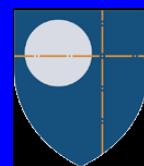




**Yale** SCHOOL of MANAGEMENT

**YALE UNIVERSITY**  
School of Public Health



**YALE UNIVERSITY**  
School of Engineering and  
Applied Science

**Homeland Security and Counter-Terrorism Research**



**The Daniel Rose Yale University - Technion Initiative**



# Terror Queues

Edward H. Kaplan

William N and Marie A Beach Professor of Operations Research  
Yale School of Management

Professor of Public Health  
Yale School of Public Health

Professor of Engineering  
Yale School of Engineering and Applied Science  
New Haven, Connecticut

# Motivation

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- “Intelligence is the heart and soul of operational counterterrorism” (Amos Guiora (2008), *Fundamentals of Counterterrorism*)
- Terror queues model is part of a research program devoted to “intelligence operations research”
- Focus on undercover agents and/or informants; goal is to understand the interaction of human intelligence with the detection and interdiction of terror plots

# Motivation

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- Reduce the rate of successful terror attacks
- Working at operations/tactical level as opposed to foreign policy, economic assistance etc.

## Intelligence to Counter Terrorism: Issues for Congress

Observers point to several major challenges that the Intelligence Community will likely encounter in supporting the counter terrorist effort.

- First is a renewed emphasis on human agents. Signals intelligence and imagery satellites have their uses in the counterterrorism mission, but intelligence to counter terrorism depends more on human intelligence (humint) such as spies and informers.

**Source:** Best RA, Congressional Research Service Report RL31292, 2003,  
<http://www.au.af.mil/au/awc/awcgate/crs/rl31292.pdf>

# N.Y. / Region

## Man Is Charged With Plotting to Bomb Federal Reserve Bank in Manhattan

By MOSI SECRET and WILLIAM K. RASHBAUM

Published: October 17, 2012

Federal prosecutors in Brooklyn charged a 21-year-old Bangladeshi man with conspiring to blow up the Federal Reserve Bank of New York, saying he tried to remotely detonate what he believed was a 1,000-pound bomb in a van he parked outside the building in Lower Manhattan on Wednesday.



But the entire plot played out under the surveillance of the [Federal Bureau of Investigation](#) and the New York Police Department as part of an elaborate sting operation, according to [court papers](#).

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 REPRINTS

THE  
SESSIONS  
COMING SOON

OP-ED CONTRIBUTOR

## The Terrorist Next Door

By MICHAEL A. SHEEHAN

Published: May 3, 2010

 SIGN IN TO

So law enforcement has to focus on preventing sophisticated terrorist organizations from establishing a presence within the United States. The good news is that we know how to do this. The bad news is we aren't doing it enough. No other American city even attempts to do what New York has accomplished. The New York Police Department's intelligence and counterterrorism units, working both with the F.B.I. and independently, manage a network of informant and undercover operatives around the area. It was no accident that last year when a Denver man who was planning to bomb the New York subway system arrived in the city, the F.B.I. was aware of his travels, and a radical cleric he met with was already a police informant.

# Motivation

**BBC**  
**NEWS**

**Watch** One-Minute World News

Last Updated: Wednesday, 2 May 2007, 13:53 GMT 14:53 UK

[E-mail this to a friend](#) [Printable version](#)

## MI5 watch 2,000 terror suspects

By Frank Gardner  
BBC security correspondent

**The number of terror suspects being monitored by MI5 in the UK has grown by a quarter in the past six months, the BBC has learned**

The security service and police are monitoring about 2,000 individuals who they say are actively involved in supporting al-Qaeda.

Some are thought to have direct links with al-Qaeda in Pakistan.

The fertiliser bomb plot case has highlighted the links to terrorist training camps in Pakistan.

More than 400,000 Britons each year go to Pakistan on innocent family visits.

But Pakistani intelligence agents cannot follow everyone.

**FERTILISER BOMB TRIAL**

**LATEST NEWS**

- ▶ Terror case 'naysayers' attacked
- ▶ 'Time wasting' in bomb plot trial
- ▶ UK plotters 'wasted their lives'
- ▶ Blair rejects 7/7 inquiry calls
- ▶ Five get life over UK bomb plot

**PLOT EXPLAINED**

**How the plot formed - and failed**

Who plotters were, how they were linked, what they planned

**FEATURES & BACKGROUND**

- ▶ Q&A: UK terrorism trial
- ▶ In pictures: Men in Pakistan
- ▶ Timeline: Operation Crevice
- ▶ Bomb plot's roots in Pakistan
- ▶ How bad could bomb have been?

**MI5 UNDER SCRUTINY**

**Revealed: Bomber transcript**

Bugged conversation with a suicide bomber.

**Panorama special investigation**

# Motivation



EDITION:  
UK

News  
& Business

Sectors  
& Industries

Analysis  
& Opinion

Smarter  
Business for a  
5th Sept

## Europe terror alert fuelled by German militants

By Stephen Brown BERLIN | Tue Oct 5, 2010 2:22pm BST

With papers picturing Berlin landmarks named as potential targets, including the Brandenburg Gate and the Fernsehturm (TV tower) that dominates the skyline, the head of the main German police union warned: "We should expect attacks."

"The number of dangerous Islamists (in Germany) lies at more than 100," Konrad Freiberg, chairman of the union, told the Passauer Neue Presse newspaper, adding that about 40 had explosives training. "This is very dangerous for us."

European and American counter-terrorism officials have also said that concerns about a group of about 100 German Islamists who had travelled between Germany and tribal border areas of Pakistan contributed to the latest security alert in Europe.



**AL QAEDA**  
COMING SOON AGAIN IN  
New York

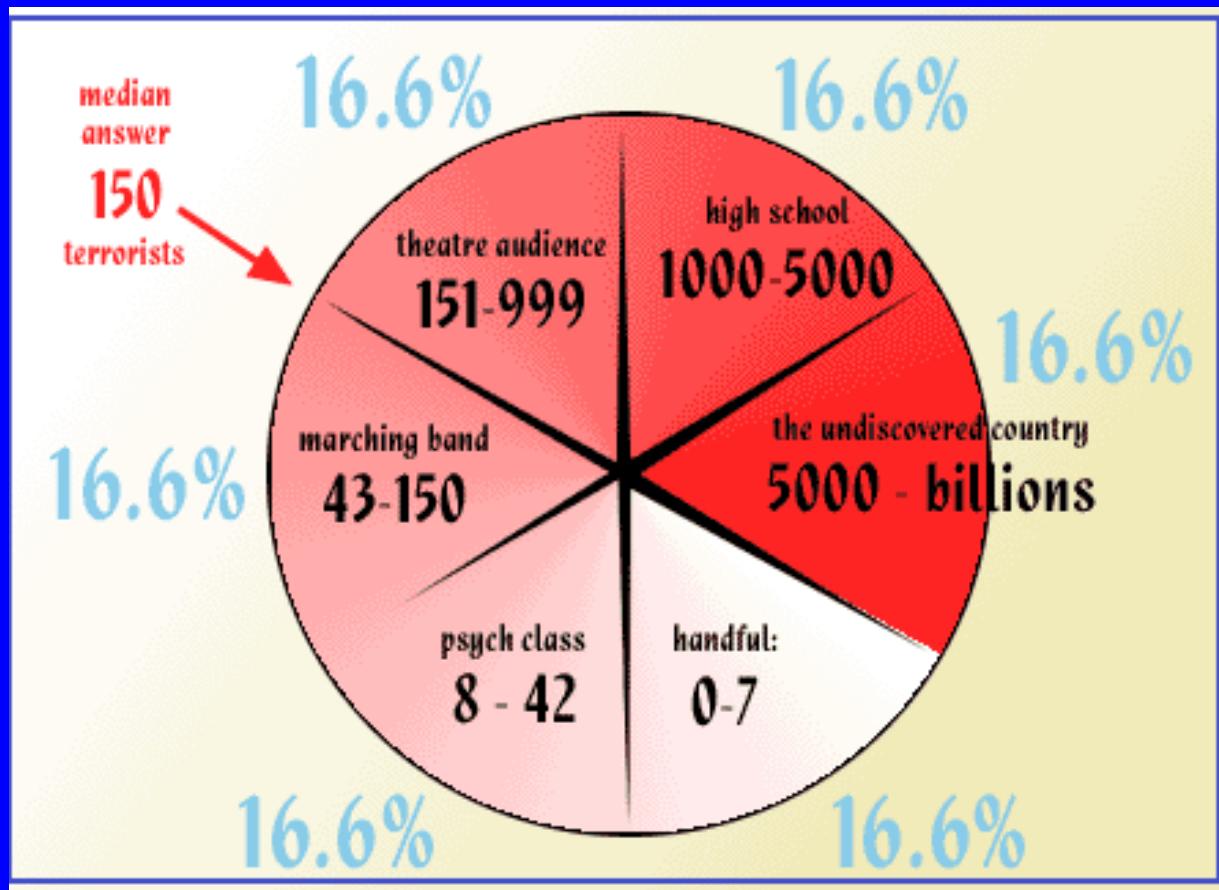
# Motivation

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- More generally, how might one estimate the extant number of undetected terror plots?

# How Many Terror Plots Are There?

- Three. And two of them are ex-girlfriends.



