A Power-Law of Death

Frank R. Baumgartner
Richard J. Richardson Distinguished Professor of Political Science
University of North Carolina at Chapel Hill

Frankb@unc.edu

May 6, 2011

Introduction

- The distribution of executions across the countries of the world, US states, and US counties corresponds to what statisticians call a “power law.”
- This means that the relation between the cumulative frequency of the event and the severity of the event follows this equation: $F(x) = ab^{-\alpha}$
- Where F(x) means the cumulative frequency of x; a is a constant, b is the severity, and α is a parameter to be estimated.

What that means

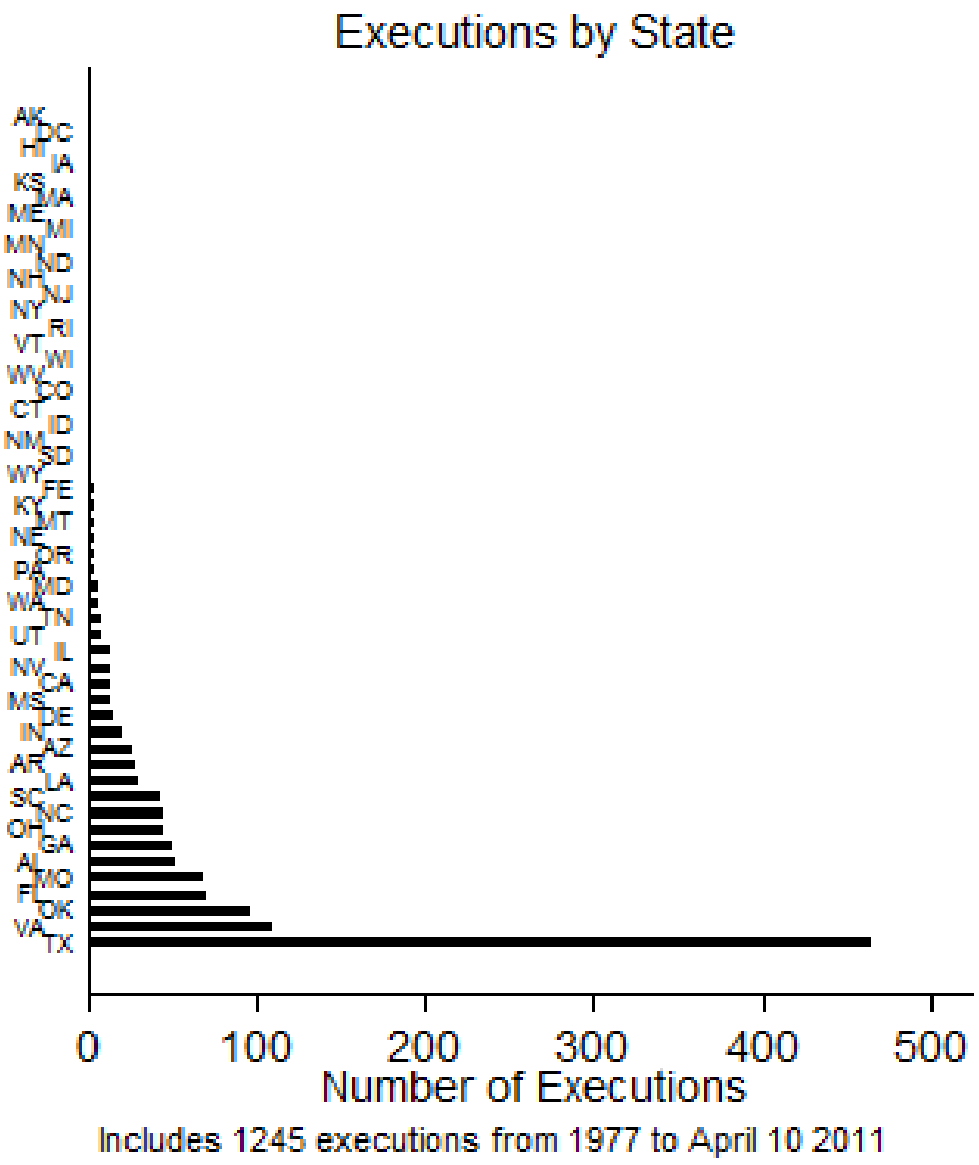
- If one plots the frequency of the event against the severity of the event, and uses a log scale for both the x and the y axis, a series that has a “power law” characteristic will array along a straight line.
- Power-laws are “extreme value” distributions in which theories suggest a “self-reinforcing” process must be generating the distribution.
- If events occurred randomly, they could not generate such a distribution.

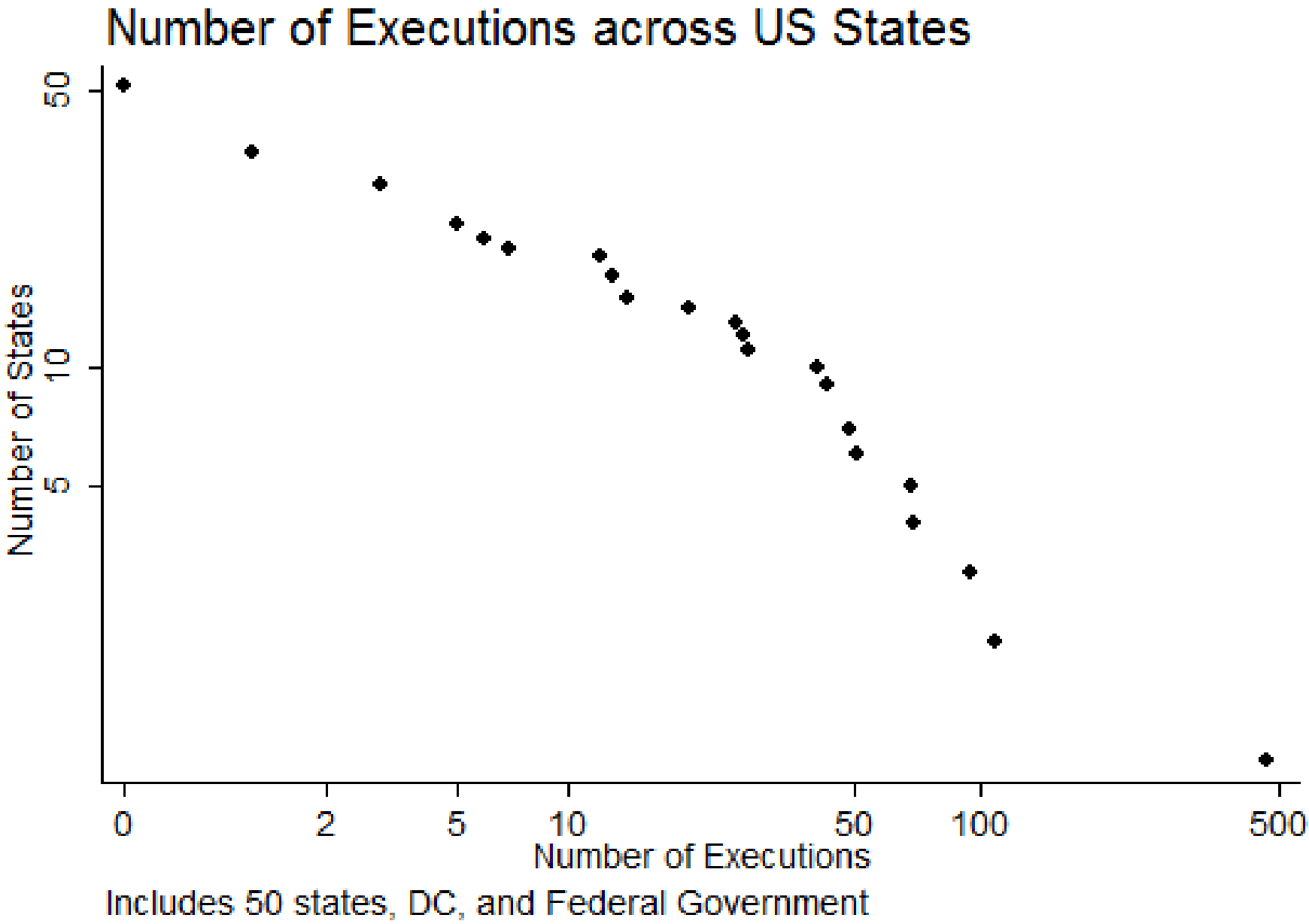
Implications

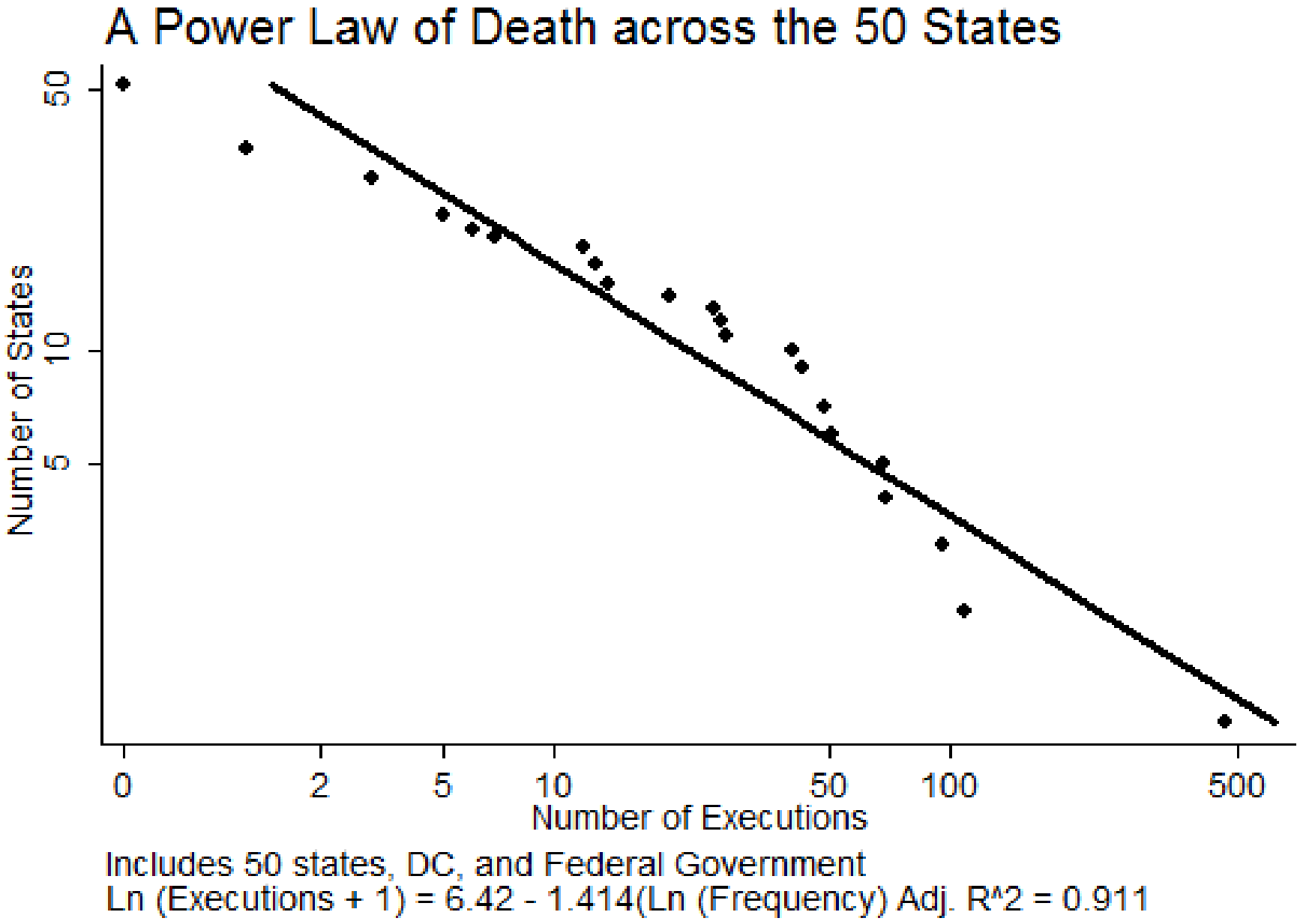
- What process could produce a “self-reinforcing” outcome for executions?
- Local legal communities may never or very rarely generate executions, in which case norms and procedures develop to “self-reinforce” this abstention from capital punishment.
- Or, they may start down the path, and when they do the path becomes easier in subsequent cases.
- If the distribution of executions is a power-law, it suggests something of this nature.
- A self-reinforcing legal culture is strong evidence of arbitrariness, since the odds of execution are related to the number of previous executions in that jurisdiction, not the characteristics of the crime.

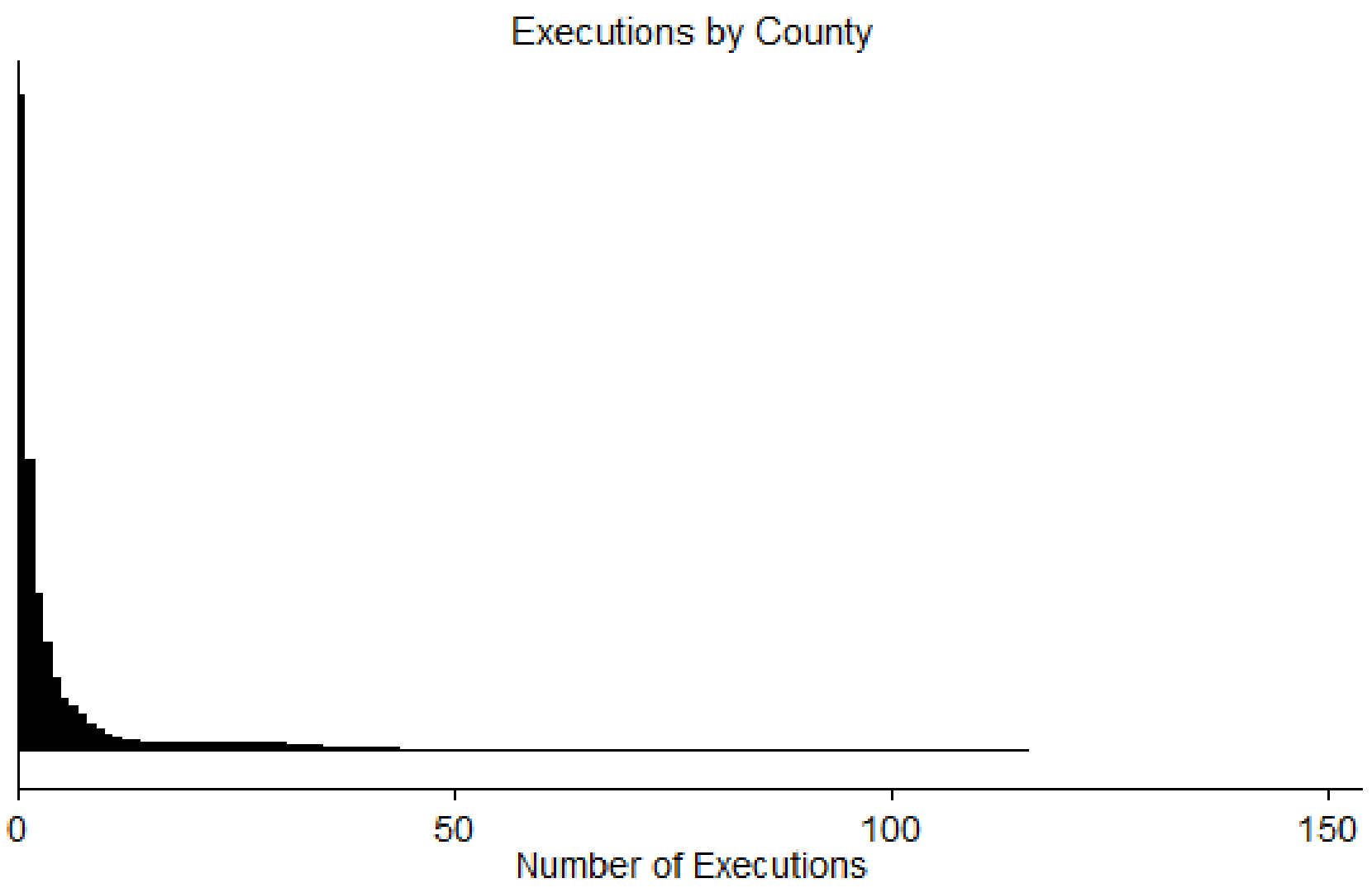
The Data

- Data compiled on all US executions since 1976 as of April 11 2011, 1245 executions in total.
- Analyses by county do not include 3 executions by the federal government.
- Subsequent slides show for states and counties the distribution, first as simple counts, then on a log-log plot to test for the presence of a power law. This is also shown then for successive time periods from 1977 forward, for counties. Finally we consider all countries in the world, from 2007 to 2010. The power law is ubiquitous.
- Thanks to UNC undergraduate students BJ Dworak, Matt Nolan, Linden Wait, and Amber Clifford for research assistance.

