STA 660 - Data Analysis Practicum

LMPD Traffic Stop Analysis

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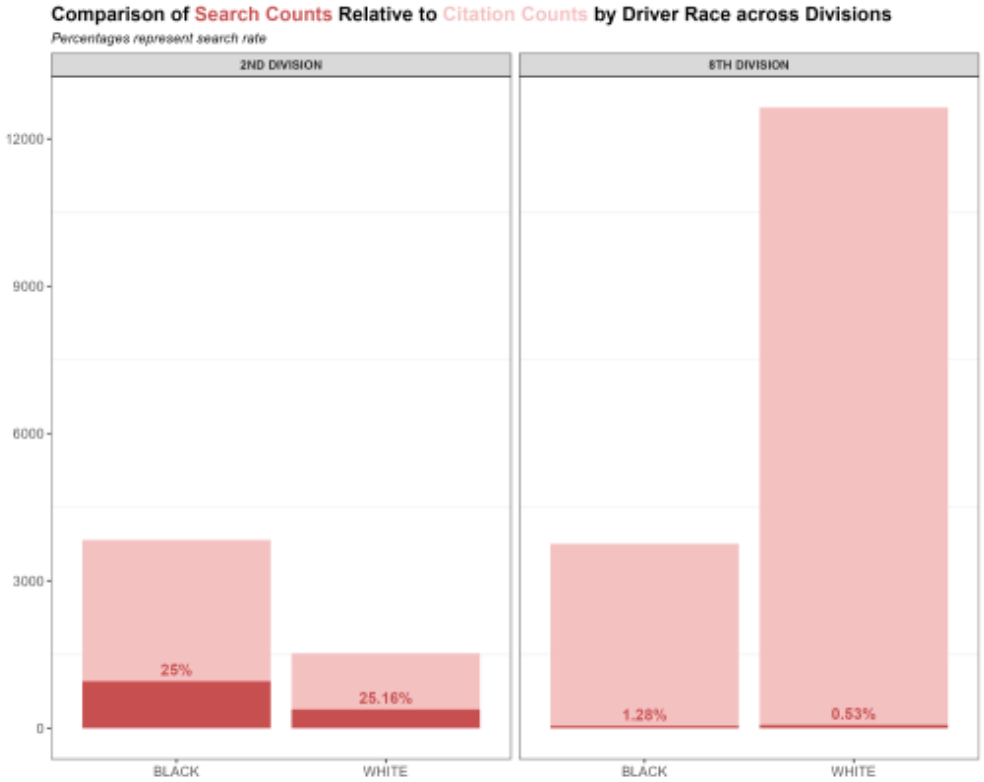
Introduction

- Research question: How do racial dynamics between drivers and officers affect the likelihood of a search during traffic stops in Louisville's richest and poorest divisions, and how do these effects vary by time of day?
- Motivations:
  - Do Black drivers face higher search rates than White drivers, despite Louisville's majority-White population?
  - Understanding search rate differences by time of day can inform better police staffing
- Implications:
  - Identify and address racial and socioeconomic disparities in policing through data-driven insights
  - Develop equitable staffing and training programs that promote non-discriminatory practices, equal opportunity, and public safety