# Research Contribution

---

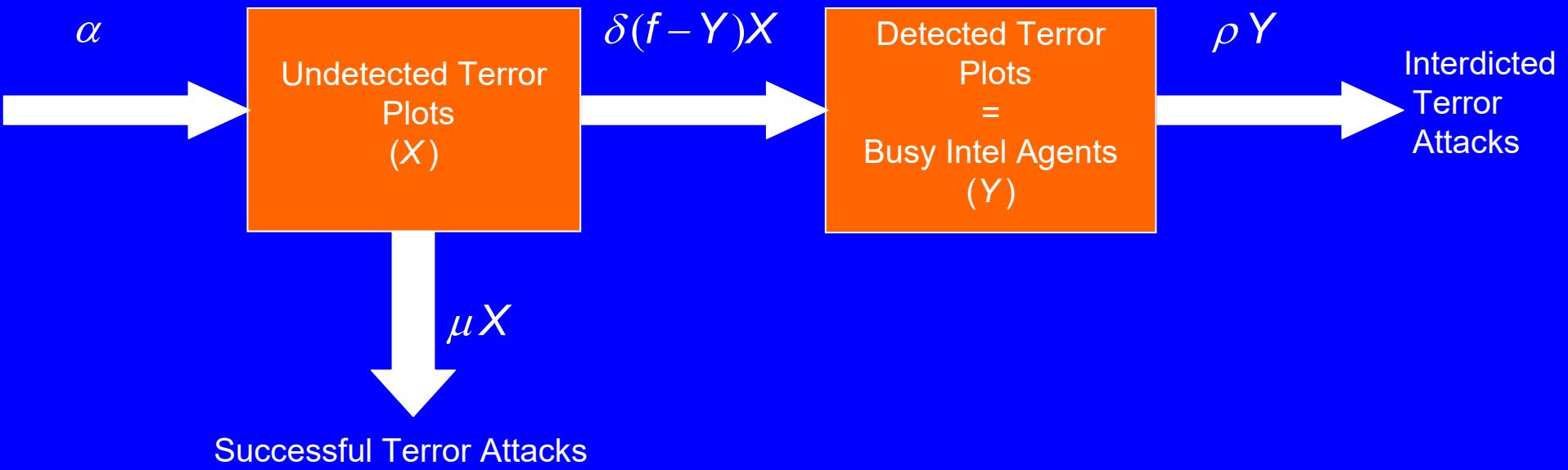
- Present analysis models the interaction between terror threats, HUMINT and counterterror operations using queueing theory
- Model shows how changing the terrorists' operating environment improves the chance that HUMINT detects terror threats
- Model also enables estimation of the number of undetected terror plots

# Terror Queues

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- Consider terror plots as customers
- Customers arrive when new plots are hatched
- Servers are undercover agents or informants
- Service commences when a plot is detected by an available agent (servers have to find customers)
- Service concludes when the plot is interdicted (agents occupied with specific plots are busy)
- Successful terror plots are equivalent to customers who abandon the queue (drop out) before receiving service
- *Idle servers and waiting customers co-exist!*
- *Servers want to provide good service, but customers don't want to be served!*

# Terror Queue Model



## Parameters

$\alpha$  = terror plot arrival rate

$\mu$  = unobstructed terror plot completion rate

$\delta$  = terror plot detection rate

$\rho$  = detected terror plot interdiction rate

$f$  = total number of intel agents

## State Variables

$X$  = number of undetected terror plots

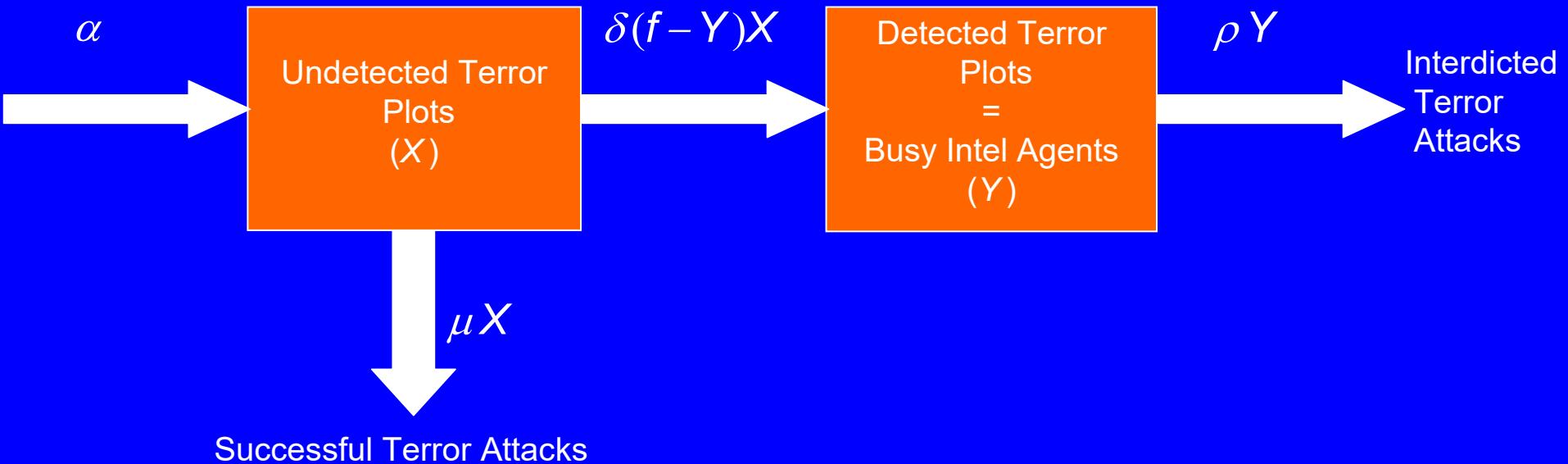
$Y$  = number of detected terror plots/busy intel agents

# Terror Queue Model

---

- Want to know  $E(X)$ ,  $E(Y)$ , interdiction rate etc.
- Would also like to know the conditional distribution of the number of terror plots ( $X$ ) given the number of busy intelligence agents ( $Y$ )
- Accomplish this by building a Markov model to determine the joint probability distribution of  $X$  and  $Y$

# Follow The Flows



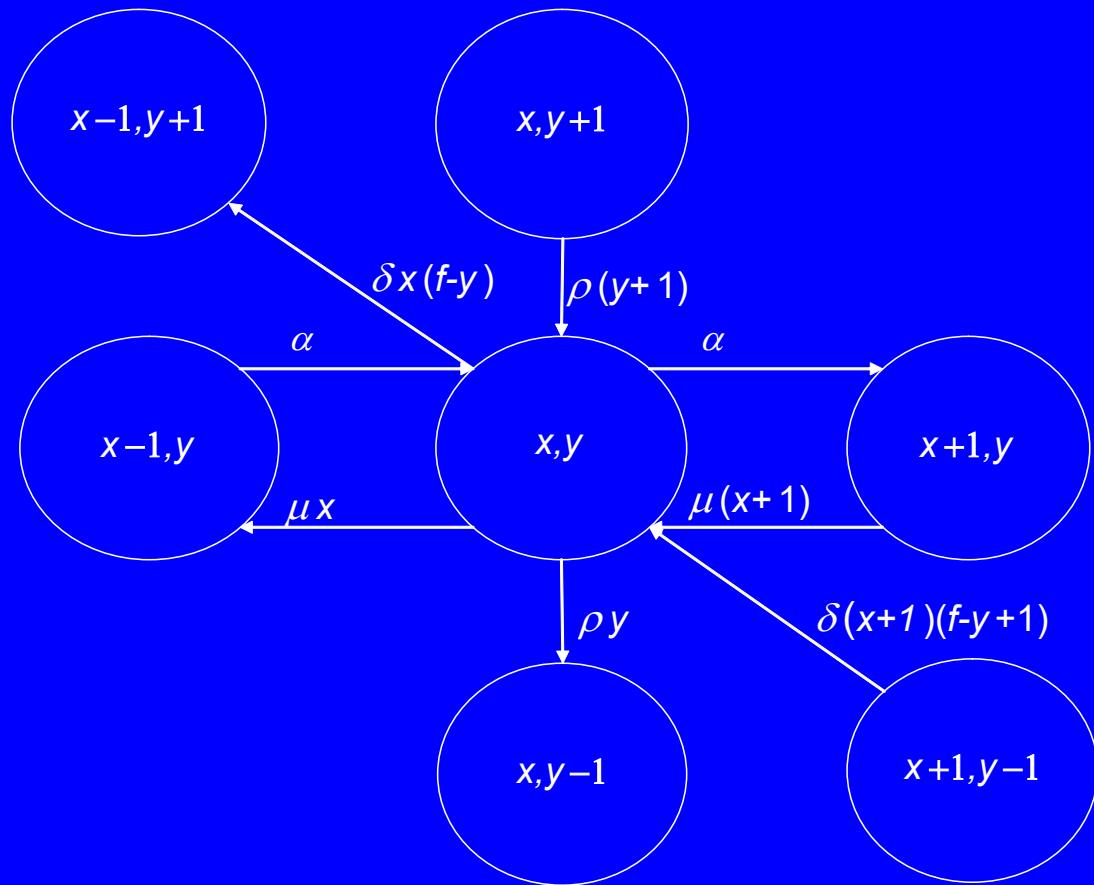
□ Solve:  $\alpha = \mu x^* + \delta x^*(f - y^*)$

$$\delta x^*(f - y^*) = \rho y^*$$

for  $x^* \approx E(X)$  and  $y^* \approx E(Y)$

Goal: determine the joint probability distribution of detected, undetected terror threats:

$$p_{xy} = \Pr\{X=x, Y=y\}$$

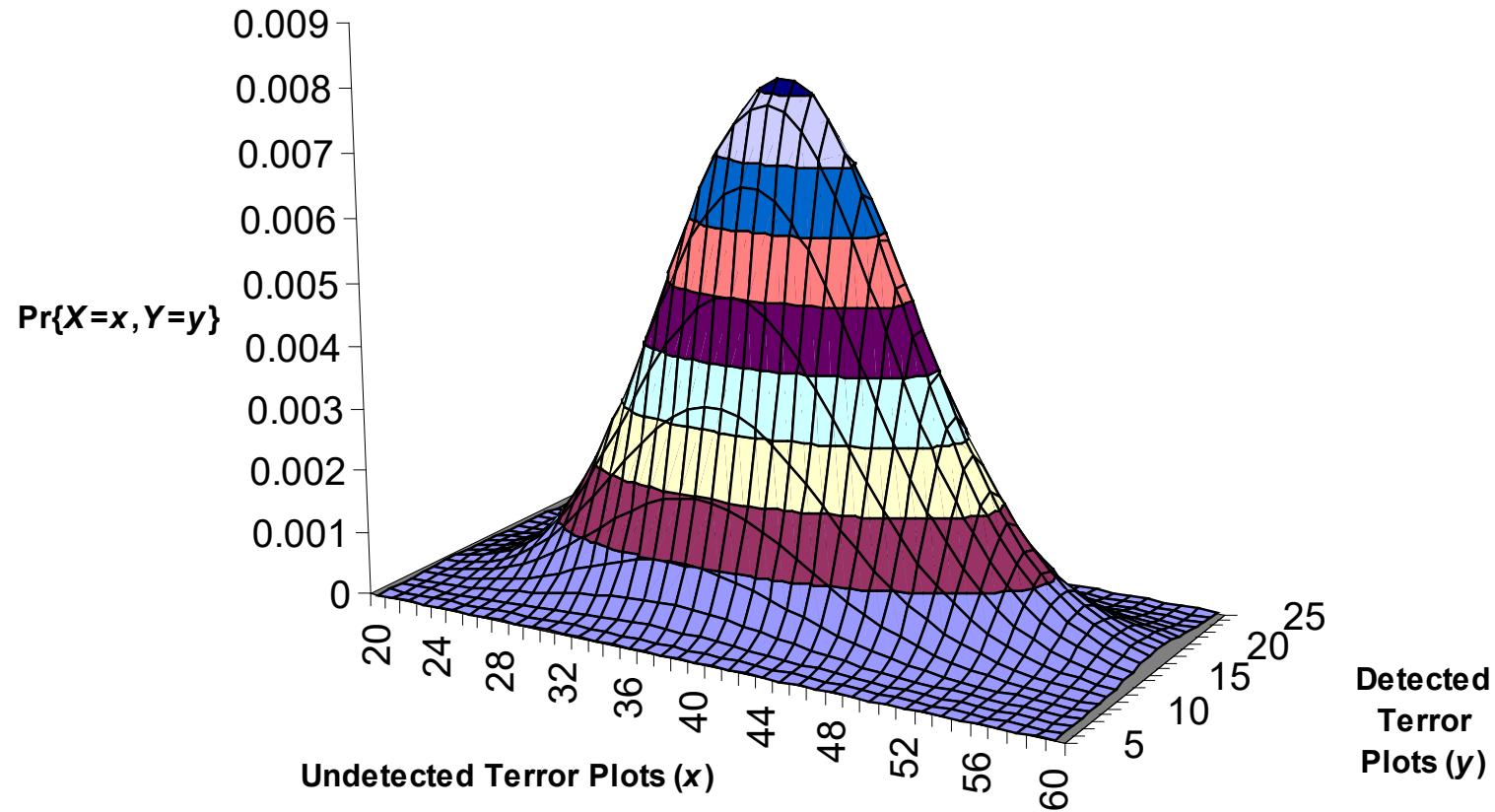


Generic balance equation:

$$\begin{aligned}
 & (\alpha + \mu x + \rho y + \delta x(f-y))p_{xy} \\
 = & \alpha p_{x-1,y} + \mu(x+1)p_{x+1,y} + \rho(y+1)p_{x,y+1} + \delta(x+1)(f-y+1)p_{x+1,y-1}
 \end{aligned}$$

Also boundary equations for  $x=0$  and  $y=0, f$  plus probability conservation

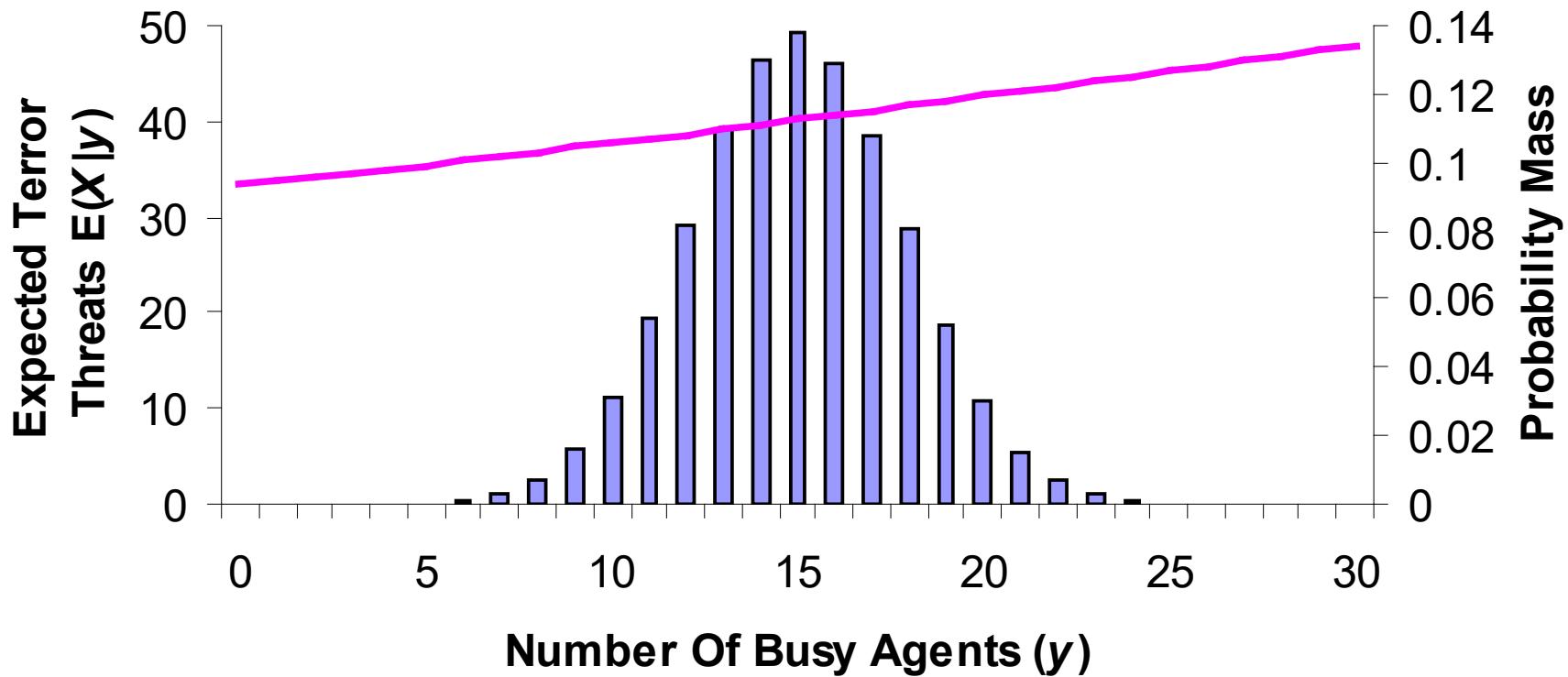
# Joint Distribution of Undetected ( $X$ ) and Detected ( $Y$ ) Terror Plots



Looks like bivariate normal distribution!

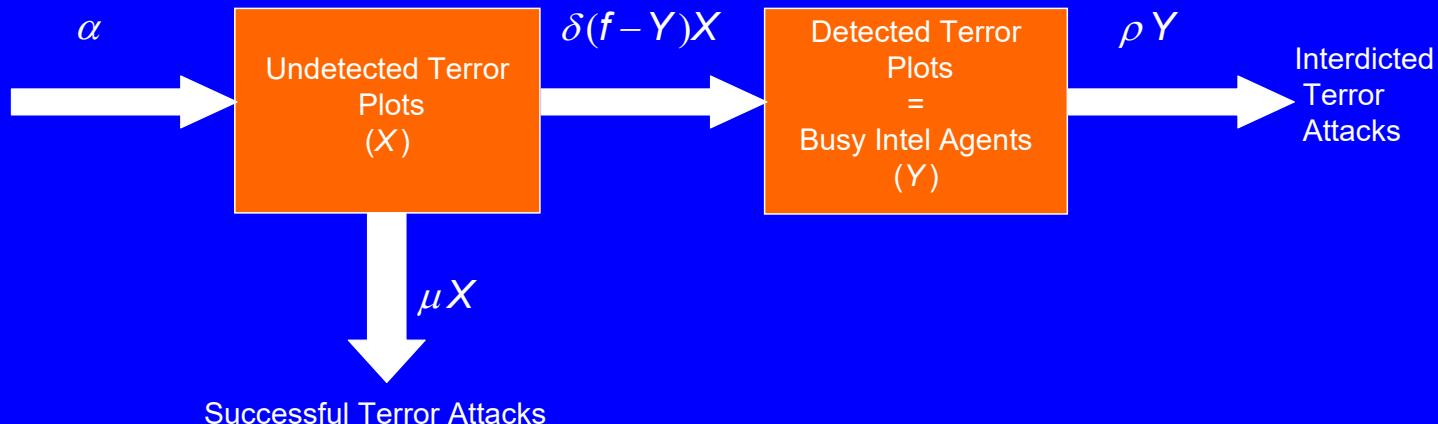
# Inference in Terror Queue Model

**Inference In Terror Queue Model**



Note that  $E(X|Y=y)$  is linear in  $y$ !