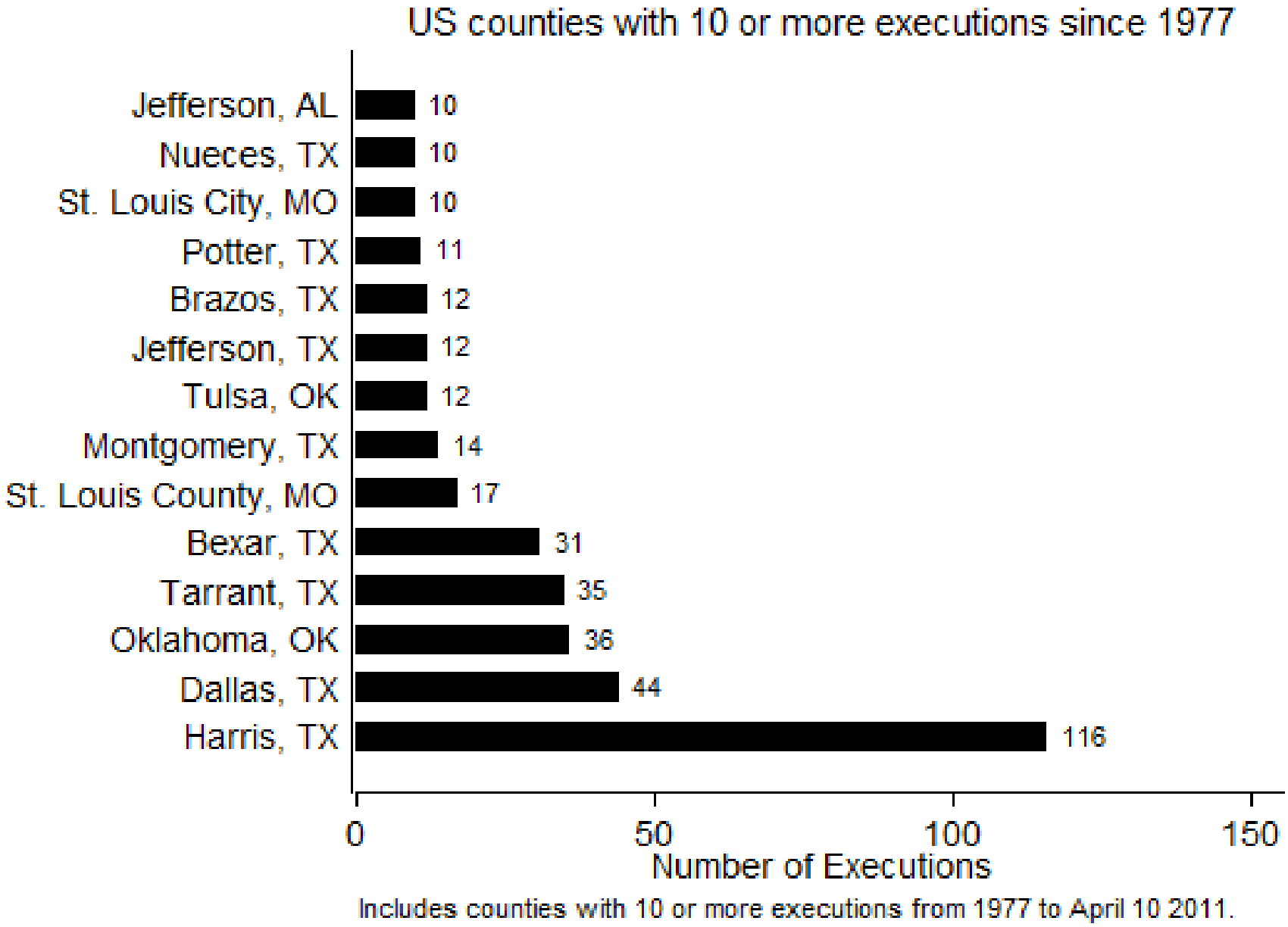

Executions by State
AK
DC
HI
IA
KS
MA
ME
MI
MN
ND
NH
NJ
NY
RI
VT
WI
WV
CO
CT
ID
NM
SD
WY
FE
KY
MT
NE
OR
PA
MD
WA
TN
UT
IL
NV
CA
MS
DE
IN
AZ
AR
LA
SC
NC
OH
GA
AL
MO
FL
OK
VA
TX
0
100
200
300
400
500
Number of Executions
Includes 1245 executions from 1977 to April 10 2011

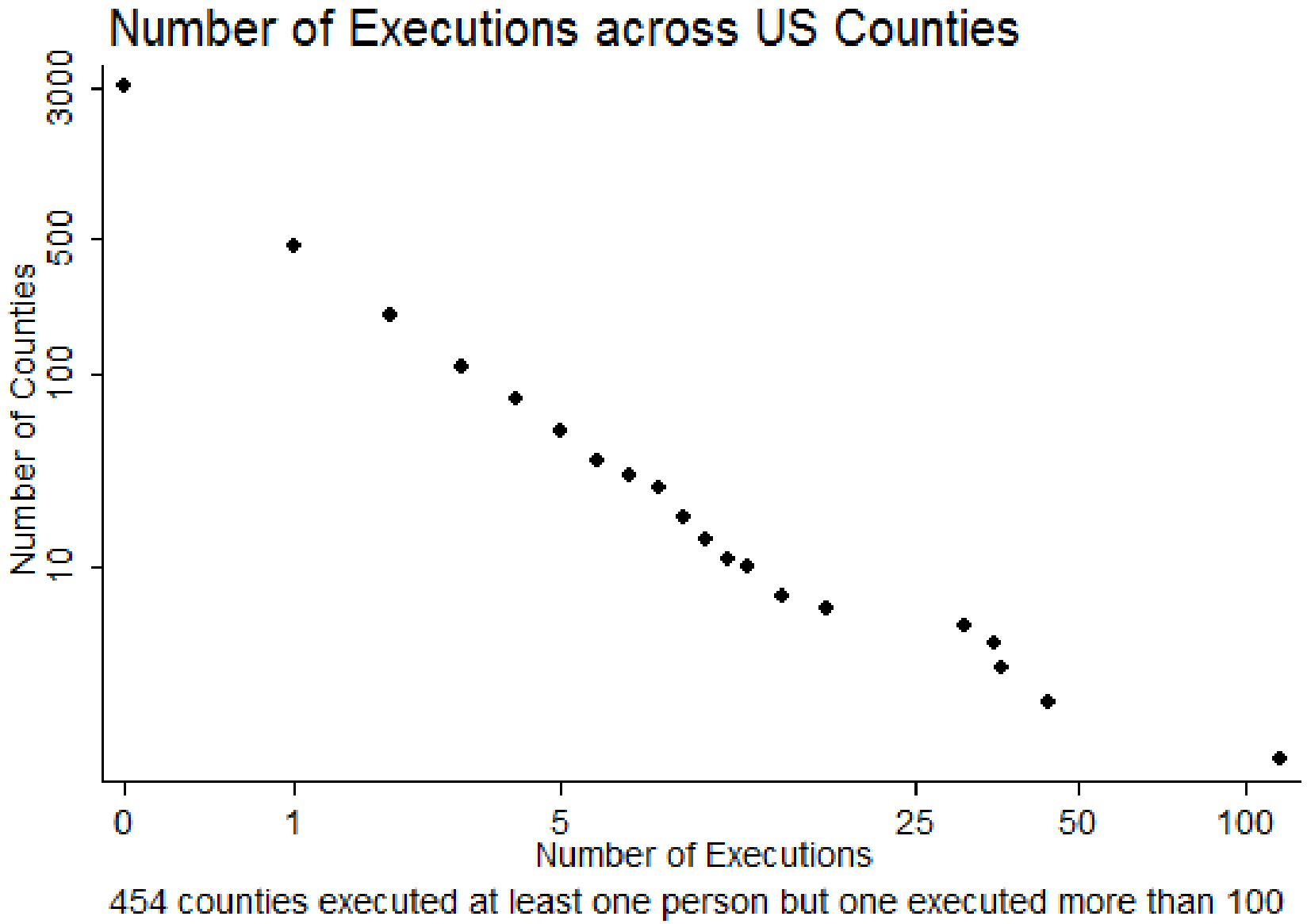

Number of Executions across US States
Number of States
50
10
5
0
2
5
10
50
100
500
Number of Executions
Includes 50 states, DC, and Federal Government

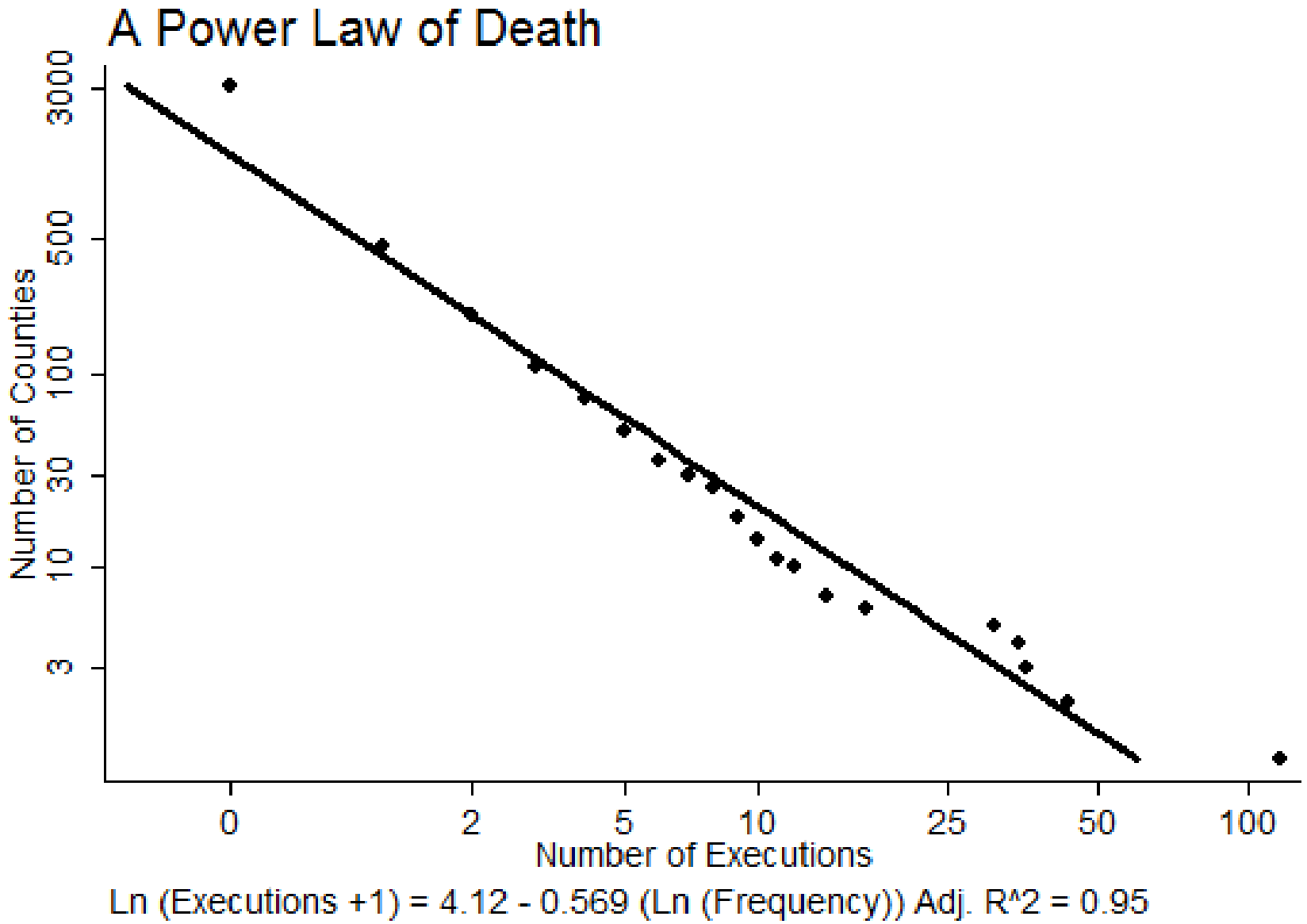

A Power Law of Death across the 50 States
Number of States
50
10
5
0
2
5
10
50
100
500
Number of Executions
Includes 50 states, DC, and Federal Government
Ln (Executions + 1) = 6.42 - 1.414(Ln (Frequency) Adj. R^2 = 0.911