Data

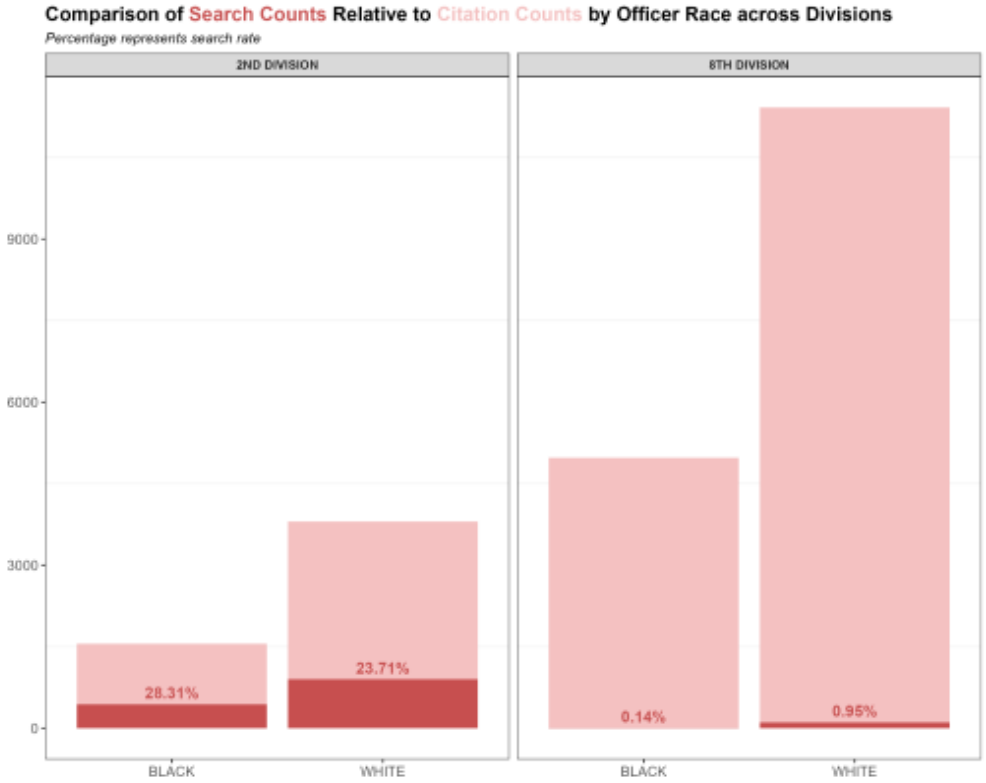
- Citations and searches of Black and White drivers by Black and White officers in Division 2 (least affluent) and Division 8 (most affluent) from 2019 to 2022
  - Measure of affluence is based on median income
  - **Division 8 (Zip Code 40206)**: Median income $175,156, predominantly White (94.9%)
  - **Division 2 (Zip Code 40202)**: Median income $5,856, predominantly Black (86.4%)
    (Source: https://www.city-data.com/income/income-Louisville-Kentucky.html)
- The time when the citation was issued is categorized into two groups
  - Daytime: 6 AM to 6 PM
  - Nighttime: 6 PM to 6 AM

Exploratory Data Analysis



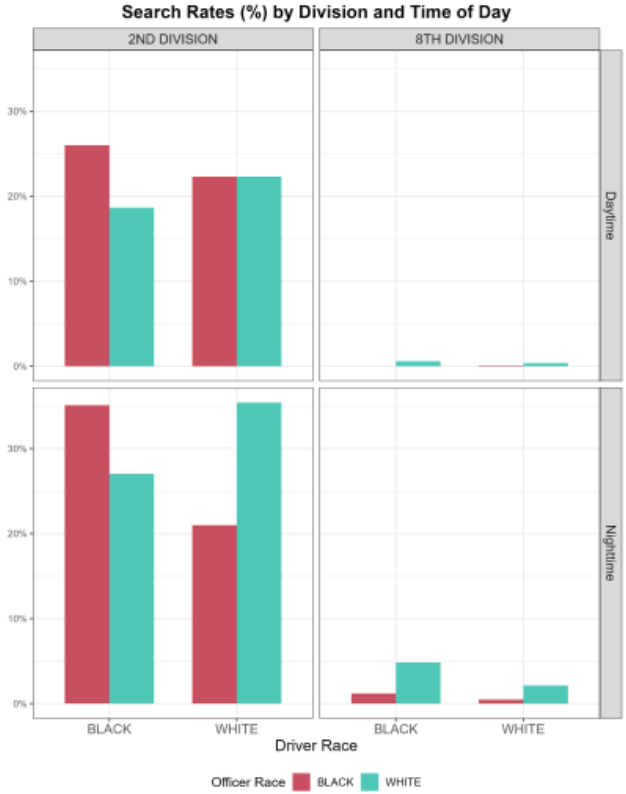
- The number of citations in division 8 (16,398) is three times the number in division 2 (5,358)
- Only 0.7% of stops resulted in searches in most affluent division as compared to 25% in least affluent division
- But there is **significantly** lower search rate in division 8 than in division 2

