TO CATCH A THIEF: ENDOGENOUS POLICING AND CHOICE OF LOCATION BY CRIMINALS

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Motivation and Introduction

- Hotspot policing where one patrols areas with high concentrations of crime is celebrated as a success story of policing.
- This has led to police being deployed in some high crime areas.
- Yet while there is moderate evidence on its effectiveness, there are no studies that look at longer term impacts.
- Given that criminals can move, one needs to consider optimal responses to changes in policing on criminal location choice in that area and other neighbouring areas.
- Indeed, some empirical studies actually do find displacement
- For example, ‘Operation Menas’ in London involved a double patrol team of uniformed officers patrolling bus stops three times a day, for 15 minutes $\rightarrow 37$ percent reduction in incident reports by bus drivers but a 25 percent increase in victims reporting incidents in nearby areas.

Research Questions

- How should police allocate resources optimally across regions given people can choose where to locate?
- Given rational policing and criminal location decision making, what does the equilibrium distribution of policing resources and location choice look like?

THIS PAPER

- Characterise this optimal location and spending allocation in a model with multiple regions with both a fixed and optimally chosen police budget
- Account for the social (negative) externality of having more potential criminals in a region
- Understand how the relative value of crime opportunities across areas determine the solution to the problem i.e. optimal location choice and distribution of police resources

Related Literature

- Hotspot policing (Sherman and Weisburd 1995)
- Theoretical modelling limited
- Zenou (2003)-social interaction and distance to work affect crime rates
- Verdier and Zenou (2004)-beliefs, endogenous location and opportunity to commit crime $\rightarrow$ self-fulfilling equilibrium with different ex post crime rates between two groups with same ex ante propensities
- Bandyopadhyay and Chatterjee (2010)-self fulfilling equilibrium through biased citizen reporting and rational policing
- Mathieson et. al (2023) and and Gao and Vasquez (2024) have a spatial search model of criminal activity
- Our model has both endogenous location choice and policing

The Environment

- Consider a region R which has a continuum of population with measure $N > 0$.
- R comprises of two areas A and B.
- Any member in the population is free to locate in any of the areas.
- Relocation from one area to another is costless.
- In each of the areas, a member of the population can choose to get involved in crime activities.
- If a positive measure of individuals (say $n_j > 0$) get involved in crime activities in area $j = A, B$, then this mass of *criminals* jointly get a payoff of $v_j > 0$.

The Environment

- For any i belonging to the set n_j, the expected gain from getting involved in criminal activity in city j is $\frac{v_j}{n_j}$.
- Let P_j be level of policing in city j. $P = P_A + P_B$.
- For any i belonging to the set n_j, the probability of getting caught is $\frac{P_j}{n_j} \Rightarrow$ i's expected cost of getting caught is $c_i \frac{P_j}{n_j}$.
- c_i: cost type of individual i. c_i is uniformly distributed over the population from 0 to C, $C > 0$.
- Net expected payoff to i from getting involved in criminal activities in city j is
$$U_{ij} = \frac{v_j - c_i P_j}{n_j}$$
- W.L.O.G, we normalise the expected payoff of a non-criminal to 0. Also assume $v_j - CP_j < 0$ for $j = A, B$.

EQUILIBRIUM

- We conjecture an equilibrium as follows:
  - There exist two thresholds c_1 and c_2 such that $0 < c_1 < c_2 < C$.
  - All individuals with $c_i \in (0, c_2)$ get involved in criminal activities.
  - $c_i \in (0, c_1)$ locate in A and $c_i \in (c_1, c_2)$ locate in B.
  - $c_i > c_2$ remains as non-criminals and they are indifferent between locating either in A or B.
- We will show that the conjectured equilibrium exists iff we have

$$\frac{P_A}{v_A} \geq \frac{P_B}{v_B}$$

Existence of Equilibrium

- For given values of c_1 and c_2, we have $n_A = \frac{c_1}{C}N$ and $n_B = \frac{c_2 - c_1}{C}N$
- First we compute the thresholds c_1 and c_2:
  - c_2 computed from the following indifference condition:

$$\frac{v_B - c_2 P_B}{c_2 - c_1} = 0 \Rightarrow c_2 = \frac{v_B}{P_B}$$

  - c_1 computed from the following indifference condition:

$$\frac{v_A - c_1 P_A}{c_1} = \frac{v_B - c_1 P_B}{c_2 - c_1} \Rightarrow c_1 = \frac{v_A}{P_A + P_B}$$

  - Mass of non-criminal is $\frac{C - c_2}{C}N$.
  - Need to show:
    - For any $c < c_1 (\in (c_1, c_2))$, $\frac{v_A - cP_A}{c_1} \geq (\leq) \frac{v_B - cP_B}{c_2 - c_1}$.
    - For any $c > c_2$, $v_A - cP_A < 0$ and $v_B - cP_B < 0$.