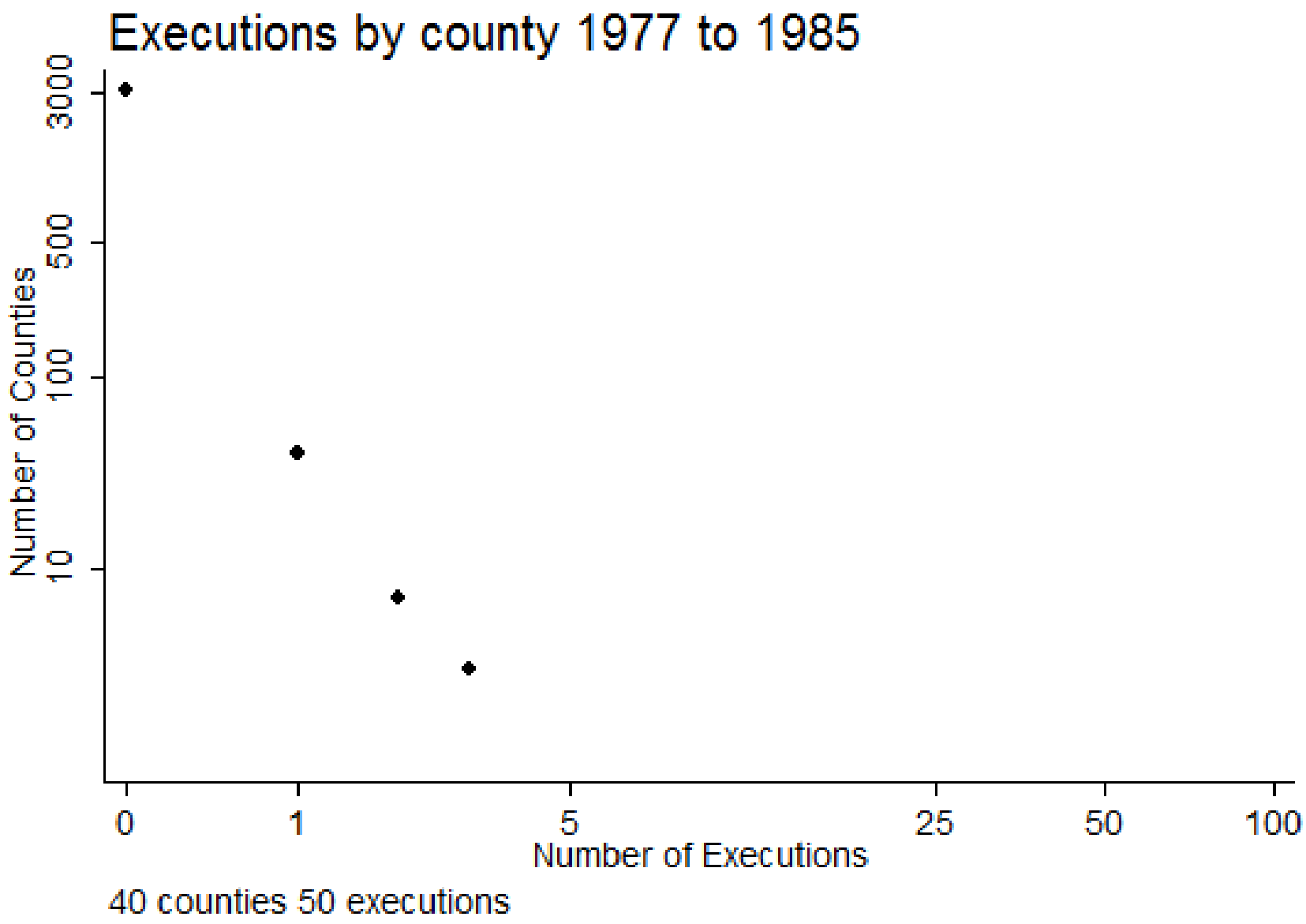


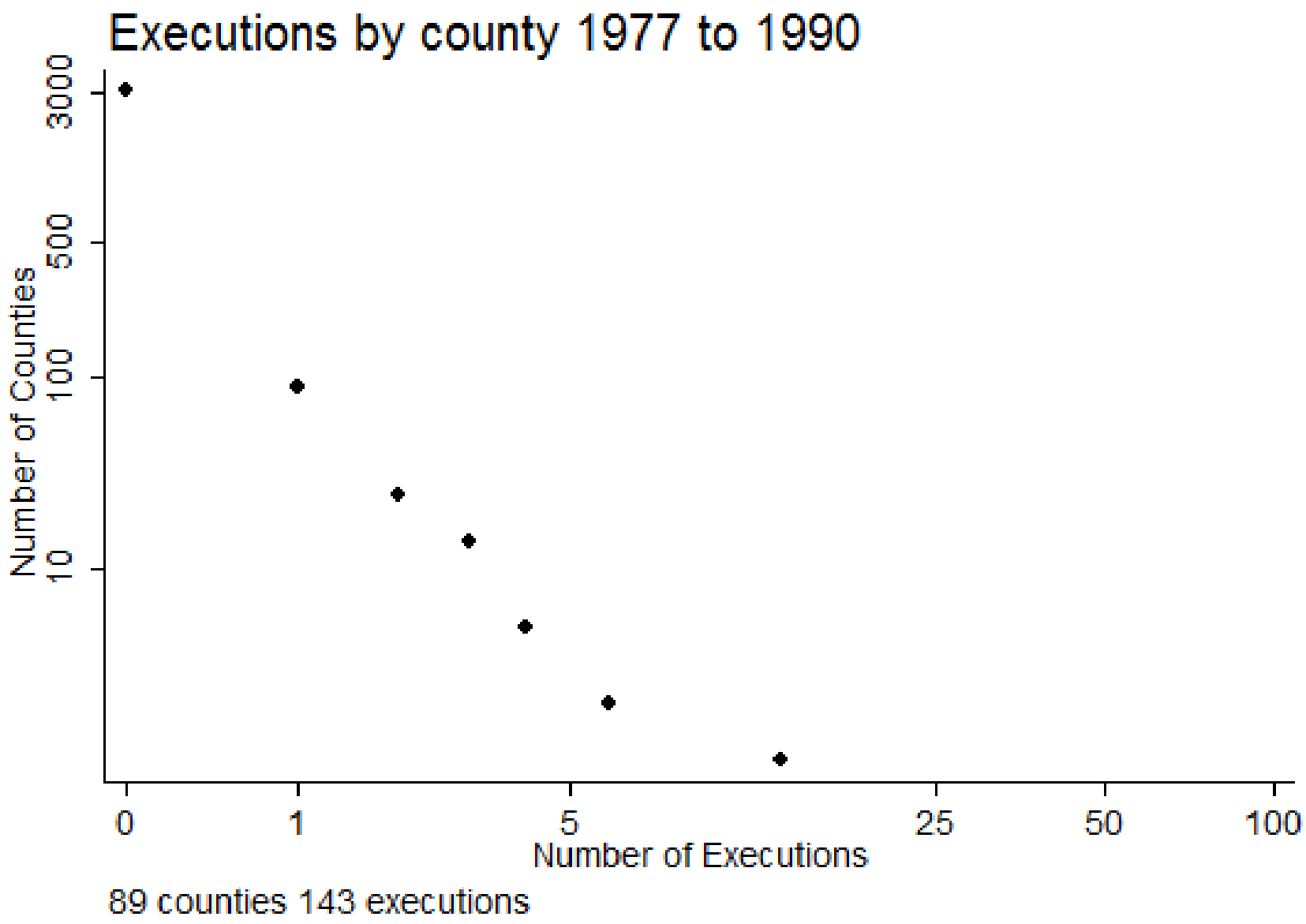
Includes 1245 executions from 1977 to April 10 2011.
2692 counties have executed no inmates 455 at least one and Harris County 116.

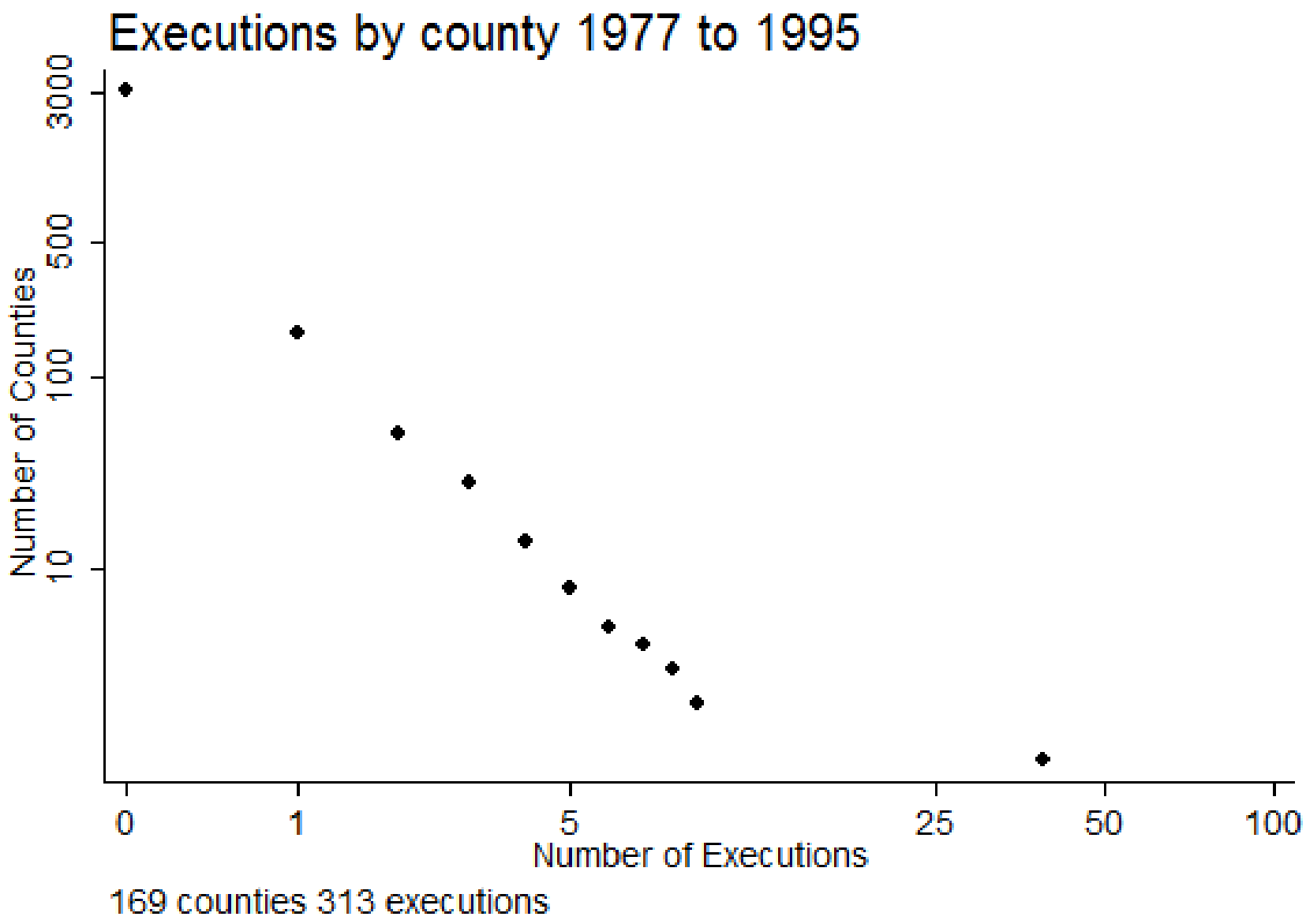

US counties with 10 or more executions since 1977
Jefferson, AL
10
Nueces, TX
10
St. Louis City, MO
10
Potter, TX
11
Brazos, TX
12
Jefferson, TX
12
Tulsa, OK
12
Montgomery, TX
14
St. Louis County, MO
17
Bexar, TX
31
Tarrant, TX
35
Oklahoma, OK
36
Dallas, TX
44
Harris, TX
116
0
50
100
150
Number of Executions
Includes counties with 10 or more executions from 1977 to April 10 2011.

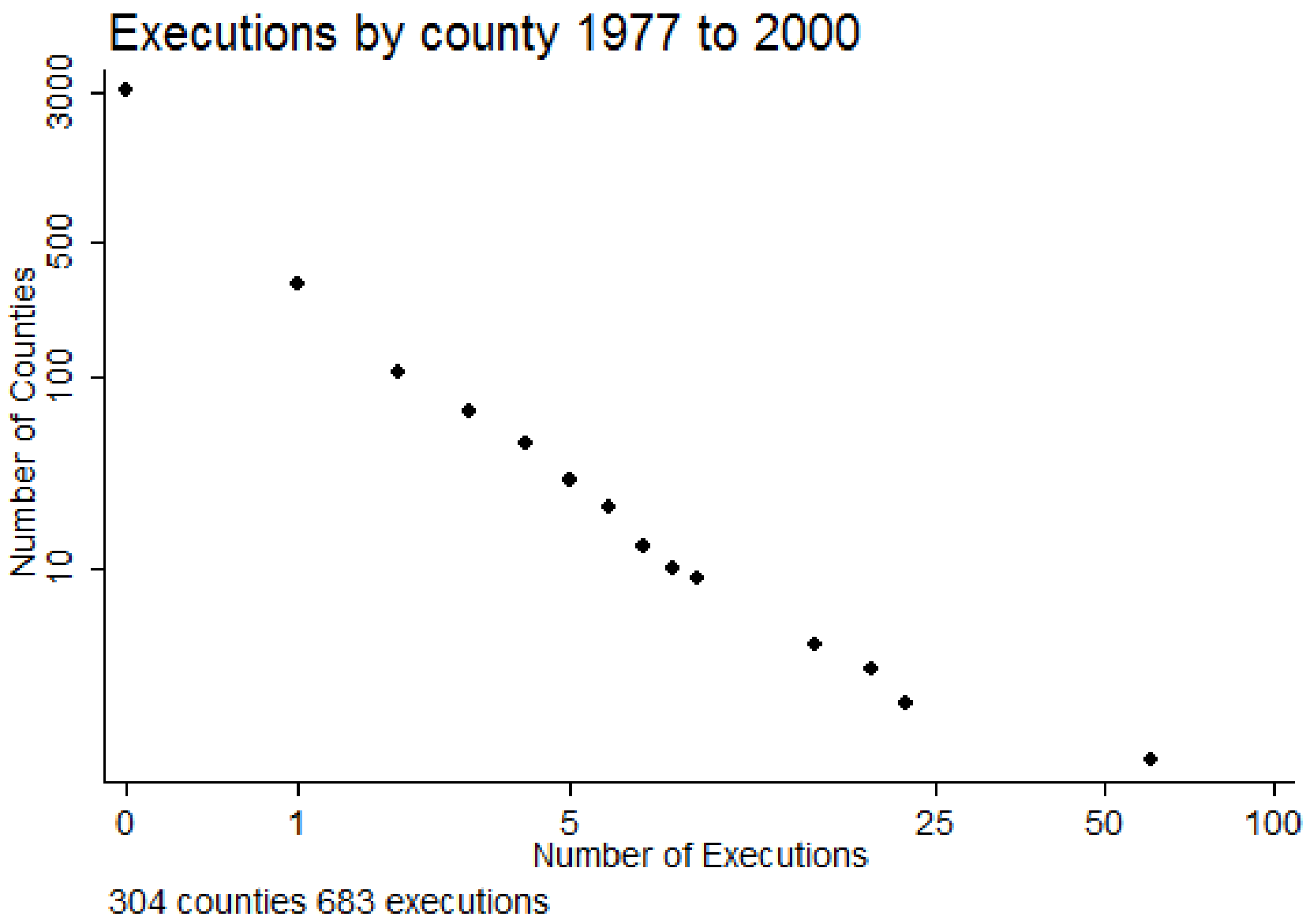

Number of Executions across US Counties
Number of Counties
3000
500
100
10
0
1
5
25
50
100
Number of Executions
454 counties executed at least one person but one executed more than 100

