

Trends and fluctuations in the severity of interstate wars

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the *decline of war* hypothesis

since World War II, interstate wars: occur less often or kill fewer people or both
a.k.a. the "long peace"

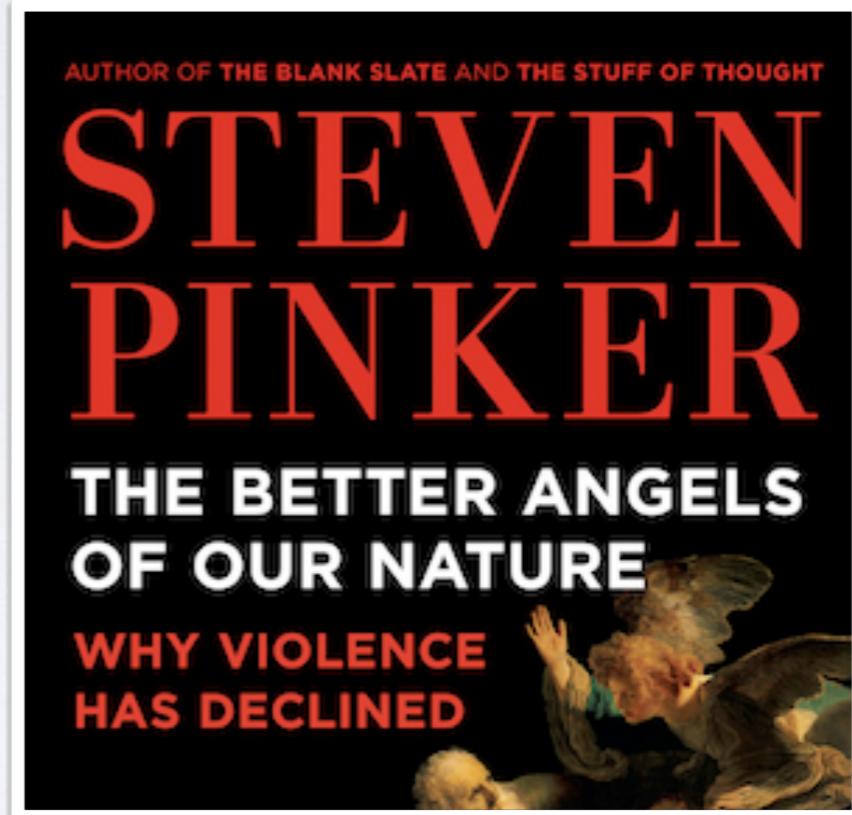


the *decline of war* hypothesis

since World War II, interstate wars: occur less often or kill fewer people or both
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most popularly advanced by Pinker, in
The Better Angels of our Nature

- decline of violence, more generally
- including decline of war hypothesis
- multiple lines of evidence
- in part a per-capita argument



the decline of war hypothesis

since World War II, interstate wars: occur less often or kill fewer people or both
a.k.a. the "long peace"

and well studied in conflict research

- 70 years of "liberalism" arguments
- focus on mechanisms for decline
- spread of democracy
- peace-time alliances
- economic trade
- international organizations

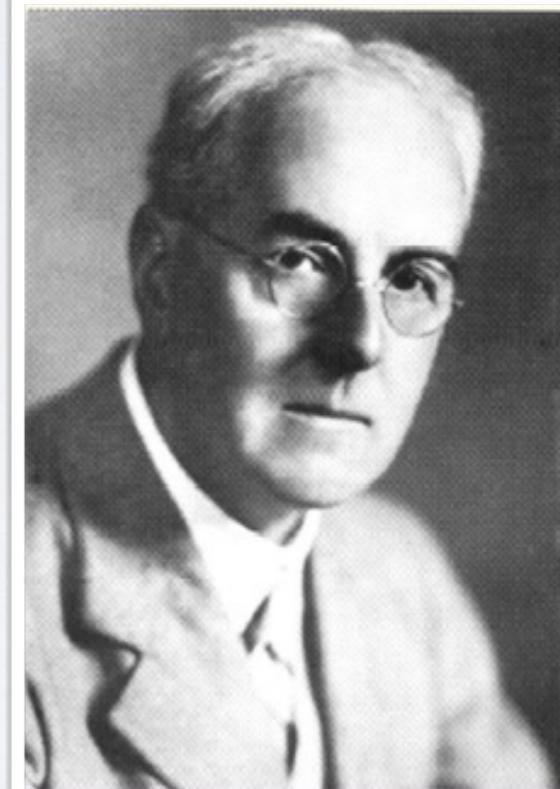


the *decline of war* hypothesis

since World War II, interstate wars: occur less often or kill fewer people or both
a.k.a. the "long peace"

but not uncontroversial

- 100 years of "realism" arguments
- focus on statistical patterns in wars
- war is *stationary*
- most prominently, L.F. Richardson (1941)
- most recently, Cirillo & Taleb (2015)