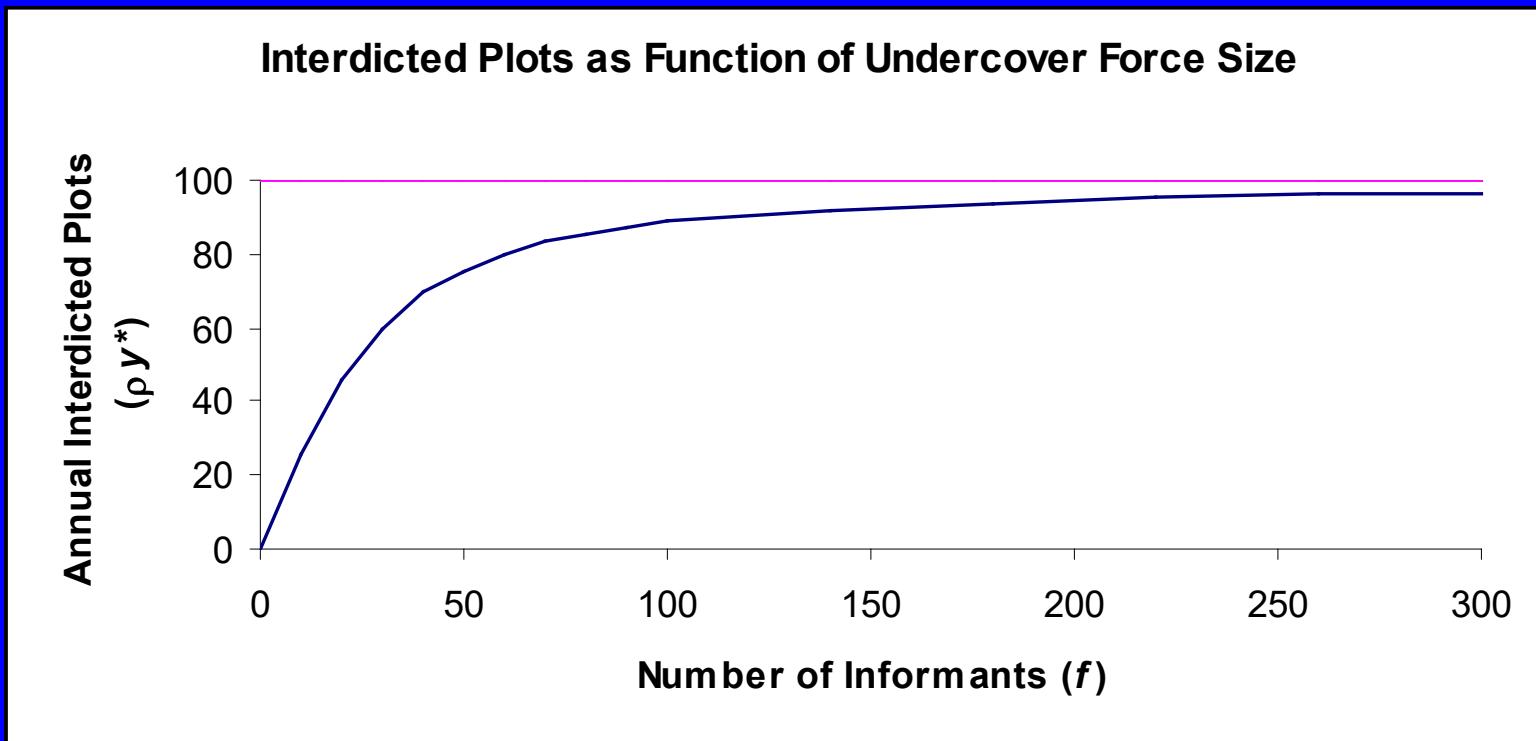
# Reducing the Rate of Successful Terror Attacks



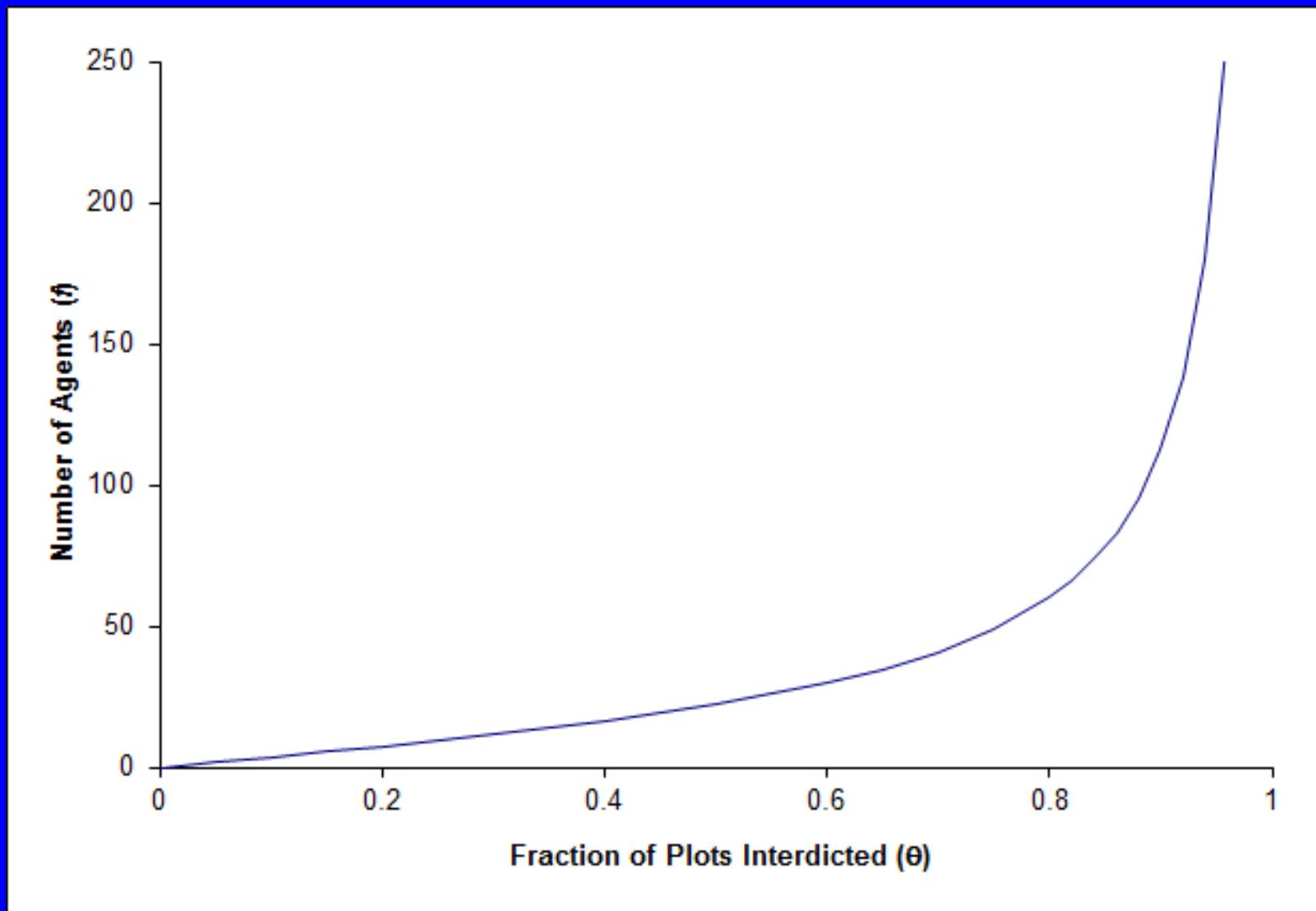
- Successful terror attack rate =  $\mu E(X)$ 
  - Delay terrorists (reduce  $\mu$ )
  - Improve detection (increase  $\delta$ )
  - Speed interdiction (increase  $\rho$ )
  - Have lots of agents (increase  $f$ )

# Staffing

- How many agents/informants?
- Diminishing return in interdictions with number of agents



# How Many Agents?



# What About The US?

---

- According to the FBI:
- <400K people on consolidated terrorism watch list
  - <16K people on selectee (can be singled out for extra inspections) and no fly lists
    - » <2.5K people on no fly lists
- False positives on no fly lists well known
  - Ted Kennedy, John Lewis, Nelson Mandela, Yusuf Islam (Cat Stevens), ...
- 600 names removed from consolidated list daily

# Real Versus Fake Plots

---

- Most information collected is unrelated to real terror threats:
  - “From July 2004 through November 2007, the FBI documented approximately 108,000 potential terrorism-related threats... The FBI determined that the overwhelming majority of the threat information...had no nexus to terrorism.” (FBI’s Terrorist Threat and Suspicious Incident Tracking System, US Dept of Justice, Audit Report 09-02, November 2008)

# Lots of Agents

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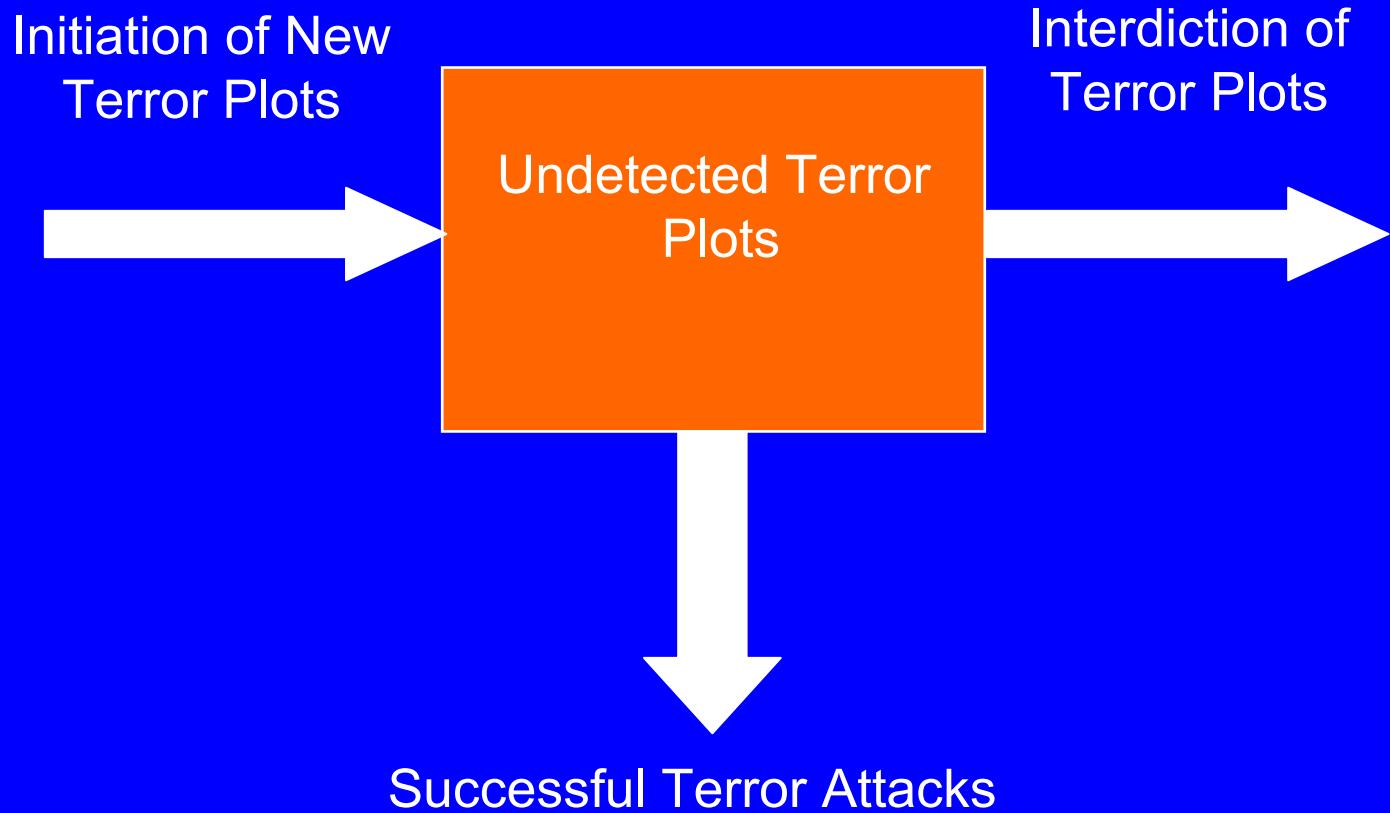
- Since 9/11 the FBI “...increased the number of Special Agents working terrorism matters from 1,351 to 2,398.”