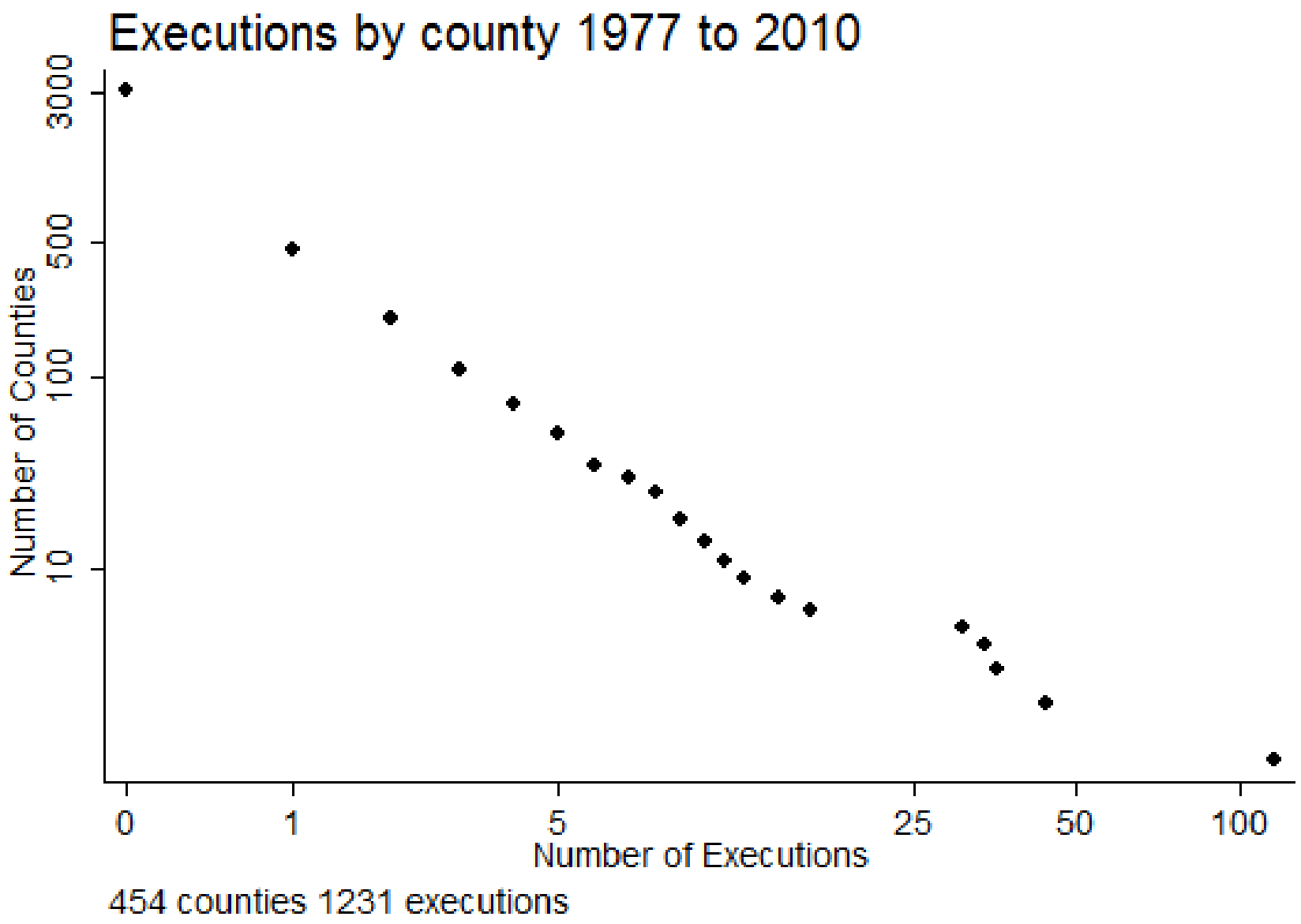

A Power Law of Death
Number of Counties
3000
500
100
30
10
3
0
2
5
10
25
50
100
Number of Executions
Ln (Executions +1) = 4.12 - 0.569 (Ln (Frequency)) Adj. R^2 = 0.95

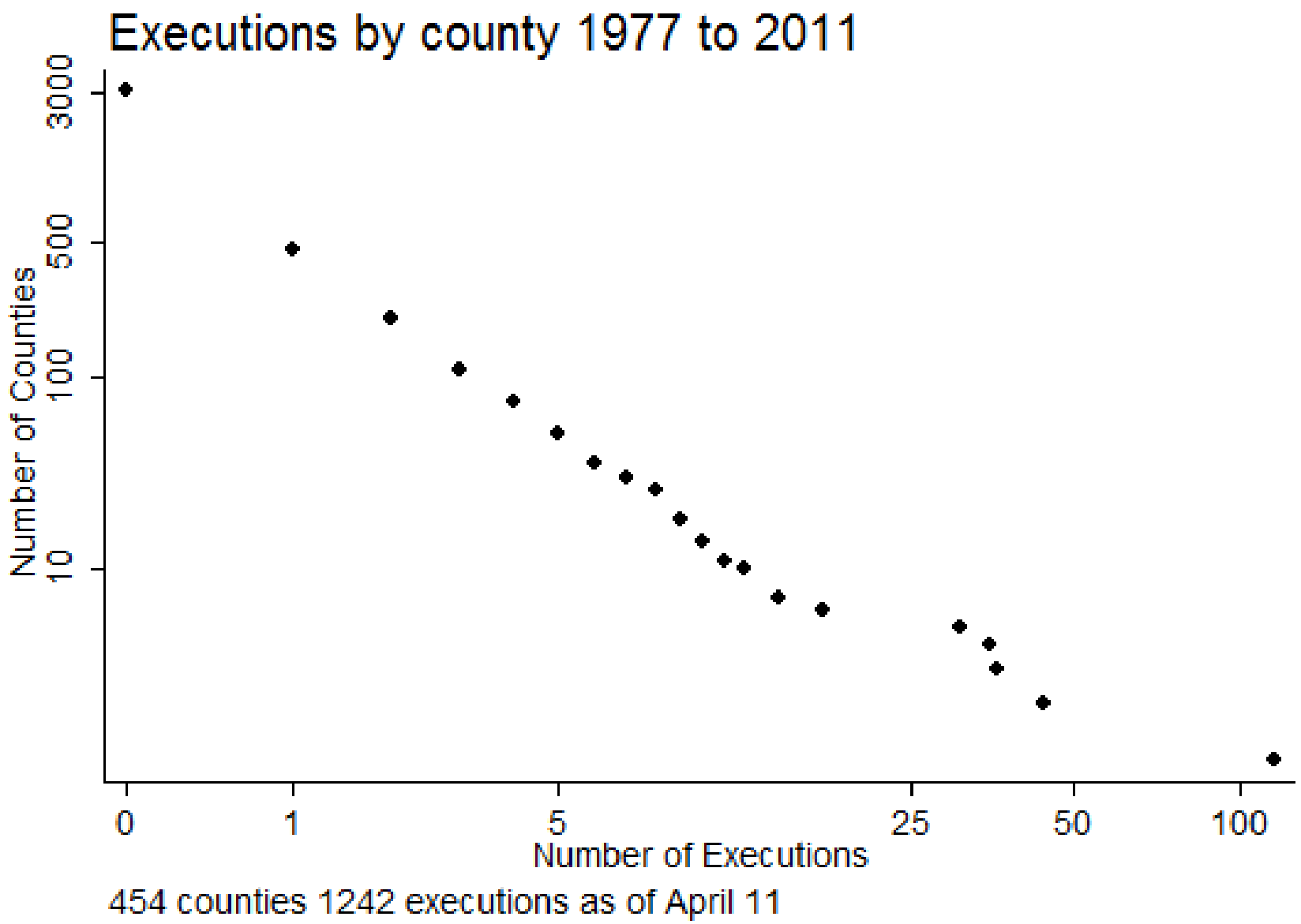

Executions by county 1977 to 1985
Number of Counties
3000
500
100
10
0
1
5
25
50
100
Number of Executions
40 counties 50 executions


Executions by county 1977 to 1990
Number of Counties
3000
500
100
10
0
1
5
25
50
100
Number of Executions
89 counties 143 executions


Executions by county 1977 to 1995
Number of Counties
3000
500
100
10
0
1
5
25
50
100
Number of Executions
169 counties 313 executions


Executions by county 1977 to 2000
Number of Counties
3000
500
100
10
0
1
5
25
50
100
Number of Executions
304 counties 683 executions

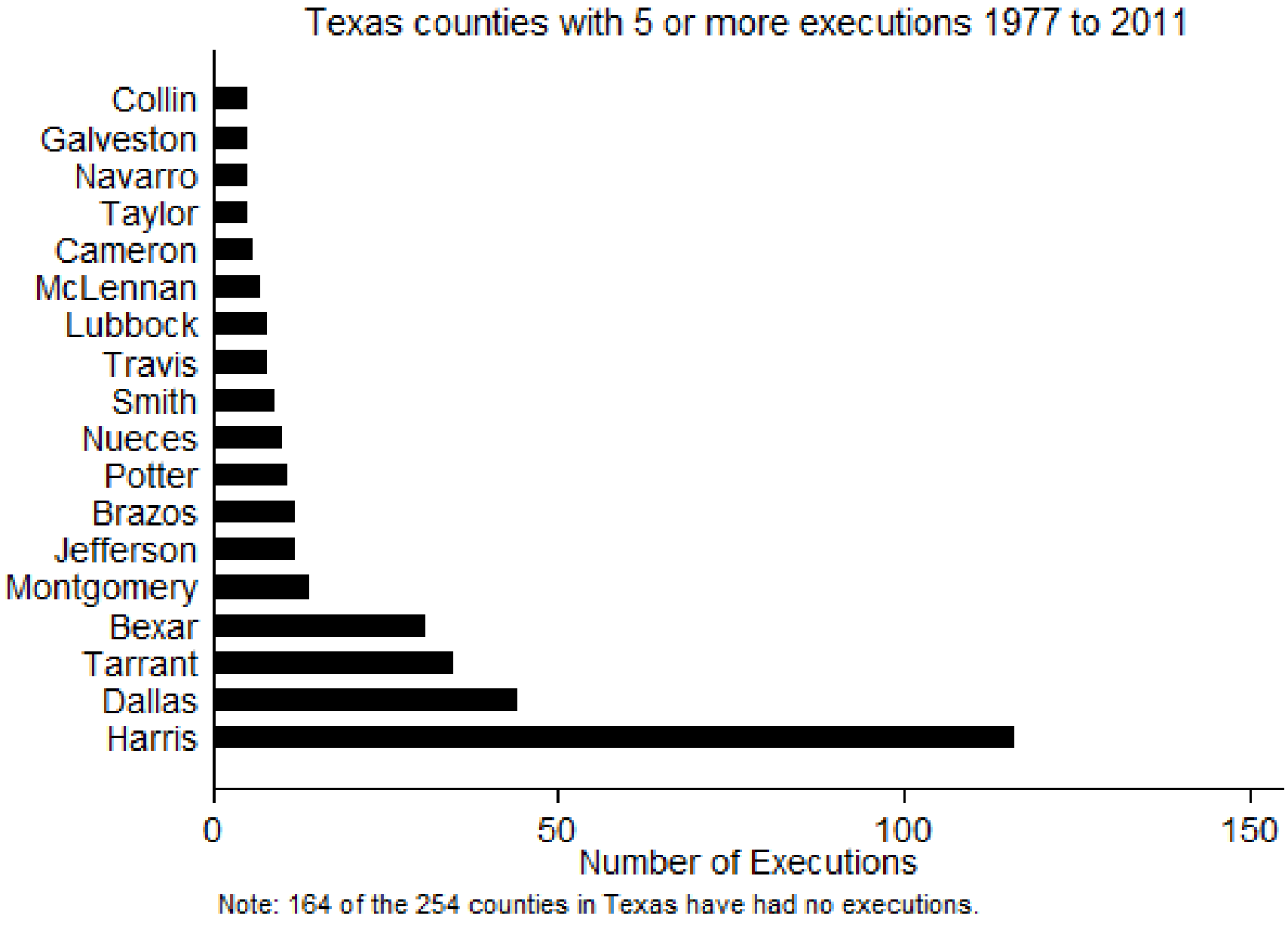

Executions by county 1977 to 2010
Number of Counties
3000
500
100
10
0
1
5
25
50
100
Number of Executions
454 counties 1231 executions

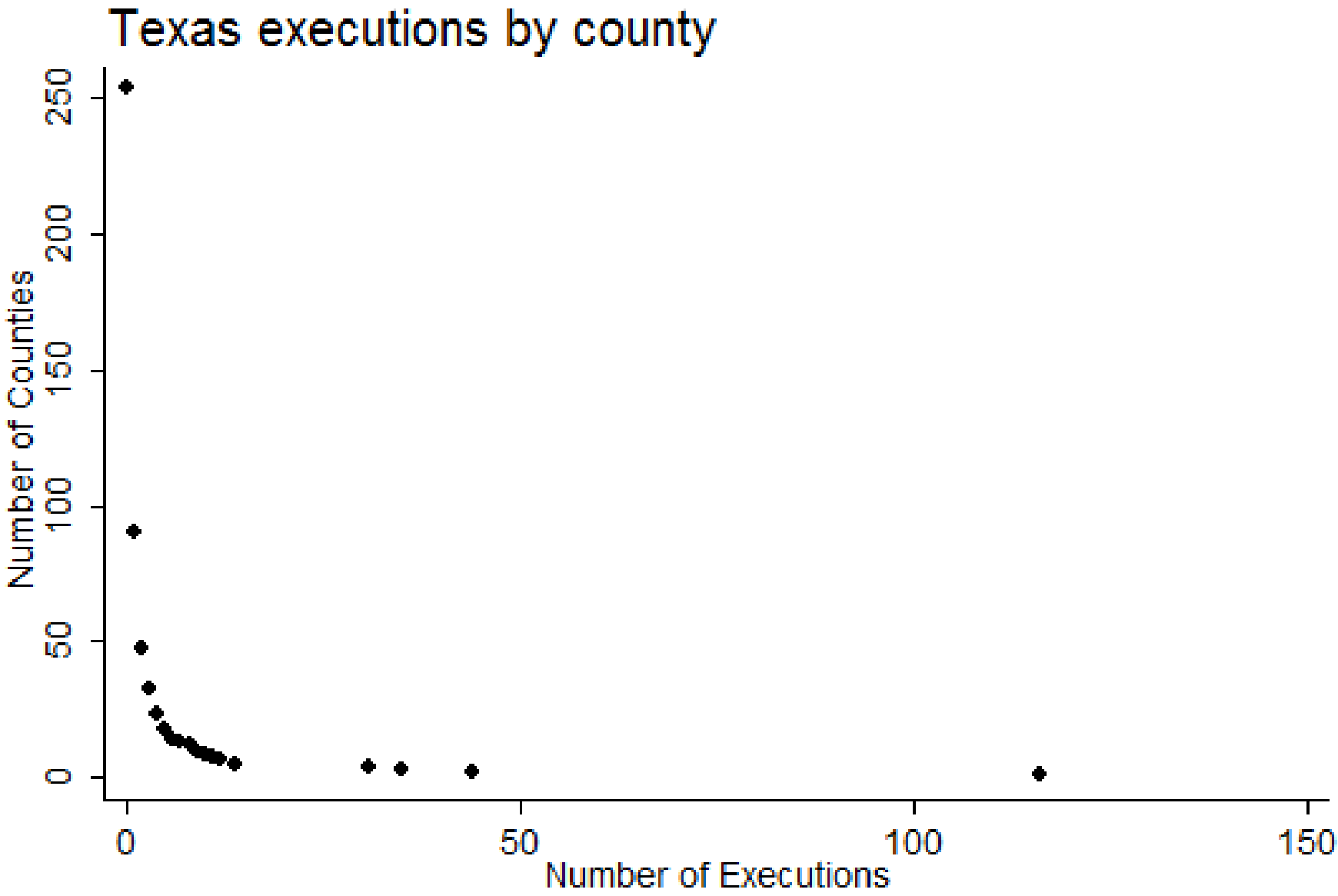

Executions by county 1977 to 2011
Number of Counties
3000
500
100
10
0
1
5
25
50
100
Number of Executions
454 counties 1242 executions as of April 11