Exploratory Data Analysis



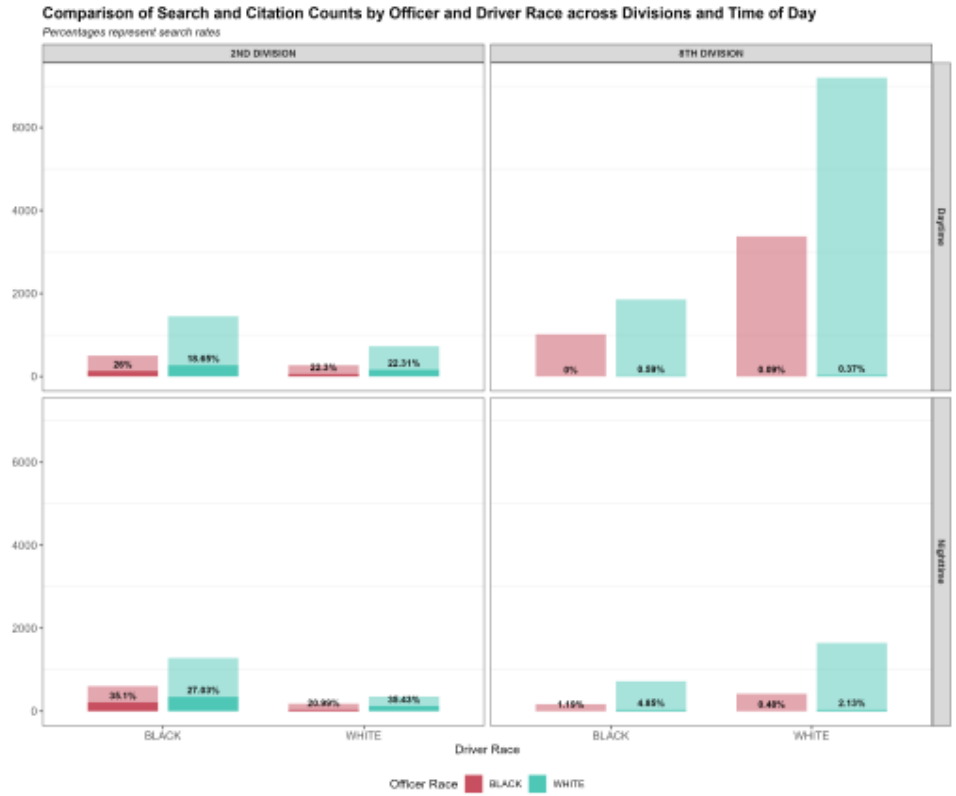
- It appears that officers are much less likely to search drivers in division 8 compared to division 2
- Black officers have a slightly higher search rate than White officers in division 2, but a significantly lower search rate in division 8

Exploratory Data Analysis



- In division 2, there seems to be a relationship (association) between the officer and driver race
  - More searches during nighttime with 36% occurring during daytime
  - Officers search drivers of the same race more than the other race during the nighttime
- In division 8, majority of searches are conducted by White officers and mostly at nighttime
  - Few black officers assigned in this division?

