#### **Chapter 5. Application to Warfare: Guerrillas, Police, and Missiles**

- Problem of Guerrillas vs Police
- Problem of the Missile Penetration System
- Limitations of Zero-Sum Games as Modeling

#### **Guerrilas**

- Suppose there are m guerrillas, n police and two arsenals
  - The guerillas take the arsenal if they are stronger than the police force at the arsenal.
  - Should the guerillas take an arsenal, they win.
  - Winning means gain one point. Loosing means gain no points.
- What should the attack plan of the guerillas be to maximize their win?
- How should the police respond to this plan?



#### **Known Wins and Losses**

- The guerrillas can clearly win if m > n
- They should attack either arsenal with full force.
- The police always win if  $n \ge 2m$
- They should defend each arsenal with force m.

# **Straffin's Simplification**

- Consider the case of 2 guerrillas and 3 police.
- Suppose the arsenals are "East" and "West"
- We could enumerate multiple possible strategies for the guerrillas and the police. On the guerilla side:
  - 2W 0E
  - 1W 1E
  - 0W 2E
- Straffin simplifies by saying the real decision is how to divide the force, not where to send it.
- This does make analysis easier, but we might doubt his insight.



## Sample Model of n=3, m=4

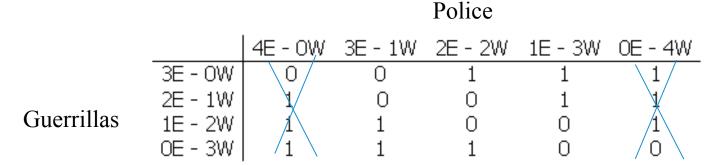
- Not given in book
- I choose to fully enumerate strategies

		Police				
		4E - OW	3E - 1W	2E - 2W	1E - 3W	0E - 4W
Guerrillas	3E - OW	0	0	1	1	1
	2E - 1W	1	0	0	1	1
	1E - 2W	1	1	0	0	1
	0E - 3W	1	1	1	0	0



## Sample Model of n=3, m=4

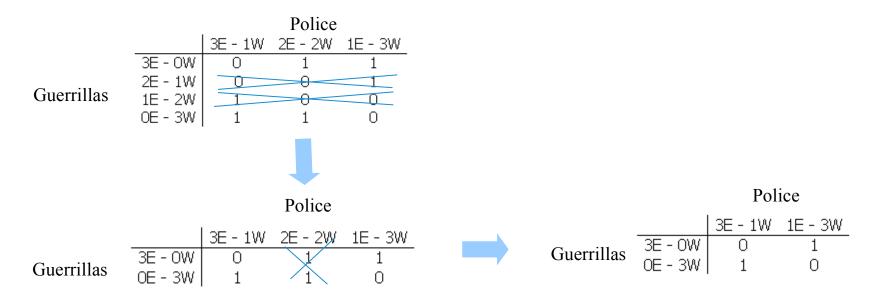
- OE is dominated by 1E for the police. Why loose an arsenal by not trying?
- Remember, the police are trying to avoid losses



- Also 4E dominated by 1E.
- The game begins to unravel



## **Further reductions possible**



- Mixed strategy 50%/50% both players
- The value of the game is 0.50



## **Reflection on the Game**

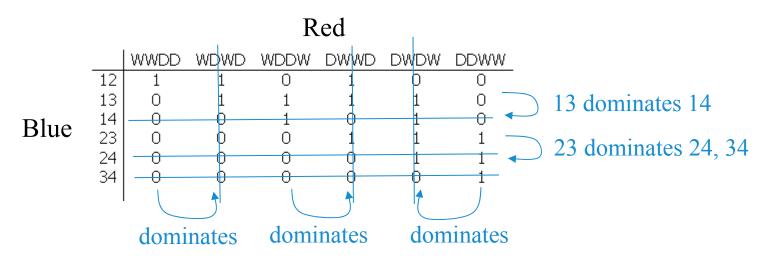
- Straffin is correct with his assumption of mixed strategies.
- Interpreting the strategies, we see that the guerrillas prefer an "all-in" strategy.
- This relates to the assumption of breaking ties in favor of the defender.
- This generalizes to larger force levels. There is no use for the solitary guerrilla.
- These features of the game ultimately stem from the assumptions of perfect knowledge. Do the opponents really know the force levels?

## **Missile Penetration Problem**

- Based on missile defense problems.
- Suppose that there are two countries, Red and Blue.
- Red has four missiles: two missiles have warheads, two missiles are dummies. Red wishes to destroy blue bases.
- Blue has two anti-missiles. Each blue anti-missile can scan two incoming missiles, select one and destroy it.



## **Eliminating Dominated Strategies**

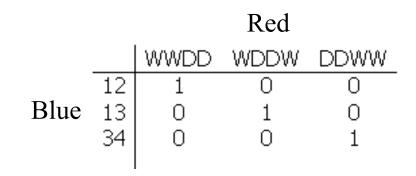


 Dominated strategies give up wins to dominated strategies (its more than counting wins)



#### **Reduced Game Matrix**

• Mixed strategy solution 1/3, 1/3, 1/3 for both players



• The basic insight: send the red missiles in volleys, hoping to overwhelm blue defenses

## Small Scale Tactics and Zero-Sum Games

- Straffin defends the use of zero-sum games in military tactical planning
- However he acknowledges its limitations in largerscale strategic questions of war
- Another explanation for Straffin's reservation
  - Some strategic choices in warfare open up entirely new theaters of war.
  - Thus the scale of win and loss is no longer constant
  - Thus, military planners have the capability of choosing tactics which open up a non-zero sum game.