Existence of Equilibrium

- Define the function $\Gamma(c)$:

$$\Gamma(c) = \frac{v_A - cP_A}{c_1} - \frac{v_B - cP_B}{c_2 - c_1}$$

- $$\frac{P_A}{v_A} \geq \frac{P_B}{v_B} \Leftrightarrow \Gamma^{'}(c) \leq 0$$

- Since $\Gamma(c_1) = 0$, $\Gamma^{'}(c) \leq 0$ ensures the first equilibrium condition.

- Also, $\frac{P_A}{v_A} \geq \frac{P_B}{v_B} \Leftrightarrow$ for all $c > c_2$

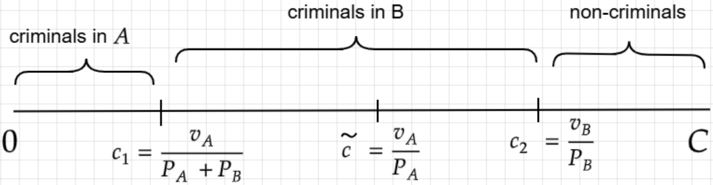
$$v_j - cP_j < 0$$

ILLUSTRATION OF EQUILIBRIUM

$$\frac{P_A}{P_B} \geq \frac{P_B}{V_B} \quad \Leftrightarrow \Gamma'(c) \leq 0$$

$$\frac{P_A}{v_A} \geq \frac{P_B}{B} \quad \Leftrightarrow v_j - cP_j < 0 \; for \; c > c_2$$

$$\frac{P_A}{v_A} \geq \frac{P_B}{v_B} \text{ sufficient (not necessary) to guarantee } c_2 > c_1$$



Optimal Choice of Policing: Fixed P

- Define the payoff off the society as

$$U_P(n_A,n_B) = -\frac{1}{2}(n_A^2 + n_B^2) - \frac{1}{\beta}(P_A + P_B)^\beta$$

  such that $\beta > 1$
- Using the equilibrium values of c_1 and c_2 we get

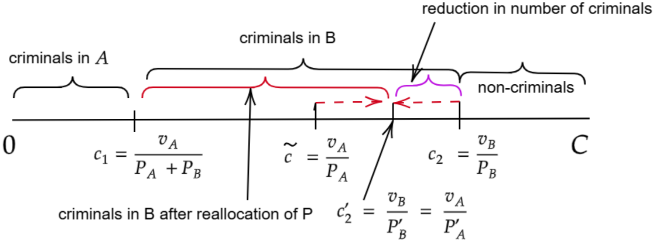
$$U_P(n_A,n_B) = -\frac{1}{2P^2}[v_A^2 + \{\frac{Pv_B}{P_B} - v_A\}^2] - \frac{1}{\beta}P^\beta$$

- Fixed $P \Rightarrow$ number of criminals can be reduced only through allocating more to B at the expense of A.
- c_1 only depends on $P \Rightarrow$ no effect on c_1 because of reallocation
- Optimal action entails increase P_B up to the point when $\frac{P_A}{v_A} = \frac{P_B}{v_B}$

Illustration of Policing reallocation

Reallocation of P when it is fixed

$$P_A + P_B = P'_A + P'_B$$



Optimal Policing: Variable P

- Two stage process:
  - Given value of $P \to$ adjust P_A and P_B such that

$$\frac{P_A}{v_A} = \frac{P_B}{v_B} \Rightarrow P_B = \frac{Pv_B}{v_A + v_B}$$

  - Substituting $P_B = \frac{Pv_B}{v_A+v_B}$ in $U_P(n_A, n_B)$ to obtain the optimal level of P.
- $$U_P(n_A, n_B) = \frac{1}{2P^2}[v_A^2 + v_B^2] - \frac{1}{\beta}P^\beta$$
- U_P is strictly concave $\Rightarrow$ optimal P is given by the F.O.C:

$$P = (v_A + v_B)^{\frac{1}{\beta+2}}$$

- Optimal value $P_B = \frac{v_B}{(v_A+v_B)^{1-\frac{1}{\beta+2}}}$
- Optimal value of $P_A = \frac{v_A}{(v_A+v_B)^{1-\frac{1}{\beta+2}}}$

Concluding Remarks

- Developed a model of optimal criminal location and policing/allocation
- Generalise the structure of equilibrium (ongoing)
- Understand how a dynamic hotspot model of policing will work
- Generate cycles or persistence?
- Develop testable predictions