Exploratory Data Analysis



- Search rate is very low in relation to the number of citations

Inferential Analysis

- Compare search frequency by **driver race** (Black, White) and **officer race** (Black, White) across:
  - Different times of the day (**Daytime** and **Nighttime**)
  - Different divisions (**2nd Division** and **8th Division**)
- Fit separate logistic regression models for each combination of time of day and division:

$$ln(\frac{p_{searched}}{1-p_{searched}}) = \beta_0 + \beta_1 \times \text{Driver Race} + \beta_2 \times \text{Officer Race} + \beta_3 \times \text{Driver Race} \times \text{Officer Race}$$

- Compare the predicted probabilities of a search between officer race with respect to driver race

Division 8 Daytime Model Result

Driver Race	Officer Race	Probability (SE)	Odds Ratio (p-value)
Black	Black	0.000 (0.000)	0.00 (0.9779)
	White	0.006 (0.002)	
White	Black	0.001 (0.001)	**0.24 (0.0179)**
	White	0.004 (0.001)	

- There is a higher chance that a driver, regardless of their race, will be searched by a White officer than by a Black officer
- Officer race doesn't play a role in whether a Black driver is searched (OR = 0, *p*-value = 0.9779)
- The odds of a White driver being searched by a Black officer is much lower (only 24%) than being searched by a White officer (OR = 0.24, *p*-value = 0.0179)

Division 8 Nighttime Model Result

Driver Race	Officer Race	Probability (SE)	Odds Ratio (p-value)
Black	Black	0.012 (0.008)	**0.24 (0.0489)**
	White	0.048 (0.008)	
White	Black	0.005 (0.003)	**0.22 (0.0375)**
	White	0.021 (0.004)	

- Still a driver of any race will be more likely to be searched by a White officer
- The odds of a Black driver being searched by a Black officer is much lower (only 24%) than by a White officer, and this result is… statistically significant (OR = 0.24, *p*-value = 0.0489)
- The odds of a White driver being searched by a Black officer is much lower (only 22%) than by a White officer (OR = 0.22, *p*-value = 0.0375)

Division 2 Daytime Model Result

Driver Race	Officer Race	Probability (SE)	Odds Ratio (p-value)
Black	Black	0.26 (0.02)	**1.53 (0.0005)**
	White	0.186 (0.01)	
White	Black	0.223 (0.025)	1.00 (0.9975)
	White	0.223 (0.015)	

- The odds of a Black driver being searched by a Black officer is higher (53%) than by a White officer (OR = 1.53, *p*-value = 0.0005)
- Whether the officer is Black or White doesn't influence the likelihood of a White driver being searched (OR = 1, *p*-value = 0.9975)

Division 2 Nighttime Model Result

Driver Race	Officer Race	Probability (SE)	Odds Ratio (p-value)
Black	Black	0.351 (0.019)	**1.46 (0.0004)**
	White	0.27 (0.012)	
White	Black	0.21 (0.03)	**0.48 (0.0007)**
	White	0.354 (0.026)	

- The odds of a Black driver being searched by a Black officer is higher (46%) than being searched by a White officer (OR = 1.46, *p*-value = 0.0004)
- The odds of a White driver being searched by a Black driver is lower (48%) than being searched by a White officer (OR = 0.48, *p*-value = 0.0007)

Summary

- There are more citations being issued during daytime but higher search rates during nighttime
- **Generally, officers of a race are more likely to search drivers of the same race**
- **Effect of officer race seems to be the strongest in division 2 during nighttime**
- In division 8
  - A random driver has a higher chance of being searched by a White officer, regardless of the time of the day (might be disproportionate racial composition within the LMPD)
  - Officers are more hesitant about searching drivers (economic status?)
- In division 2, there is higher search rate even though there are much fewer citations being issued

Caveats

- The logistic model assumes that the stops have to be independent, which is not necessarily true in this case
- Division of interest is chosen based on median income alone, which may not capture other socioeconomic factors
- Focus only on Black/White dynamics, excluding other racial groups
- Policing practices and recorded data may reflect systematic biases

Thank you for listening!

Any questions for us?