[http://www.fbi.gov/stats-services/publications/fbi\\_ct\\_911com\\_0404.pdf](http://www.fbi.gov/stats-services/publications/fbi_ct_911com_0404.pdf)

- Not all FBI Special Agents operate covertly, but other law enforcement agencies such as the New York Police Department also deploy undercover officers to disrupt terror plots

# Try Simple Terror Queue

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# What Do We Need To Know?

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- Arrival process and mean arrival rate  $\alpha$
- Probability distribution of  $D$ , time plots stay in system (i.e. time from plot arrival until execution or interdiction)
- Then if  $N$  is the number of terror plots, we have

$$E(N) = \alpha E(D)$$

# Terror Plots in the United States

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## A Poisson Model of Incidents of International Terrorism in the United States

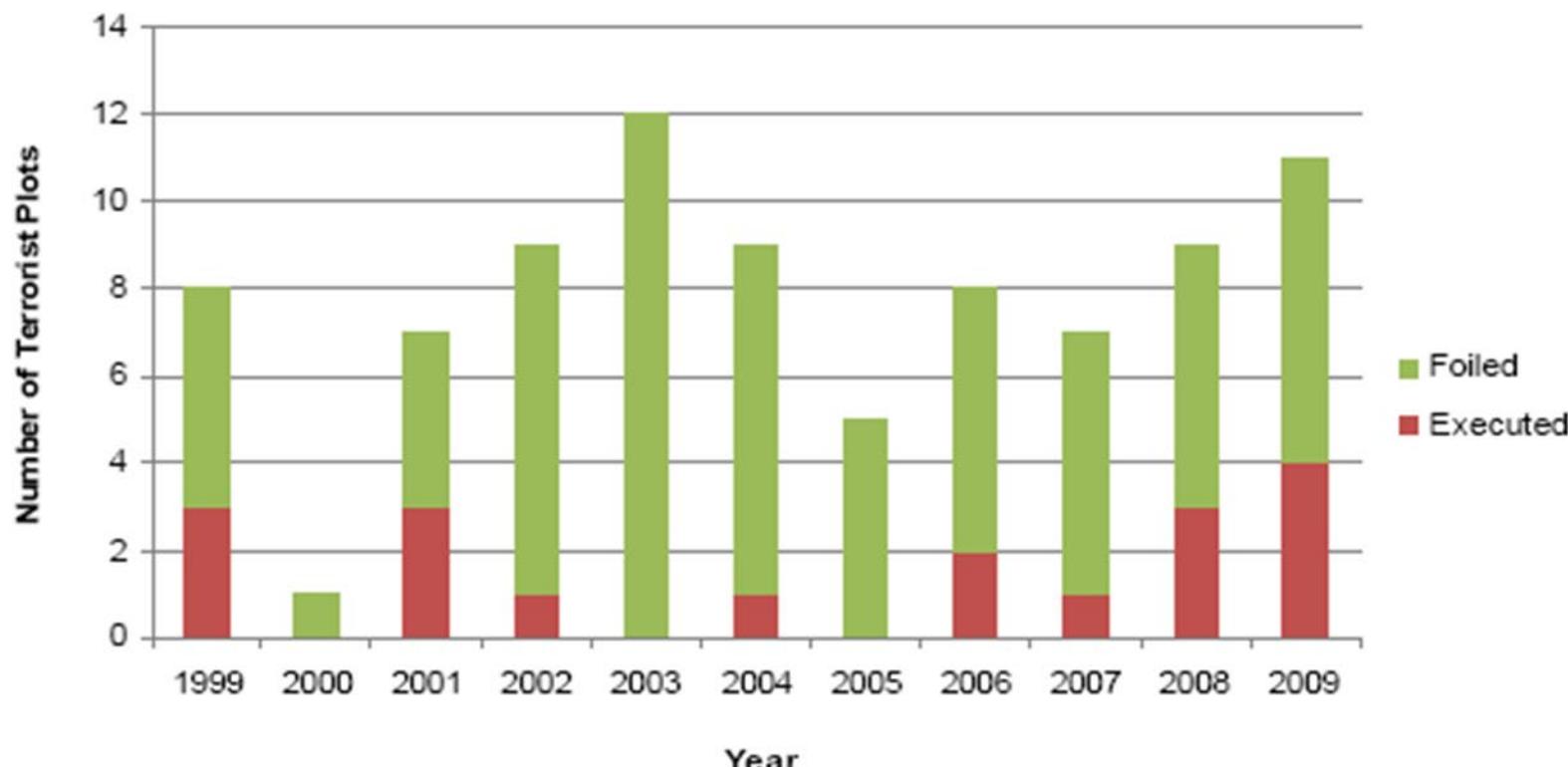
John M. Gleason

College of Business Administration  
The University of Nebraska at Omaha

*Abstract* Various haphazard, and often uncoordinated, efforts have been devoted to discouraging and combatting terrorism. Unfortunately, there has been a noticeable lack of quantitative studies of the problem of terrorism. Nevertheless, it can be expected that the problem of international terrorism will eventually be a focus for operations researchers. A factor fundamental to any OR study is an understanding of the underlying generating process for incidents of terrorism. Based on incidents of terrorism from 1968 to 1974, this paper notes that the Poisson is a good model for the occurrence of incidents of international terrorism in the United States. Results of both chi-square and Kolmogorov-Smirnov tests are presented. Finally, an unusual result, inconsistent with popular beliefs, is noted.

# Terror Plots in the United States

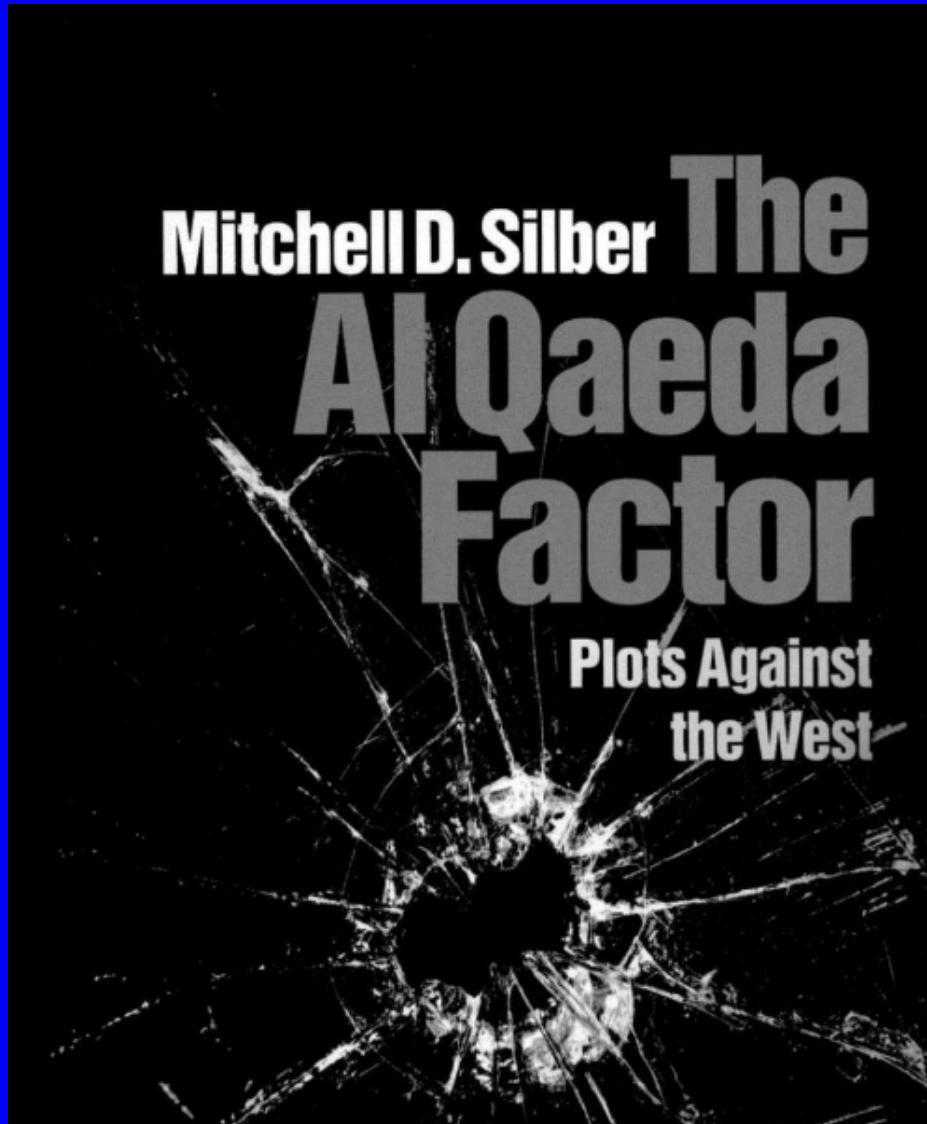
Figure 1. Foiled and Executed Terrorist Plots by Year, 1999–2009



Strom *et al*, Building on Clues: Examining Successes and Failures in Detecting U.S. Terrorist Plots, 1999-2009. Institute for Homeland Security Solutions, 2010.