These trends also hold for individual states

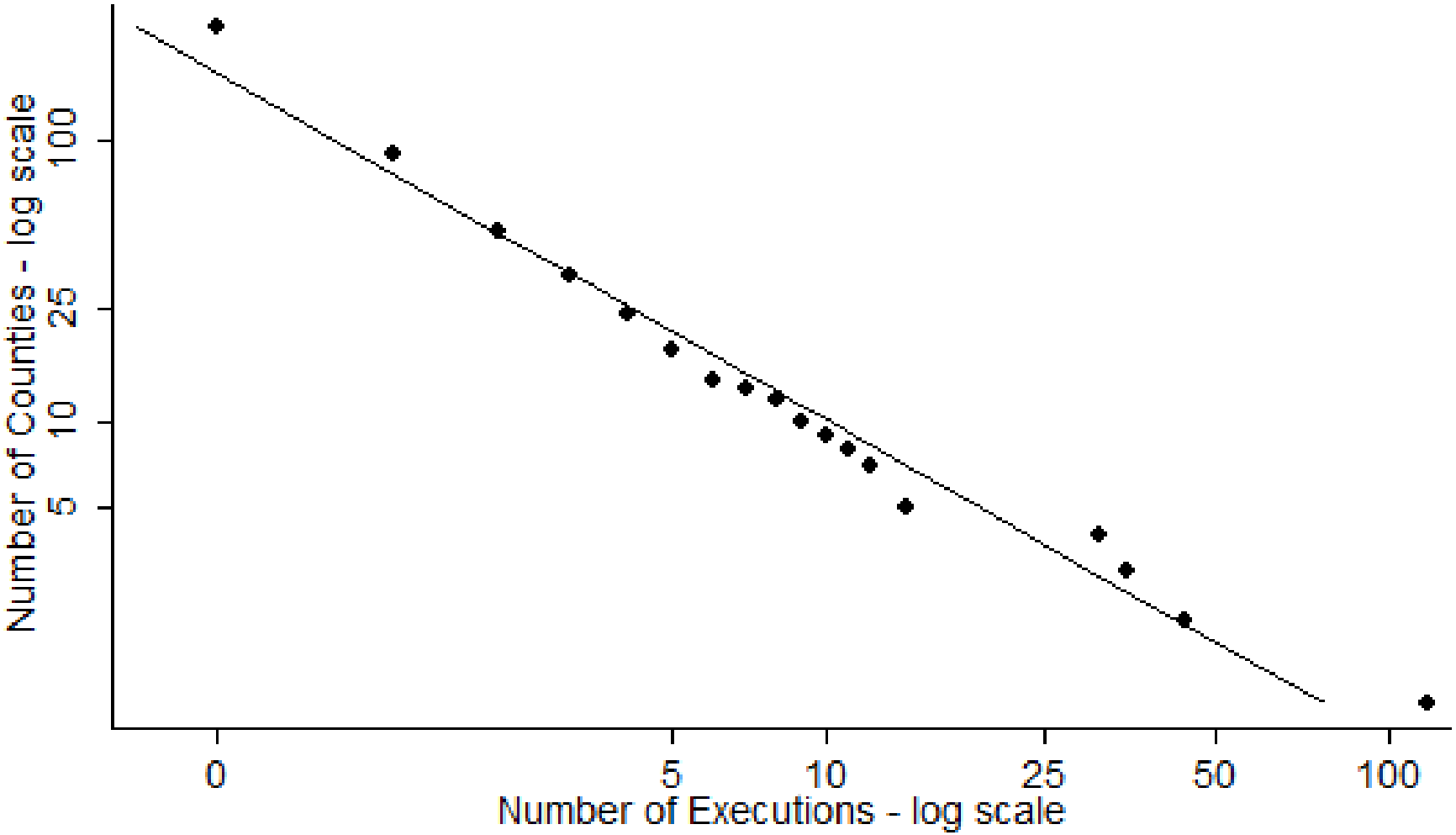
- The following slides show similar analyses for the state with by far the greatest number of executions, Texas, and for North Carolina.

- We can have greater confidence in the national analysis since it is based on a larger number of observations, but the pattern also holds within individual states.

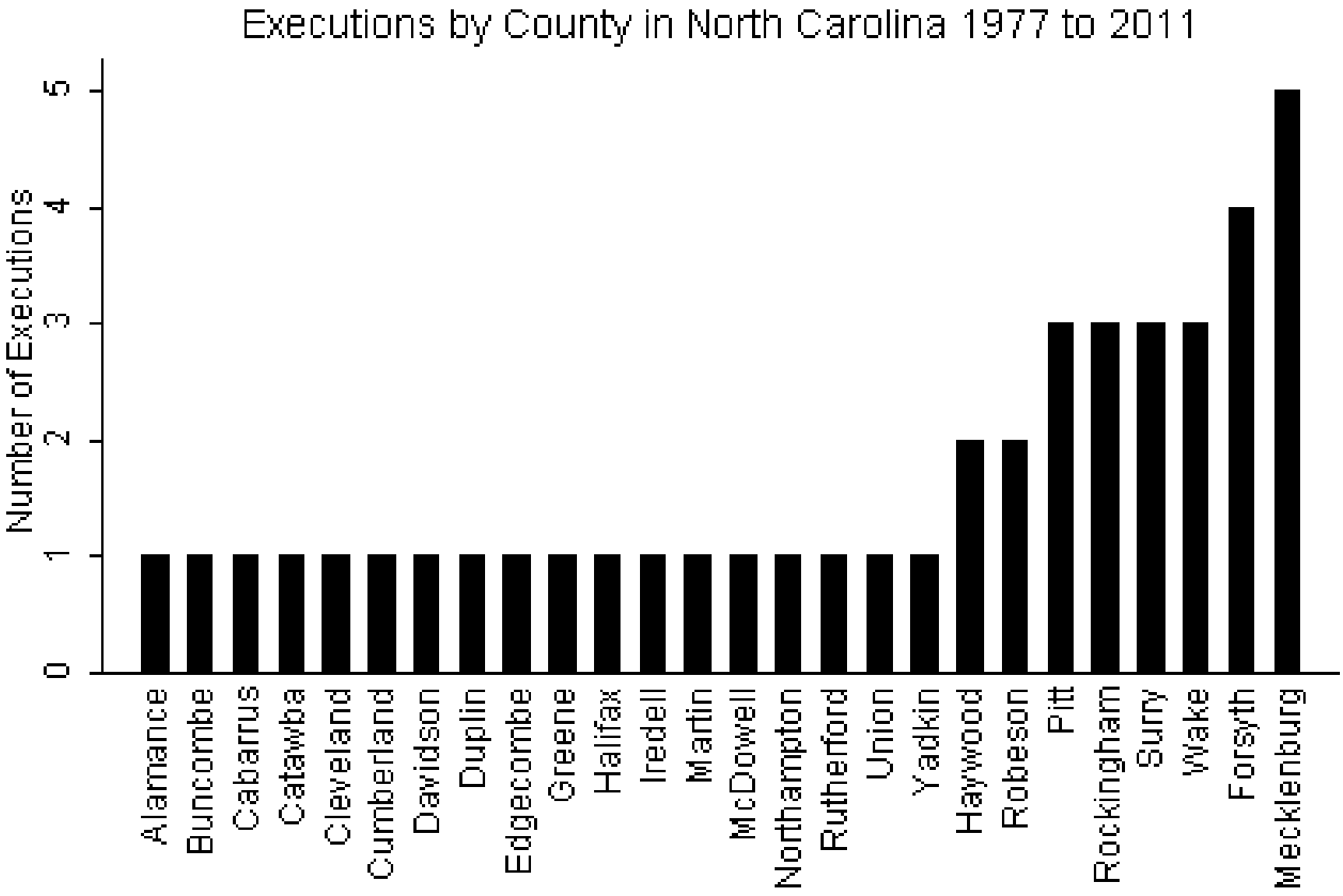

Texas counties with 5 or more executions 1977 to 2011
Collin
Galveston
Navarro
Taylor
Cameron
McLennan
Lubbock
Travis
Smith
Nueces
Potter
Brazos
Jefferson
Montgomery
Bexar
Tarrant
Dallas
Harris
0
50
100
150
Number of Executions
Note: 164 of the 254 counties in Texas have had no executions.


Texas executions by county
Number of Counties
0
50
100
150
200
250
0
50
100
150
Number of Executions
Of 254 counties, 164 have executed no one but Harris has executed 116.

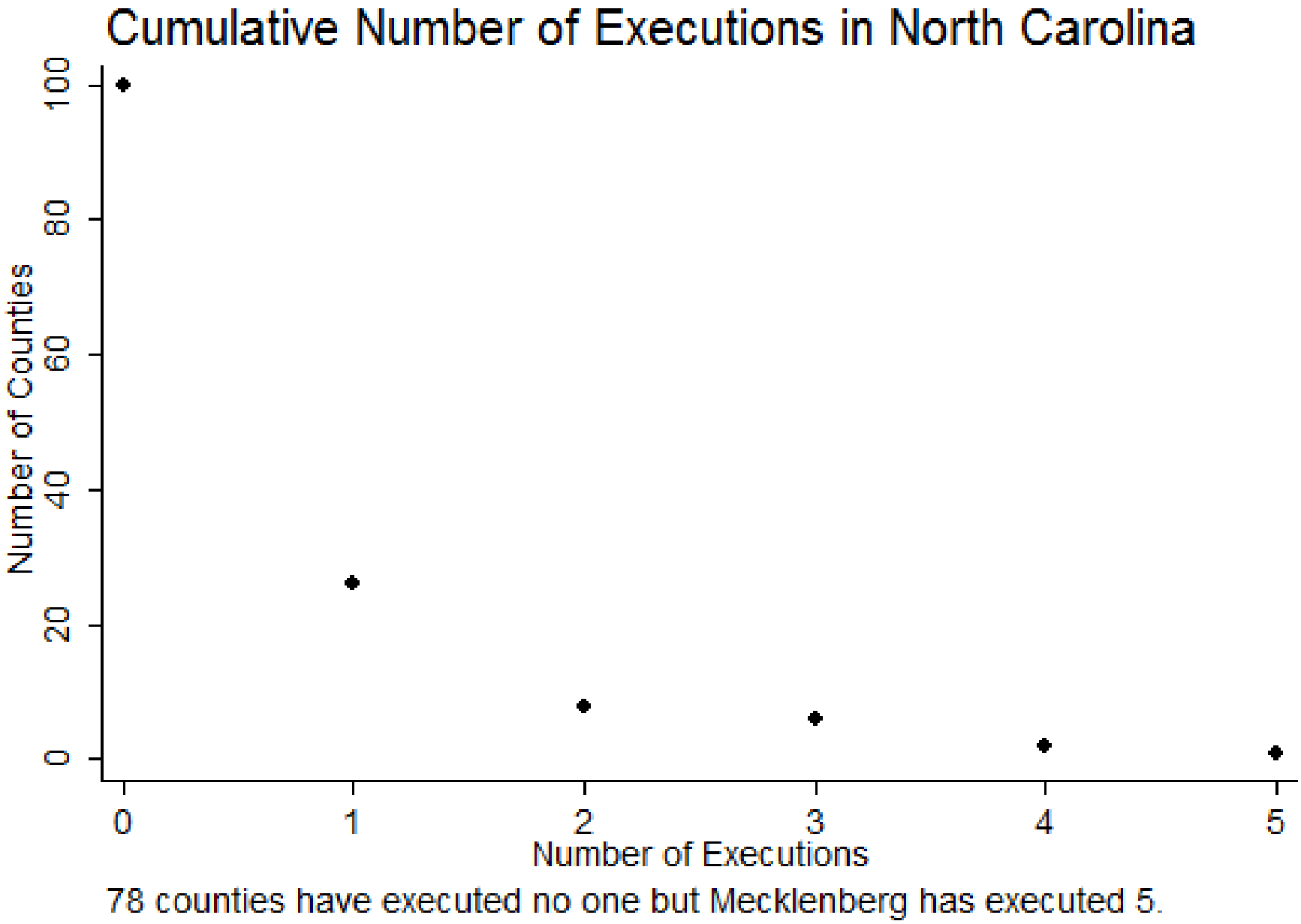
Frequency of Executions by County, Texas

