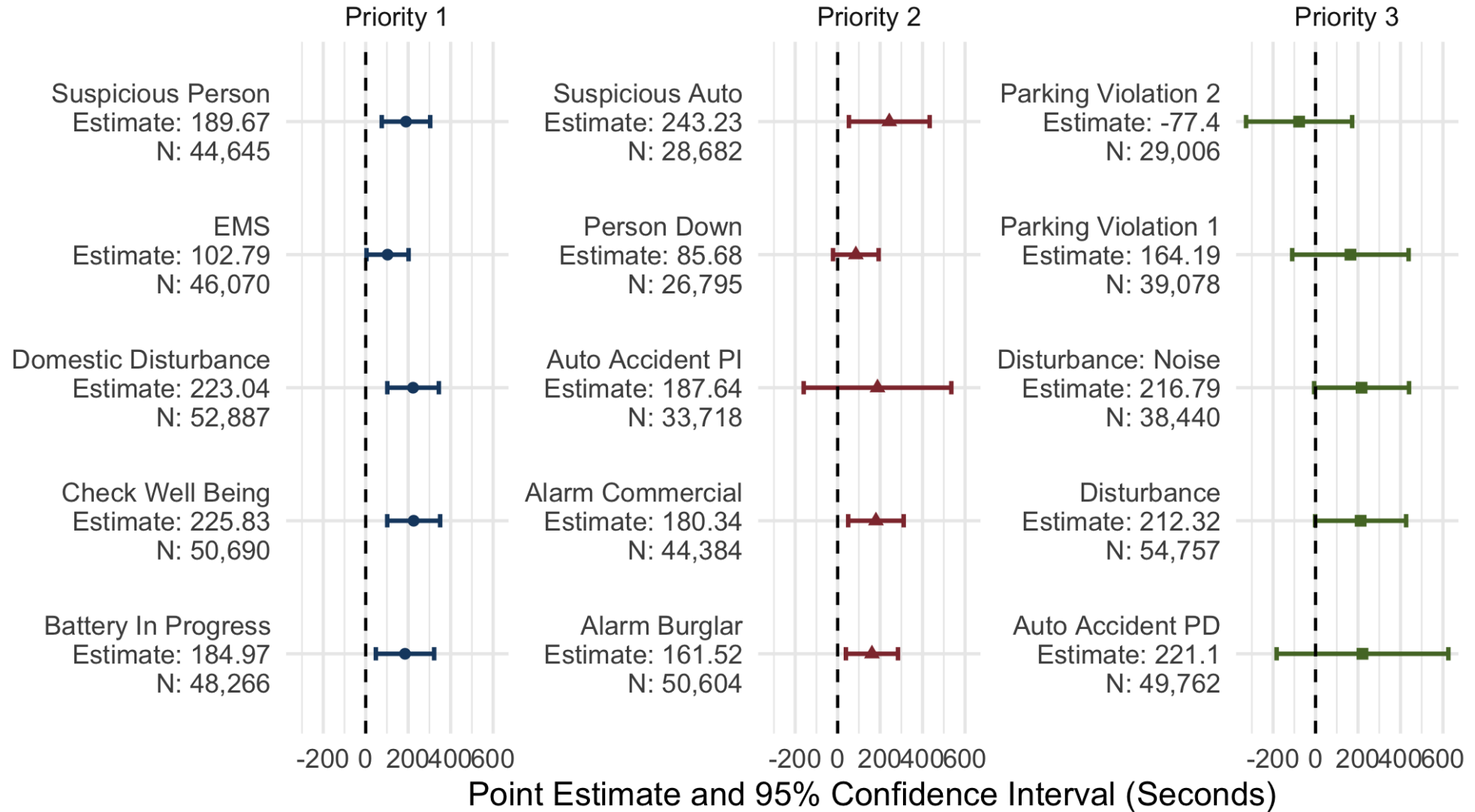
# Dynamic Effects: Call to On-Scene (Priority 1)



# Call to Dispatch Times (seconds): Top 5



# Call to On-Scene Times (seconds): Top 5



# Other Analysis:

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## Robustness:

- TWFE Robust Estimators
- Alternative Variation: Alerts
  - 1 additional alert = +18 seconds to dispatch
- Sample Selection:
  - Remove 2020 (Covid)
  - Remove never-treated

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## Heterogeneity:

- Break-downs by:
  - Officer Hours
  - Weekdays/Weekends
  - Night/day (in progress)

# Conclusion:

## Main Takeaways:

- First causal policy analysis of ShotSpotter:
  - Unintended Consequences:
    - Higher Dispatch/On-Scene Times for Priority 1 (2.5/3.0 minutes)
    - Lower Arrest Rates for Priority 1 (5% decrease)
  - Intended Consequence
    - Lower Gun Victimization
- For further research:
  - Cost-benefit analysis
  - Other suggestions?