# *Jihadi Terror Plots in the United States*

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- “...most of the operations against the West have been manned by inspired volunteers who join it from the ‘bottom up’...”
- “...that al Qaeda Core’s role in plots is in general decline is a critical finding...”



# Radicalization in the West

## The Radicalization Process

### Stage 1

### Stage 2

### Stage 3

### Stage 4

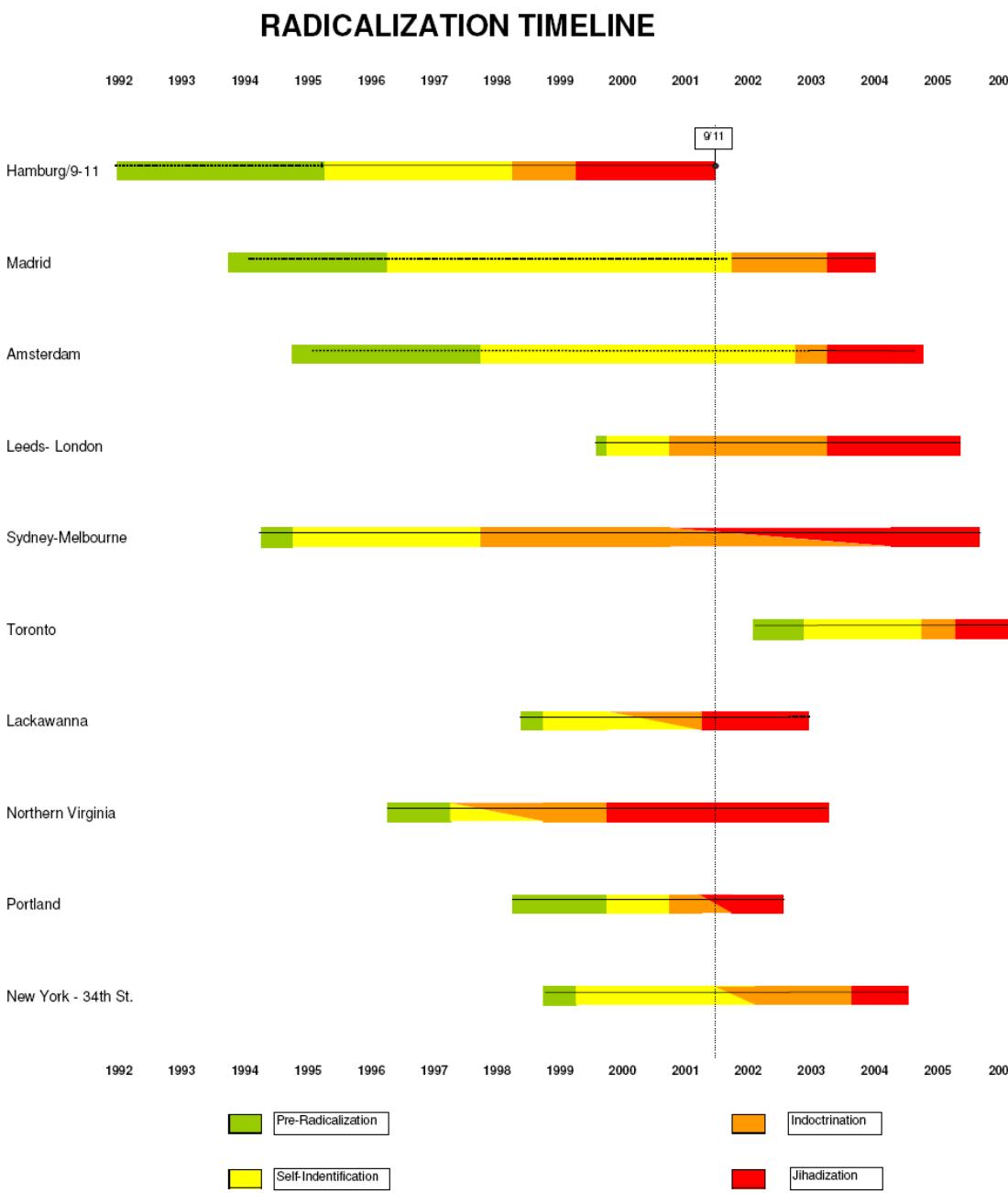
#### *Pre-Radicalization*

#### *Self-Identification*

#### *Indoctrination*

#### *Jihadization*

<ul style="list-style-type: none"><li>• Unremarkable individuals</li><li>• Age 15-35</li><li>• Local residents and citizens</li><li>• Educated</li><li>• Middle class</li><li>• Secular background</li><li>• Converts</li></ul>	<ul style="list-style-type: none"><li>• Crisis occurs</li><li>• Cognitive opening</li><li>• Search for identity</li><li>• Gravitate towards Salafi ideology</li><li>• Salafi mosque</li><li>• Changes in behavior</li></ul>	<ul style="list-style-type: none"><li>• Acceptance of ideology</li><li>• Withdrawal from the mosque</li><li>• Politicization of beliefs</li><li>• Separation from society</li><li>• Greater reliance on the “group”</li><li>• Internet use reinforces beliefs</li></ul>	<ul style="list-style-type: none"><li>• Personal obligation to jihad accepted</li><li>• Travel abroad</li><li>• Outdoor bonding, vetting and training activities</li><li>• Mental preparation</li><li>• Attack planning – reconnaissance, weaponization</li></ul>
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□ Would like duration distribution of attack planning phase

Silber, MD and Bhatt, A (2007) *Radicalization in the West (NYPD)*

# Terror Plots in the United States

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Center on Law and Security, New York University School of Law



## **Terrorist Trial Report Card:**

September 11, 2001-September 11, 2011

- The *Terrorist Trial Report Card* (TTRC) tracks and analyzes all federal criminal prosecutions since September 11, 2001 that the Justice Department claims are terror-related
- Data contain information regarding 1,054 prosecutions associated with 846 distinct defendants organized by date of indictment from 9/11/2001 through 6/30/2011

# *Jihadi* Terror Plots in the United States

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- 55% of TTRC cases are *Jihadi*
- TTRC's definition of *Jihadi* cases "...includes defendants who were formally or informally associated with an Islamist terror group -- whether one with a global jihadist ideology (i.e. Al Qaeda) or a local Islamist movement (i.e. Hamas). It also includes defendants unaffiliated with a terror group who aspired to such affiliation or who subscribed to a global jihadist ideology."
- But, overwhelming majority of those prosecuted did not link to specific terror plots targeting the United States

# *Jihadi* Terror Plots in the United States

---

- Review of *Jihadi* cases identified 26 cases linked to plans to attack Americans in US
  - thanks to NYPD's Mitch Silber for help eliminating non-plots, campfire plots, "let's play *Jihadi*" plots, etc.
- Cross check with Strom *et al* (2010) plus known attacks identified additional nine plots; 35 total
  - Sample includes: shoe bomber, captain underpants, Herald Square subway bomb, JFK fuel tanks, Time Square bomb, LAX shootings, etc.
  - Sample *excludes* Lackawanna 7, Bly Oregon camp, Northern Virginia Paintball, Atlanta casing plot, etc.

# Estimating the Duration of *Jihadi* Terror Plots in the United States

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- When does a terror plot begin?
- Hard to know exactly; indeed terrorists probably don't know exact date either
- Futile to attempt pinpointing \*the\* start date
- Not futile to determine upper and lower bounds
  - “Early start” – plot had not begun before this date
  - “Late start” – plot had certainly begun as of this date
- Estimated early and late start dates from relevant court records such as indictments, criminal complaints, and other supporting legal documents in addition to media reports and other public sources

# E.g. California Prison Conspiracy

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- From indictment, “In or about December 2004, defendant JAMES instructed defendant WASHINGTON to (1) recruit five individuals without felony convictions and train them in covert operations; (2) acquire two firearms with silencers; and (3) appoint an individual from the group he recruited to find contacts for explosives or learn to make bombs that could be activated from a distance;” suggesting an early start date of December 1, 2004.
- “Beginning on or about May 19, 2005, and continuing through on or about June 7, 2005, defendant PATTERSON used a computer to conduct internet research on the Israeli Consulate in Los Angeles,” which suggests May 19, 2005 as a late start date

## E.g. Fort Dix Plot

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- From criminal complaint, “On or about January 3, 2006, MOHAMAD SHNEWER, DRITAN DUKA, ELTVIR DUKA, SHAIN DUKA, and SERDAR TATAR conducted firearms training in Gouldsboro, Pennsylvania,”
- “On or about August 11, 2006, CW-1 (note: CW = cooperating witness) and MOHAMAD SHNEWER traveled to the Fort Dix military base to conduct surveillance... When CW-1 asked what made SHNEWER think of Fort Dix as a target, SHNEWER replied, ‘My intent is to hit a heavy concentration of soldiers...’ As SHNEWER and CW-1 drove into a specific area at Fort Dix, SHNEWER said, ‘...this is exactly what we are looking for. You hit 4, 5, or 6 humvees and light the whole place [up] and retreat completely without any losses.’ ”
- On this basis, early and late start dates were assigned to January 3 and August 11 respectively