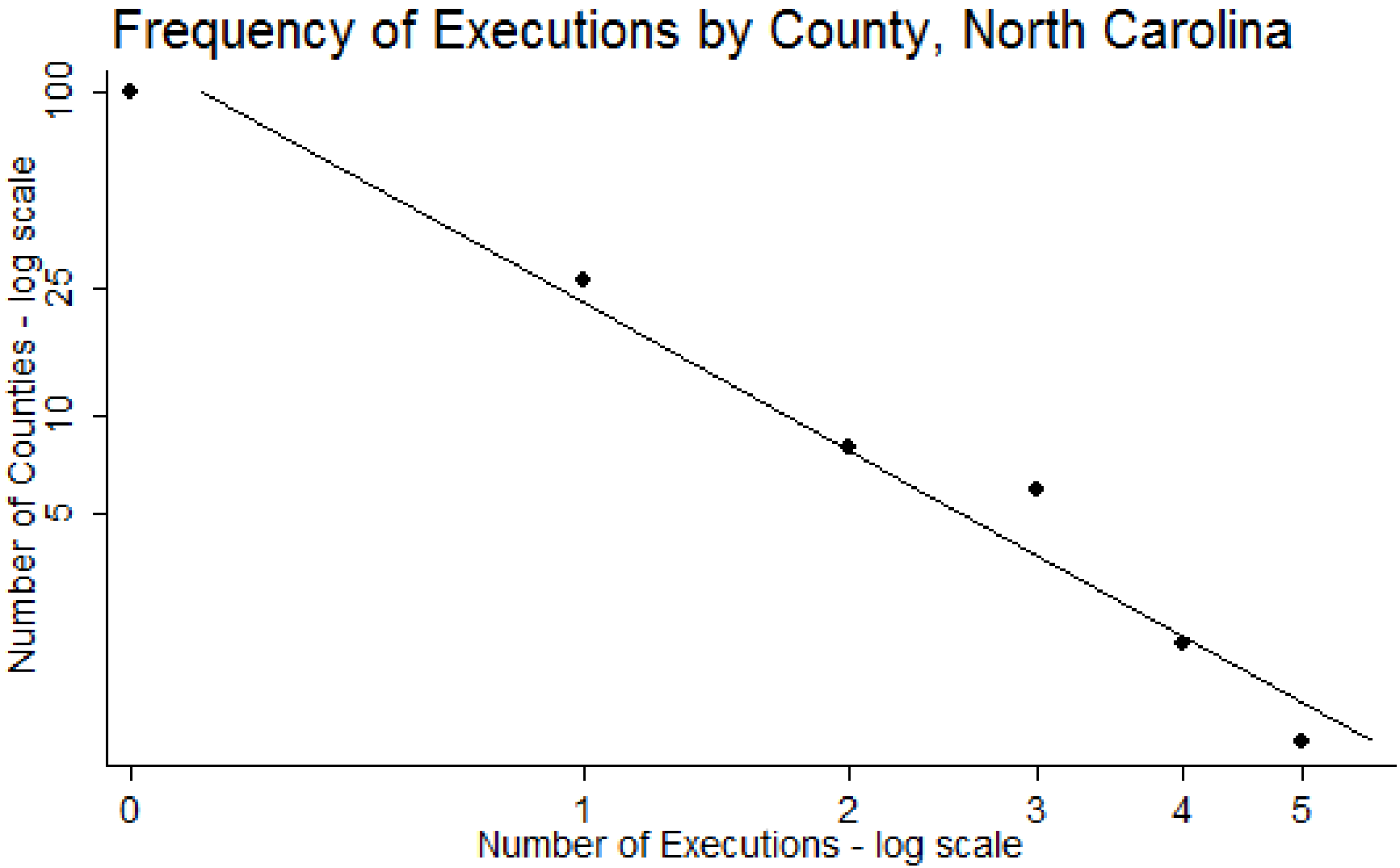


Among 254 counties in Texas, 90 have had one or more executions,
9 counties have executed 10 or more, and one (Harris) has executed 116.
Ln(Frequency) = 4.36 - 0.85(Ln (Executions+1) Adj. R2 = 0.97



Note: 74 of the 100 counties in North Carolina have had no executions.


Cumulative Number of Executions in North Carolina
Number of Counties
0
20
40
60
80
100
0
1
2
3
4
5
Number of Executions
78 counties have executed no one but Mecklenberg has executed 5.

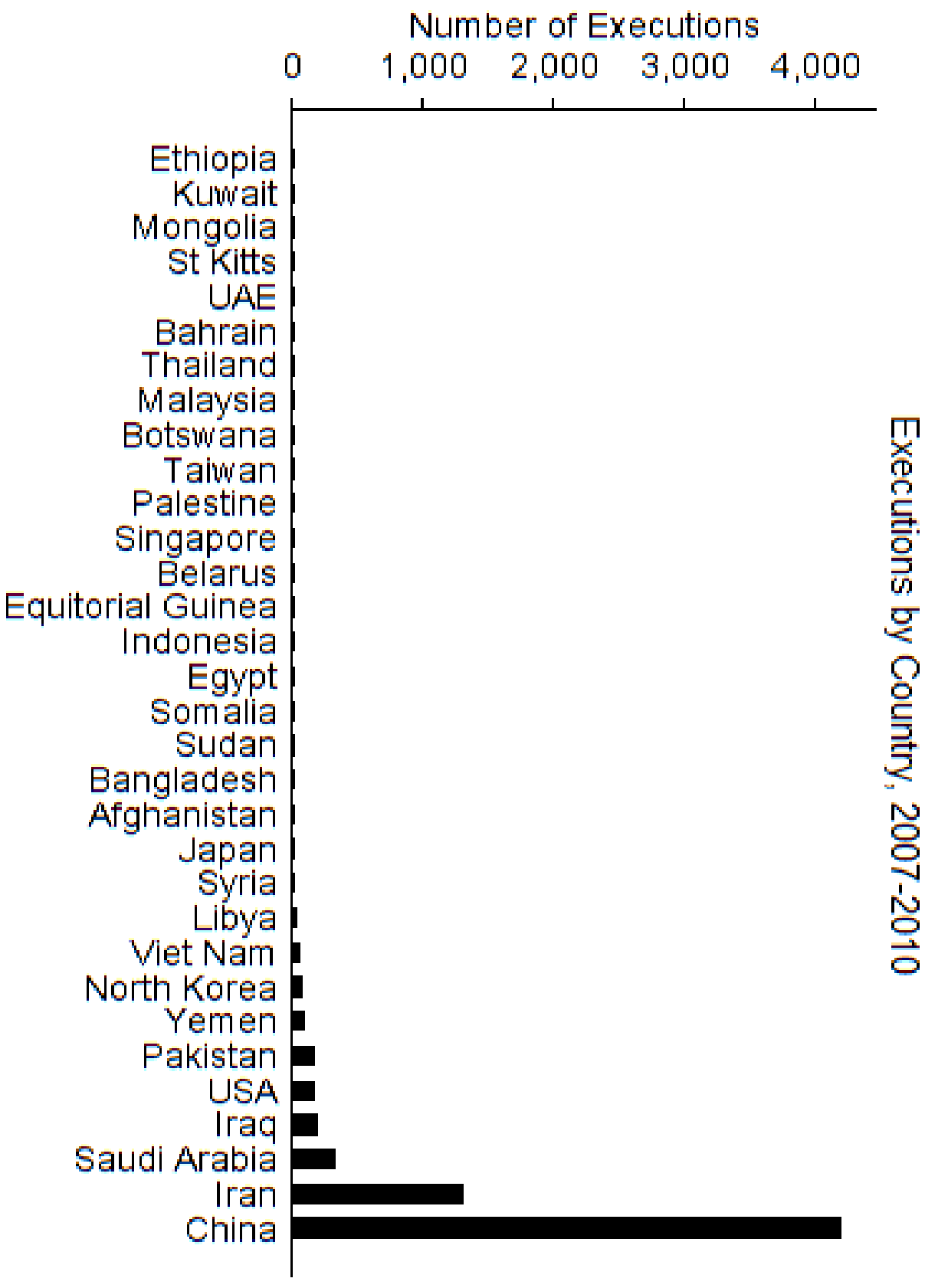


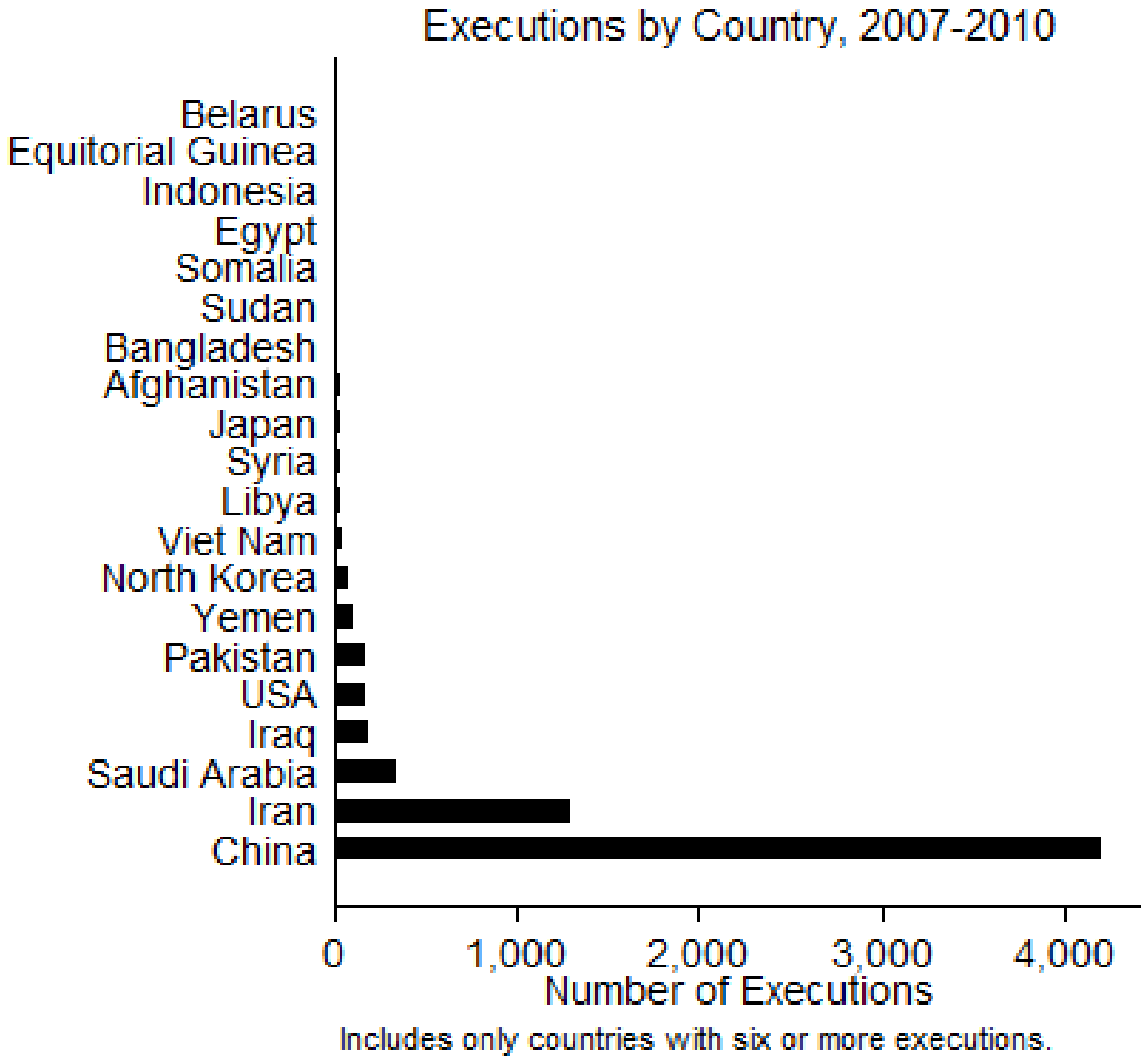
Among North Carolina's 100 counties, 26 have had one or more executions, 8 counties have executed 2 or more, and one (Mecklenberg) has executed 5.
Ln(Frequency) = 1.8 - 0.34(Ln (Executions+1) Adj. R2 = 0.95

These trends also hold for countries across the world

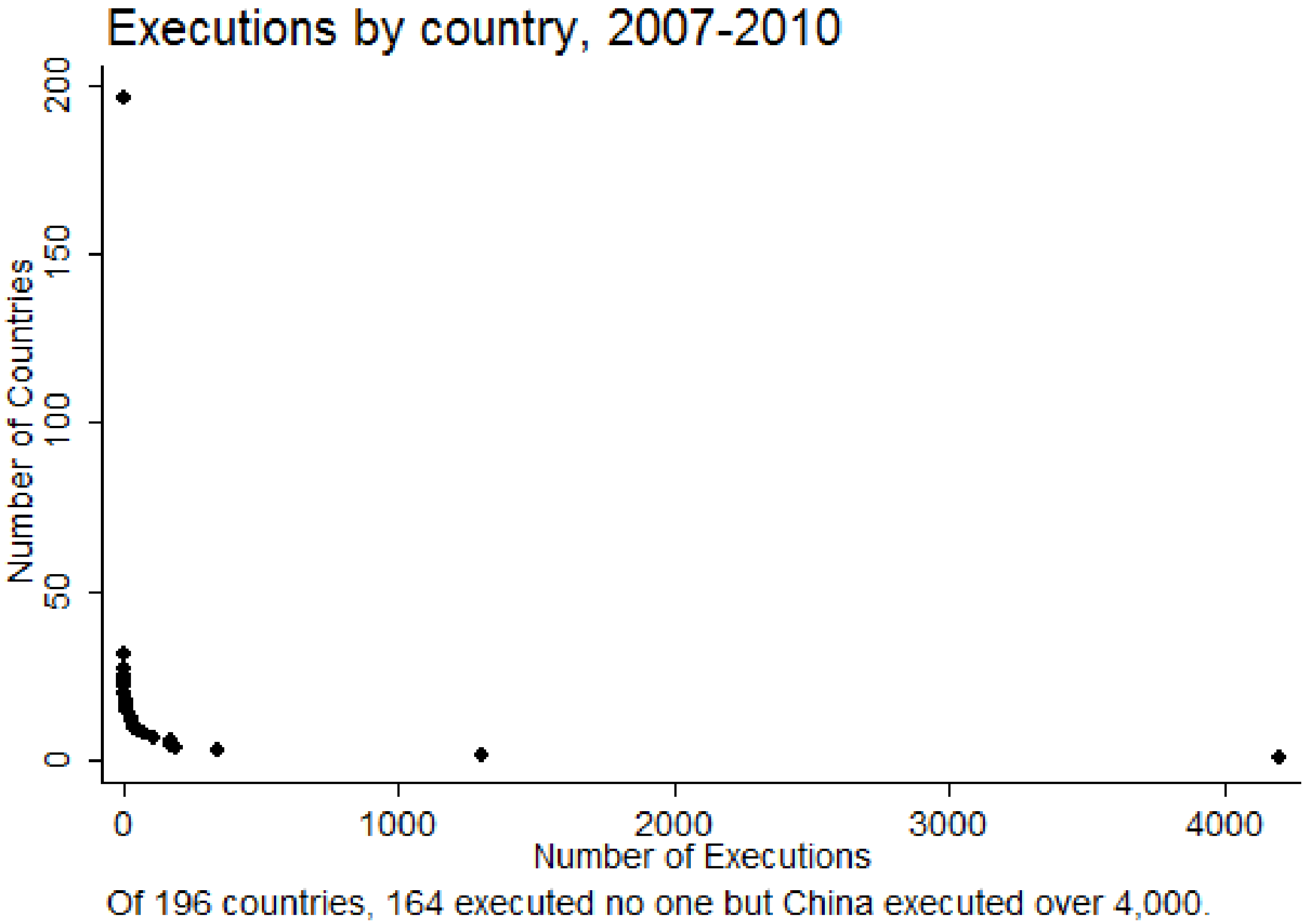
- Since 2007, Amnesty International has published an annual review of capital punishment around the world: http://www.amnesty.org/en/death-penalty/numbers

- Where they present a range, I use the lowest number in order to be conservative.
- Following charts combine 2007 through 2010.