**Table 1: Terror plot early start, late start and completion times**

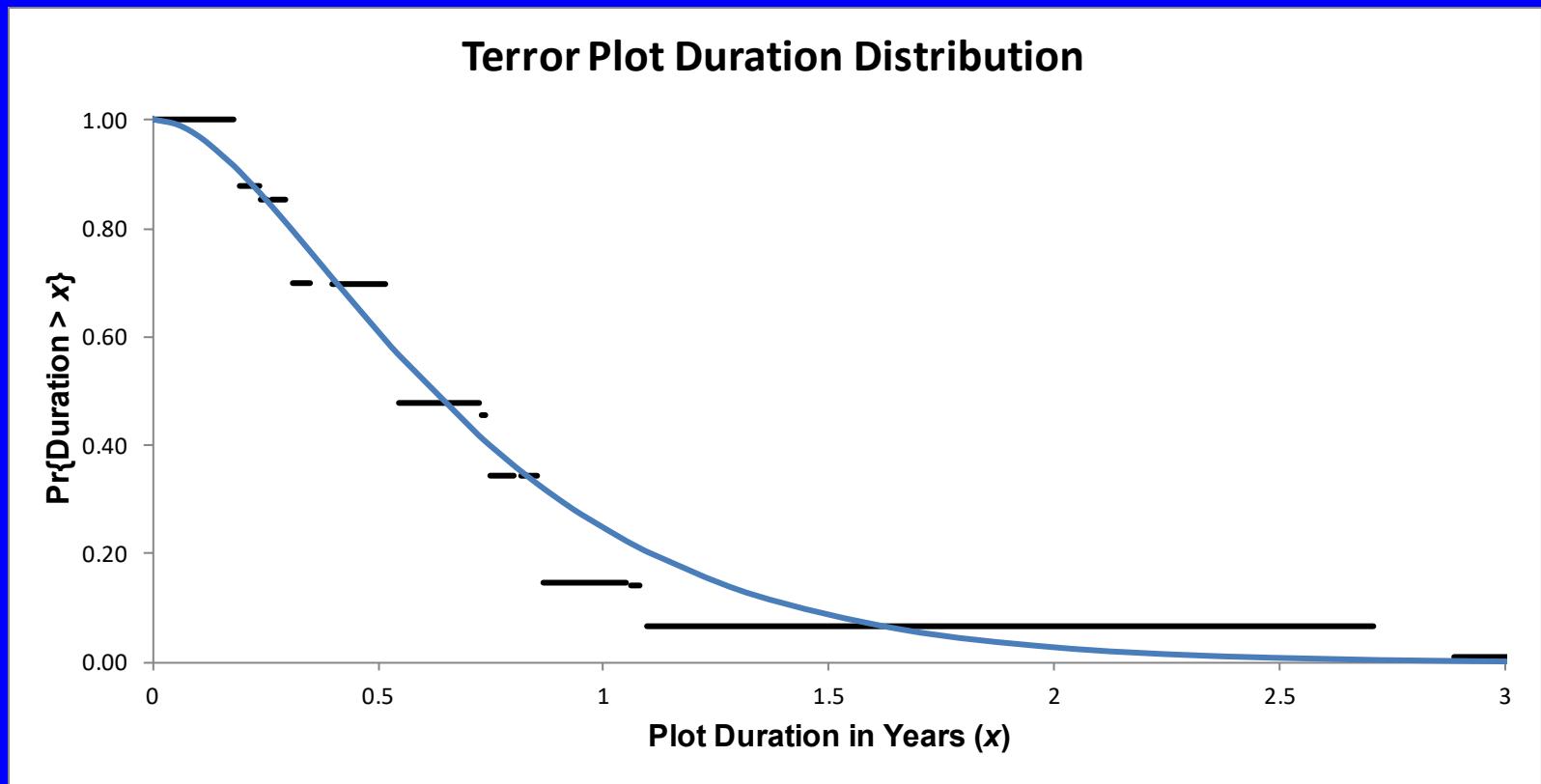
Plot	Key Convicts	Early Start ( $\tau_e$ )	Late Start ( $\tau_l$ )	End Date ( $\tau_c$ )	Source
Shoe Bomb	Richard Reid	7/1/2000	7/7/2001	12/23/2001	13
Dirty Bomb	Jose Padilla	7/24/2000	7/1/2001	5/8/2002	14
Brooklyn Bridge	Iyman Faris	1/1/2002	3/1/2002	3/19/2003	15
President Bush	Ahmed Omar Abu Ali	9/1/2002	9/30/2002	6/9/2003	16
Columbus OH shopping mall	Nuradin Abdi	1/1/2000	8/6/2002	11/28/2003	17
Shoulder fired missiles	Yasin Aref and Mohammed Mosharref Hossain	7/1/2003	11/20/2003	8/4/2004	18
Chicago courthouse	Gale William Nettles	7/1/2003	11/25/2003	8/5/2004	19
Herald Square subway	Shawaward Martin Siraj and James Elshafay	6/1/2004	6/30/2004	8/27/2004	20
Sell bomb to Al Qaeda	Ronald Allen Grecula	7/1/2002	12/31/2002	5/20/2005	21
California prison conspiracy	Kevin James and Levar Washington	12/1/2004	5/19/2005	8/31/2005	22
Chicago Sears Tower	Narseal Batiste <i>et al</i> ("Liberty City Seven")	11/1/2005	12/16/2005	6/22/2006	23
Liquid explosives on airlines	Abdulla Ahmed Ali <i>et al</i> ("Operation Overt")	12/15/2005	5/15/2006	8/9/2006	24
Rockford IL shopping center	Derrick Shareef	9/1/2006	11/29/2006	12/6/2006	25
Fort Dix NJ	Mohamed Ibrahim Shnewer <i>et al</i>	1/3/2006	8/11/2006	5/7/2007	26
Fuel tanks at JFK airport	Russell Defreitas <i>et al</i>	1/1/2006	8/1/2006	6/2/2007	27
South Florida pipe bombs	Ahmed Abdellatif Sherif Mohamed	1/1/2007	7/11/2007	8/4/2007	28
Bronx NY synagogue/Stinger missiles	James Cromitie <i>et al</i>	6/1/2008	4/10/2009	5/19/2009	29
Little Rock shootings	Abdulhakim Muhamajid Muhammad	11/14/2008	1/29/2009	6/1/2009	30
New York City subway	Najibullah Zazi	8/28/2008	12/1/2008	9/19/2009	31
Springfield IL courthouse	Michael C. Finton	11/11/2008	1/2/2009	9/23/2009	32
Fountain Place in Dallas TX	Hosam Maher Husein Smadi	1/1/2009	6/24/2009	9/24/2009	33
Fort Hood shootings	Nidal Hassan	12/1/2008	7/31/2009	11/5/2009	34
"Underwear bomb"	Umar Farouk Abdulmutallab	8/1/2009	10/15/2009	12/25/2009	35
Times Square car bomb	Faisal Shahzad	12/1/2009	2/25/2010	5/1/2010	36
Wrigley Field backpack bomb	Sami Samir Hasoun	5/29/2010	6/4/2010	9/19/2010	37
DC Metrorail	Farooque Ahmed	1/1/2010	5/15/2010	10/26/2010	38
Portland OR Christmas tree lighting	Mohamed Osman Mohamud	8/1/2009	8/19/2010	11/26/2010	39
Maryland military recruitment center	Antonio Benjamin Martinez	9/29/2010	10/22/2010	12/8/2010	40
Colorado dams and President Bush	Khalid Ali Aldawsari	3/11/2010	10/19/2010	2/23/2011	41
New York City synagogue	Ahmed Ferhani and Mohamed Mamdouh	10/15/2010	4/12/2011	5/11/2011	42

# Estimating the Duration of *Jihadi* Terror Plots in the United States

---

- This strategy produced early and late start dates for 30 of the 35 plots (could not get info for LAX shooting where perpetrator Hesham Mohamed Hadayet was killed by security guard, PATH tunnel plot where Assem Hammoud arrested in Beirut, etc)
- From these data, can estimate duration distribution from early start, late start, and plot completion (execution/interdiction) dates

# Empirical US *Jihadi* Terror Plot Duration Distribution



- Mean=270 days (SE 43)
- 95% probability interval 1 – 25 months

# How Many Terror Plots?

---

- Again, if  $N$  is number of terror plots in progress, and  $\alpha$  is the plot initiation rate, then

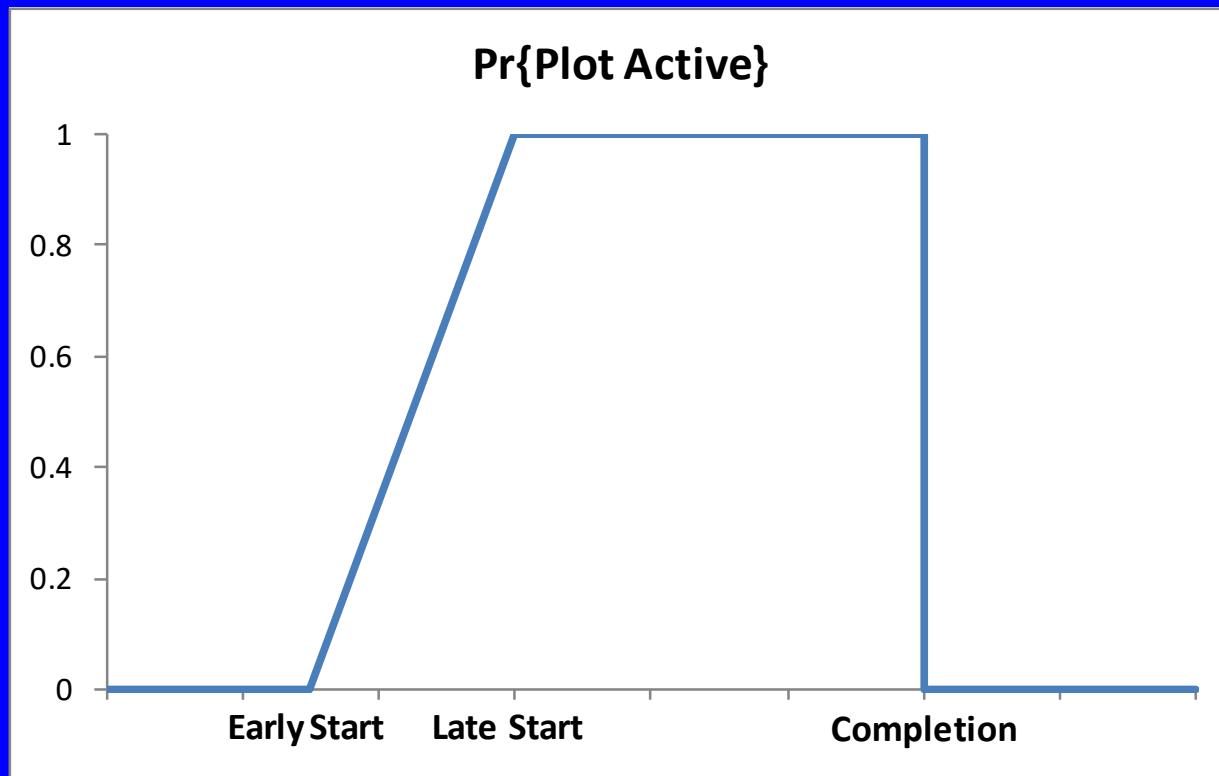
$$E(N) = \alpha E(D)$$

- Plugging in estimates for mean duration (270 days) and arrival rate (35 plots/9.8 years) yields  $E(N) = 2.64$  – not a large number!

# Plots Over Time

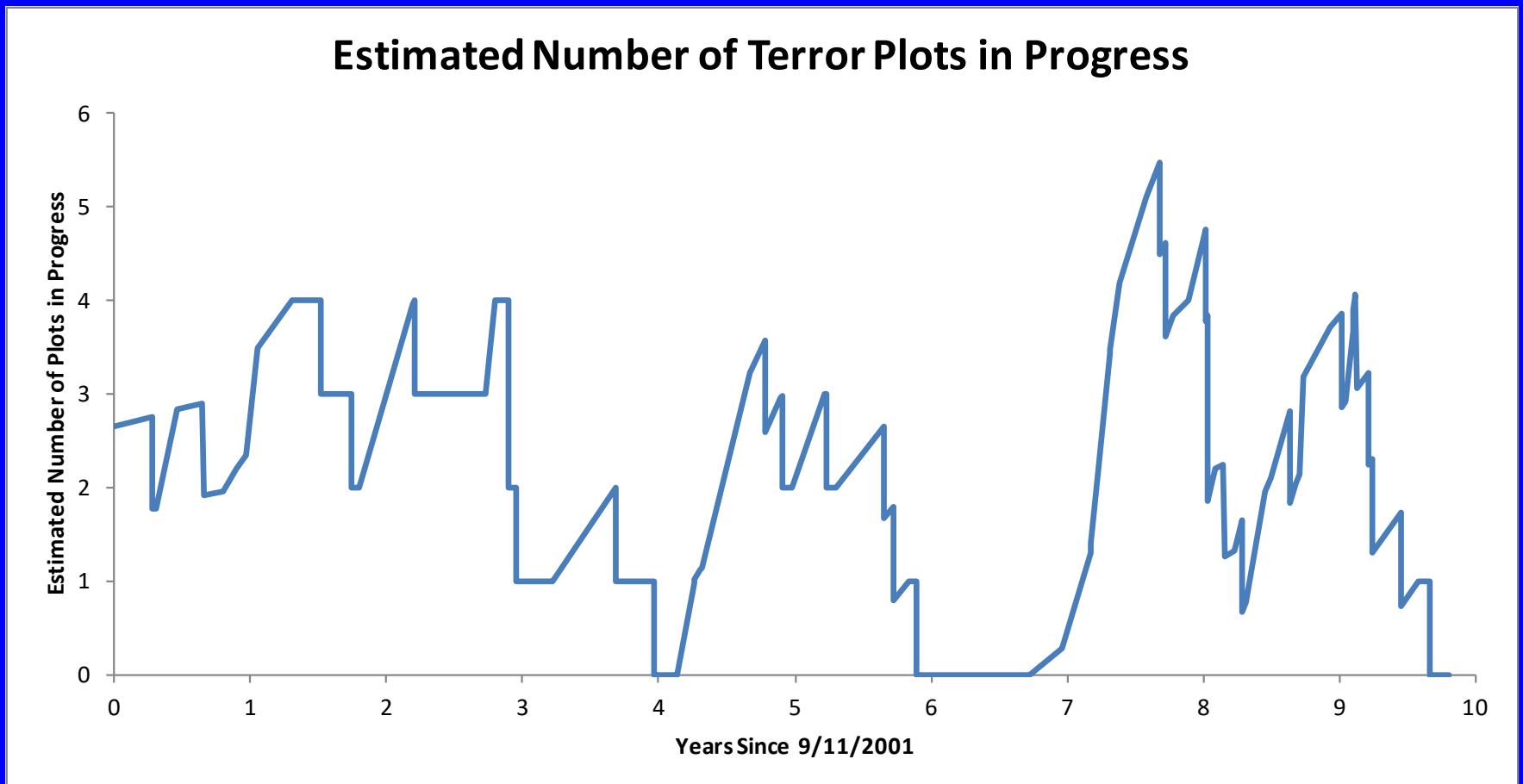
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- Let  $p(t)$  denote the probability that a particular plot is in progress at time  $t$
- $p(t)$  looks like...



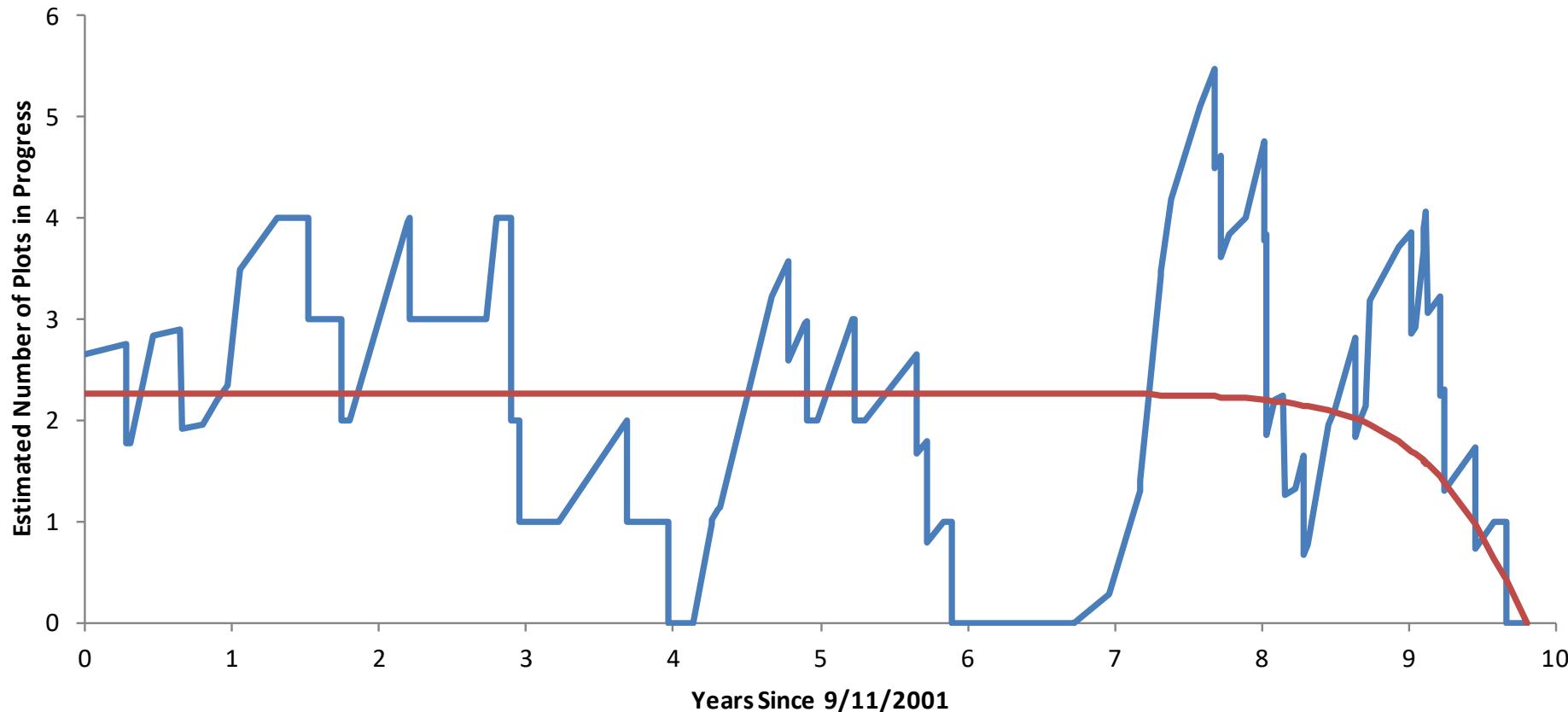
# Plots Over Time

- Summing  $p(t)$  over all plots gives expected number of “observable” active plots in data over time



# Compare to Model

Estimated Number of Terror Plots in Progress



# So All Told...

---

- Estimate about 3 *Jihadi* plots in progress in the United States
- Upper 95% confidence limit for the *mean* number of plots equals 4.12
- Conservative upper 95% confidence limit for *actual* number of plots equals 7

# Two Interpretations

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- If there are so few terror plots in play, why are we spending so much money on homeland security and counterterrorism?
  - Surely other pressing problems are more deserving of public support (education, public health, job creation...!)
- It is precisely because of our investments in homeland security and counterterrorism that there are so few plots!
  - How many airplane crashes are there each year?  
How much do we spend on airline safety?