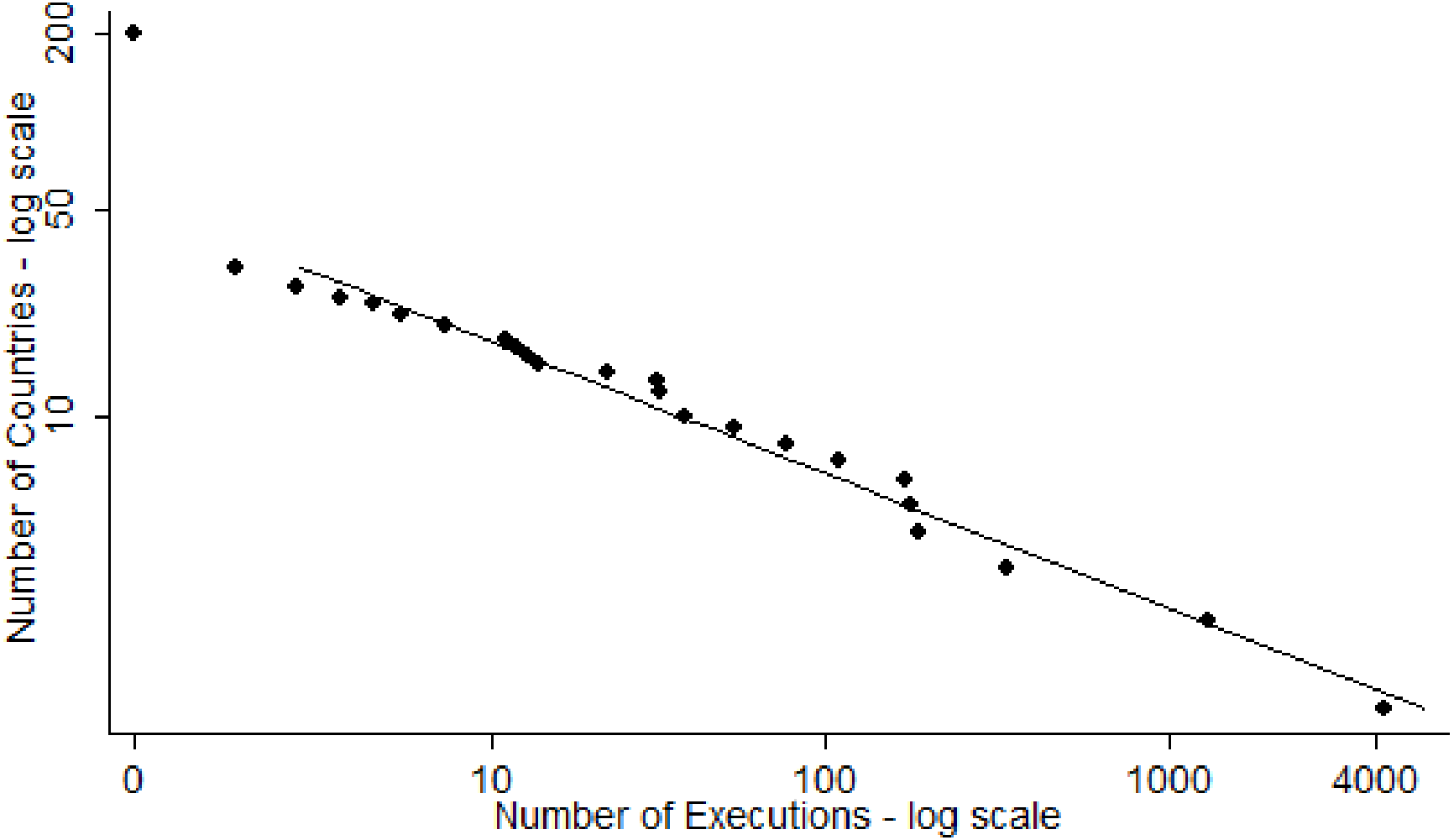

Number of Executions
0
1,000
2,000
3,000
4,000
Ethiopia
Kuwait
Mongolia
St Kitts
UAE
Bahrain
Thailand
Malaysia
Botswana
Taiwan
Palestine
Singapore
Belarus
Equitorial Guinea
Indonesia
Egypt
Somalia
Sudan
Bangladesh
Afghanistan
Japan
Syria
Libya
Viet Nam
North Korea
Yemen
Pakistan
USA
Iraq
Saudi Arabia
Iran
China
Executions by Country, 2007-2010


Executions by Country, 2007-2010
Belarus
Equitorial Guinea
Indonesia
Egypt
Somalia
Sudan
Bangladesh
Afghanistan
Japan
Syria
Libya
Viet Nam
North Korea
Yemen
Pakistan
USA
Iraq
Saudi Arabia
Iran
China
0
1,000
2,000
3,000
4,000
Number of Executions
Includes only countries with six or more executions.


Executions by Country, 2007-2010
Viet Nam
54
North Korea
77
Yemen
111
Pakistan
171
USA
177
Iraq
188
Saudi Arabia
341
Iran
1303
China
4198
0
1,000
2,000
3,000
4,000
Number of Executions
Includes only countries with 50 or more executions.


Executions by country, 2007-2010
Number of Countries
0
50
100
150
200
0
1000
2000
3000
4000
Number of Executions
Of 196 countries, 164 executed no one but China executed over 4,000.

A Power Law of Death Across the World, 2007 to 2010



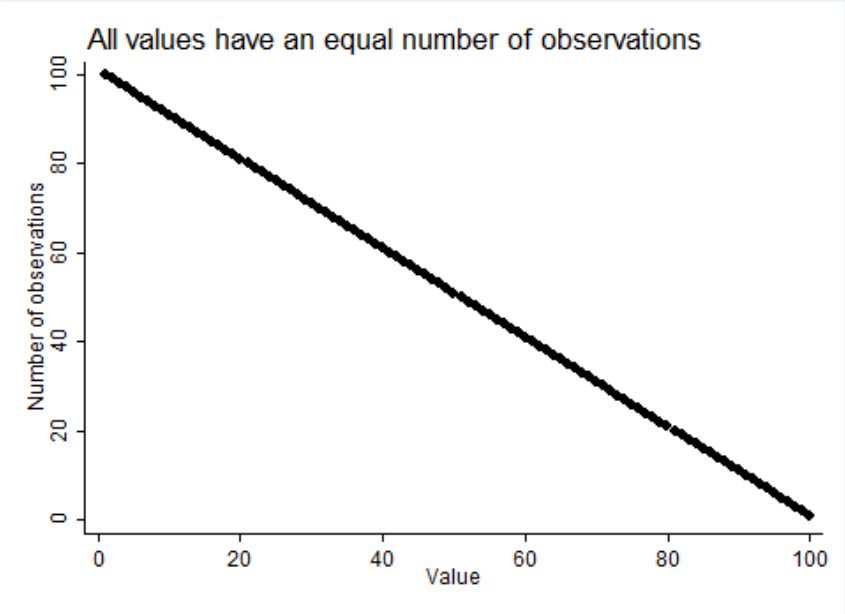
Among 196 countries in the world, 164 have had no executions, 7 have executed 100 or more, and one (China) has executed over 4,000.
Ln(Frequency) = 8.62 - 2.17(Ln (Executions+1) Adj. R2 = 0.98

Other Possible Processes

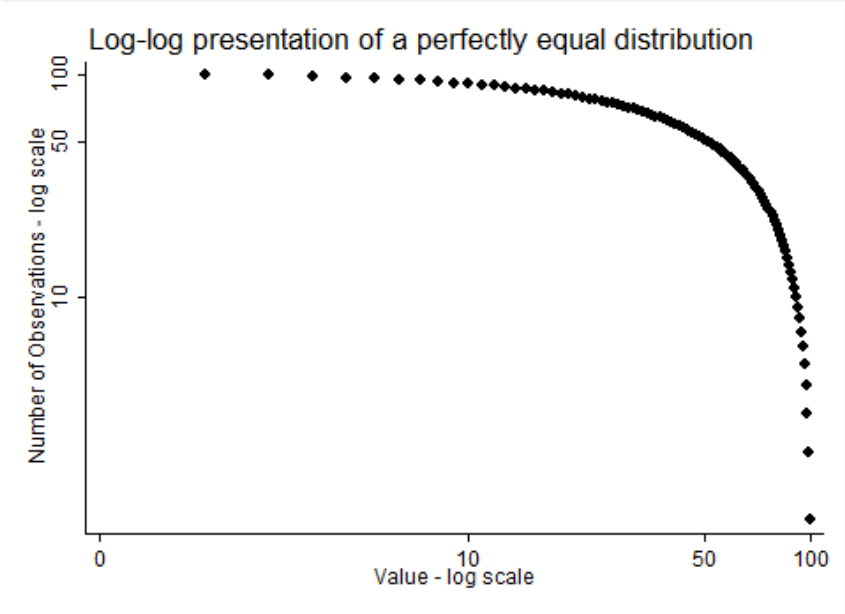
- Imagine a process with multiple stages, and a fixed percentage of the cases make it through each filter. If the filter selected out 90% of the cases each time, and we started with 100, the cases would be ordered: 100, 90, 81, 72, 63, etc. with each case having 90% of the value of the previous case.
- Or imagine a process where each stage amplifies the value: say by 20%: 1, 1.2, 1.44…
- Other processes might be that all cases are equal, or random. The following graphs show what distributions such processes would generate.

If all cases were equal

Frequency Distribution

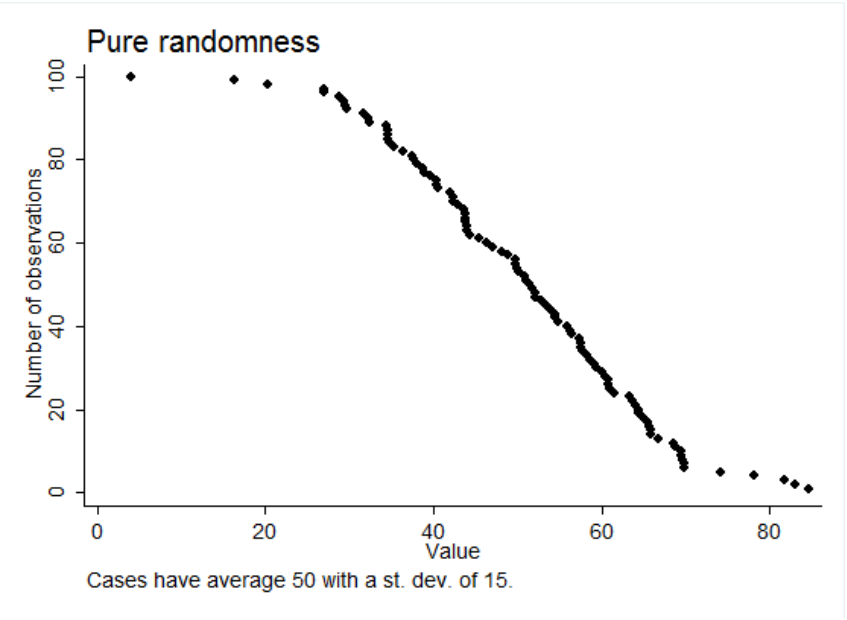


Log-Log Presentation

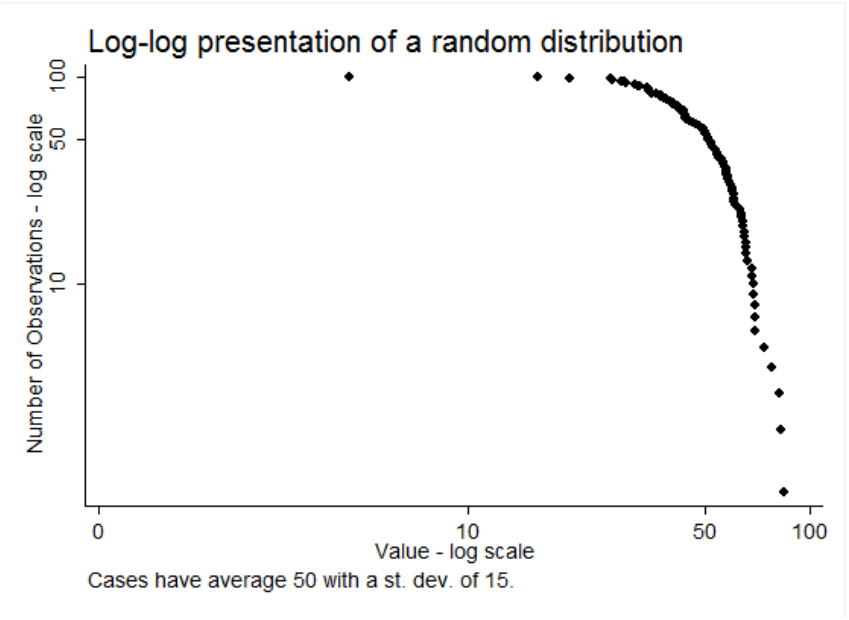


If all cases were random

Frequency Distribution

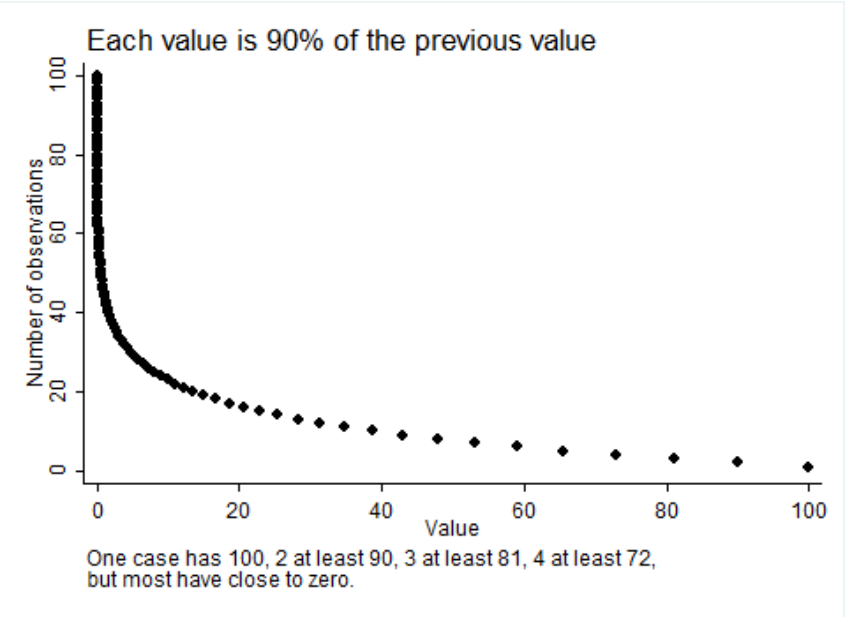


Log-Log Presentation

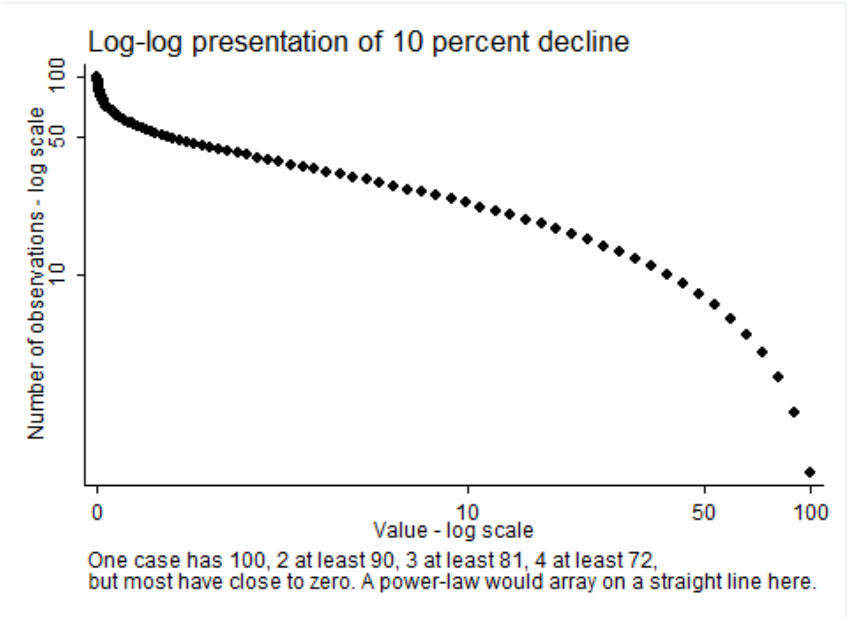


Each case 90% of previous case

Frequency Distribution

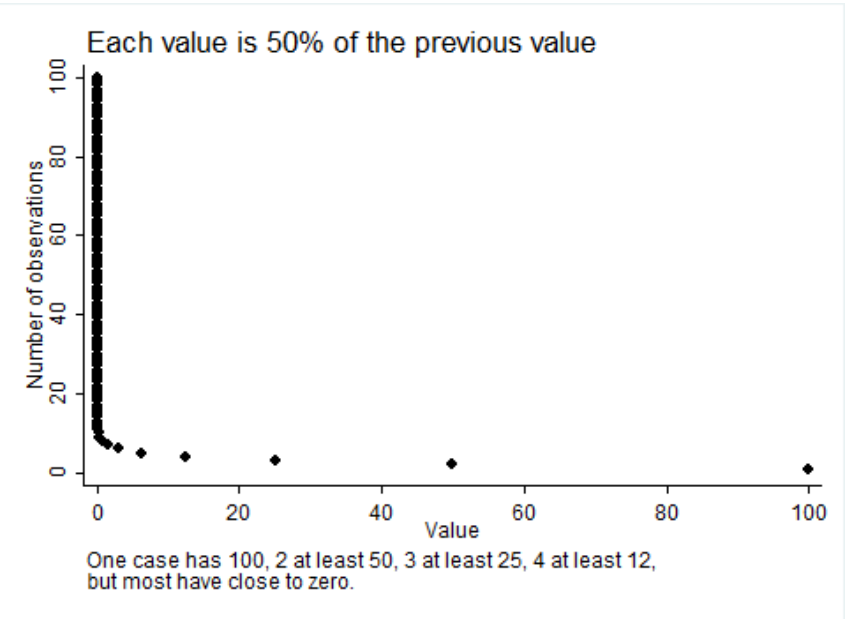


Log-Log Presentation

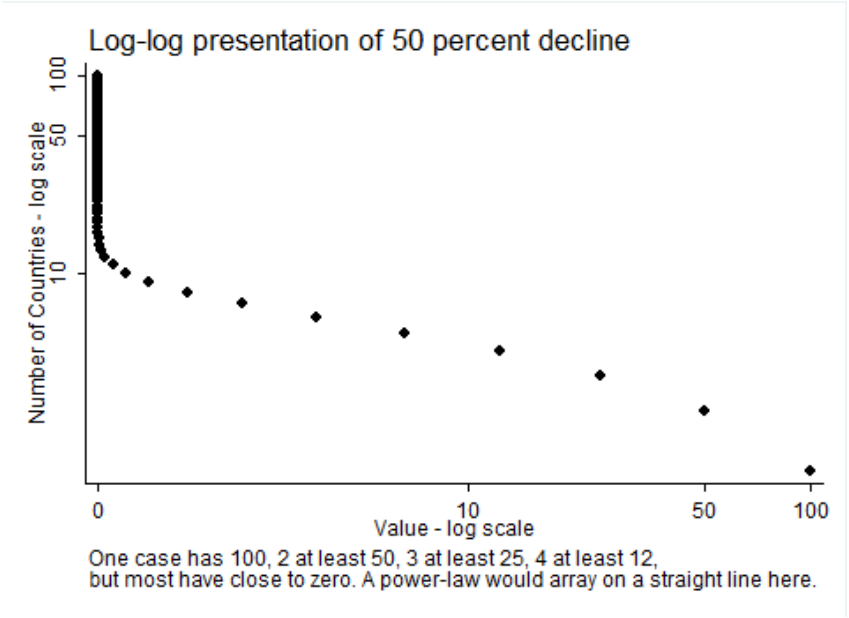


Each case 50% of previous case

Frequency Distribution

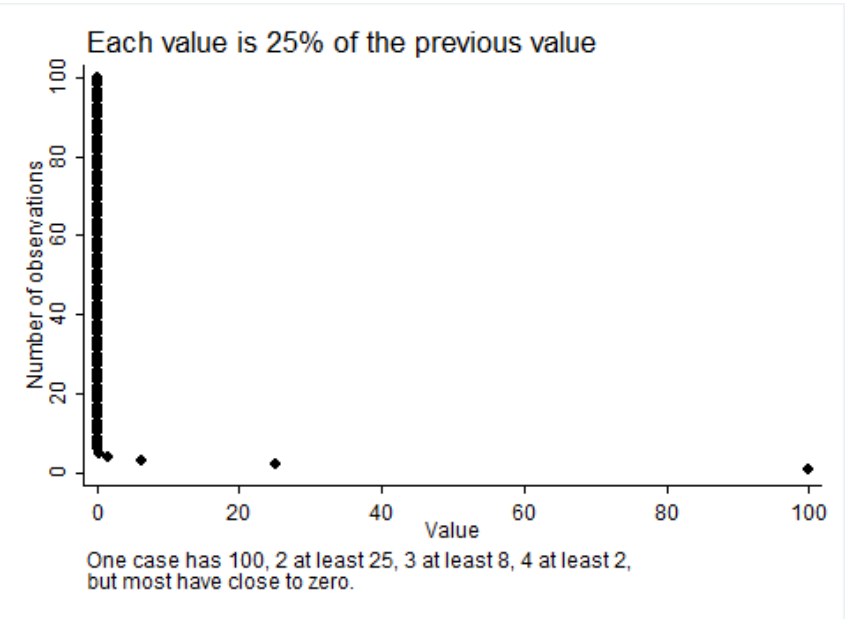


Log-Log Presentation

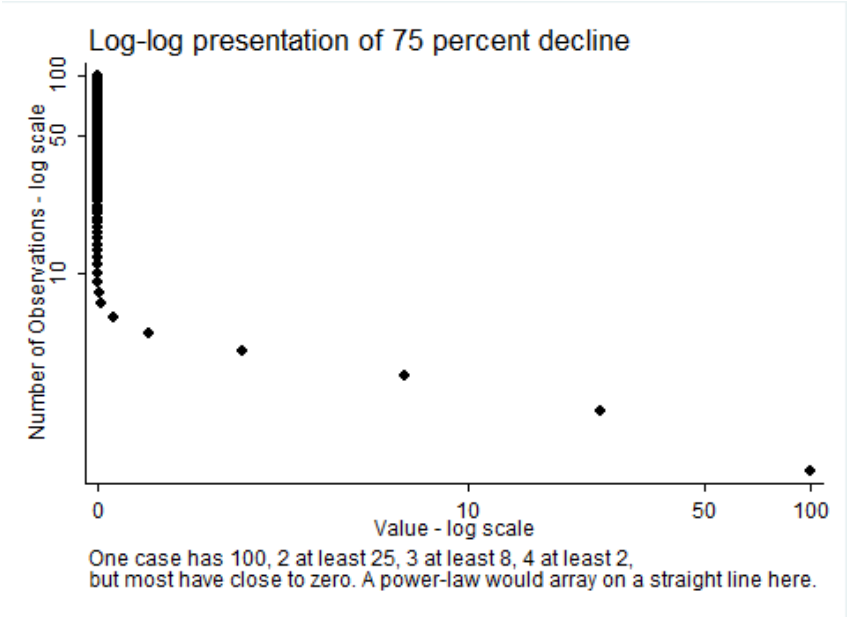


Each case 25 percent of previous case

Frequency Distribution

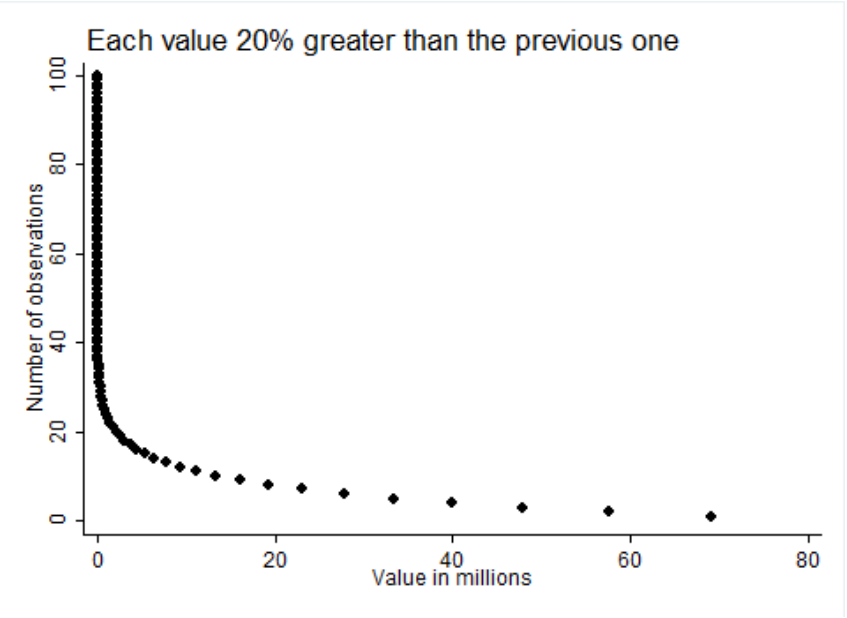


Log-Log Presentation

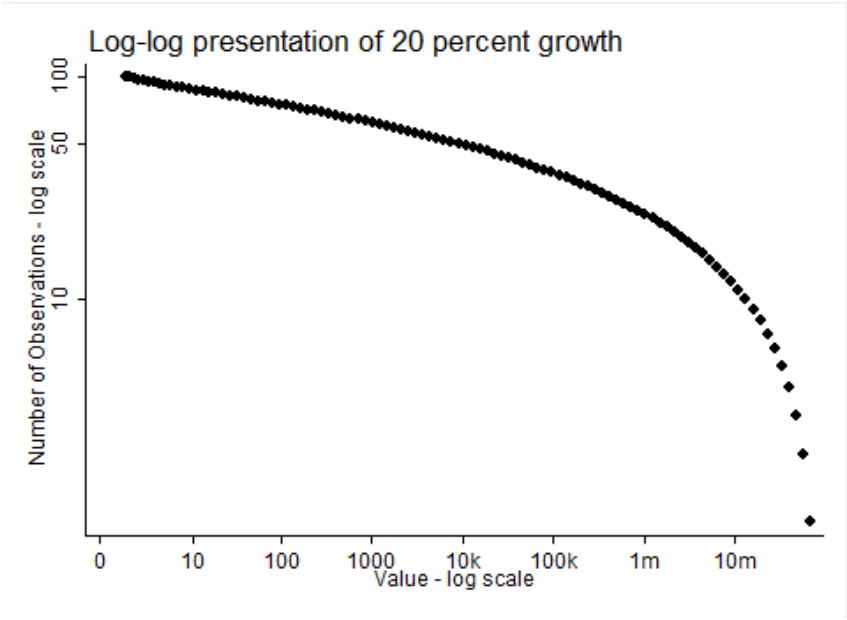


20 percent growth from case to case

Frequency Distribution



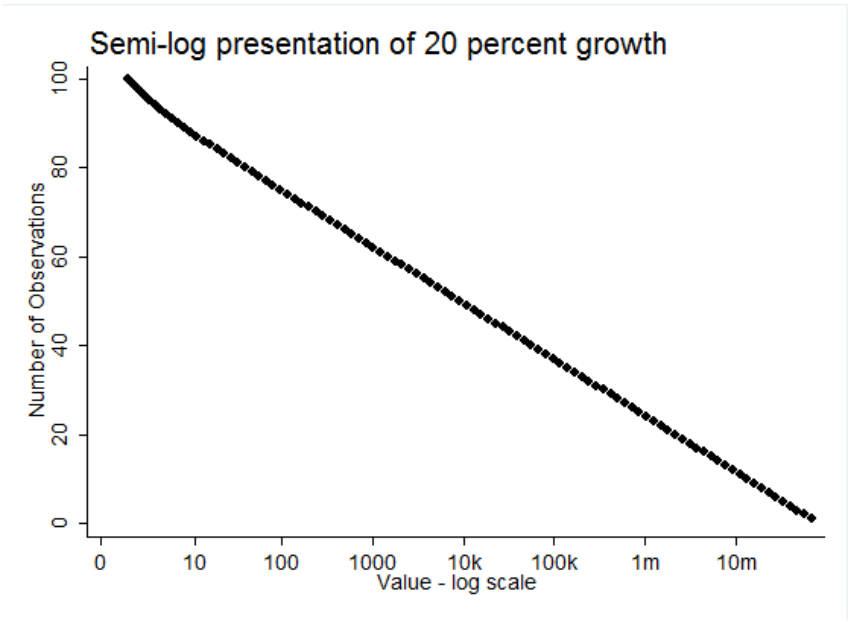
Log-Log Presentation



20 percent growth from case to case

This distribution arrays on a straight line when we take the log of the value but not the log of the frequency. This is because the logarithm perfectly captures the concept of steady percentage growth. The slope of the line relates to the percent of growth.

Semi-Log Presentation



So it can't be random

- Random processes do not produce power-law distributions.
- Rather, there must be some dynamic that causes an extreme distribution: an "amplification" parameter that pushes a few cases into the extremes while preventing the vast bulk of cases from having values much above zero.
- Most likely, local legal cultures and the development of localized norms are the key.

Local Legal Cultures

- These can reinforce a culture of “no death penalty” or they can render it relatively common.
- This simple analysis has shown that such things are plausible explanations at the county, state, and global levels.
- Of course two elements remain:
  - Demonstrate statistically that the distributions are indeed extreme value, either exponential or power-law.
  - Investigate the legal cultures and histories in jurisdictions with many and few executions to see if my hypothesis is correct “on the ground.”

Comments welcome

Frankb@unc.edu