**STATISTICS
OF DEADLY
QUARRELS**

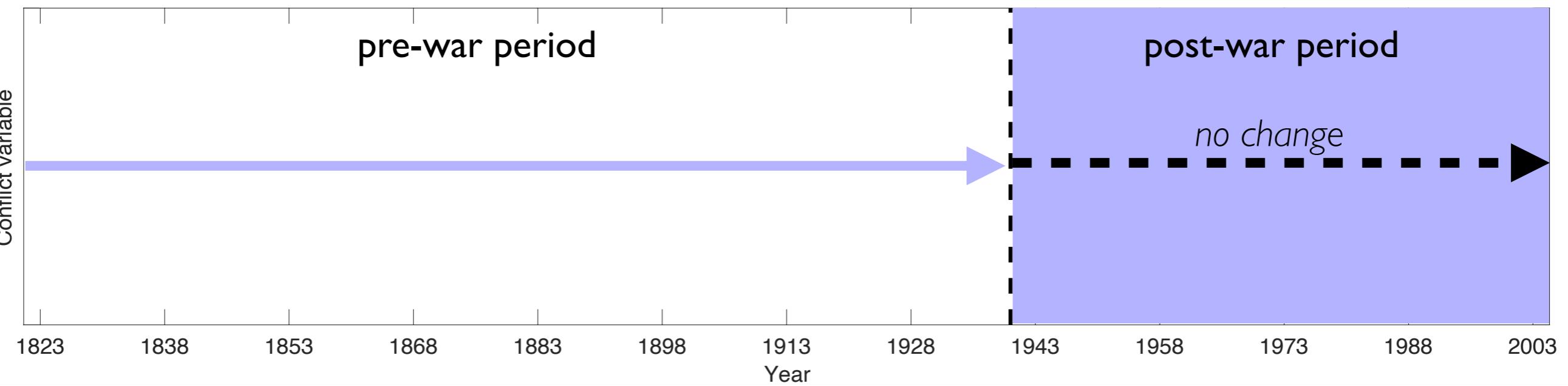
LEWIS F. RICHARDSON

a decline in war

a claim about *change* in some conflict variable Z
plausibility depends on distinguishing *no change*

a decline in war

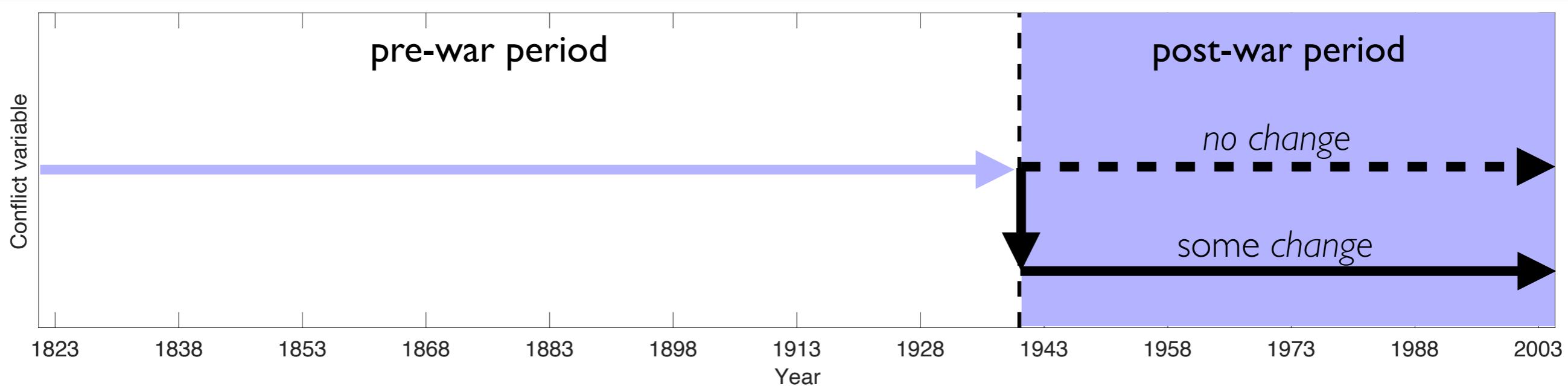
a claim about *change* in some conflict variable Z
plausibility depends on distinguishing *no change*



a decline in war

a claim about *change* in some conflict variable Z

plausibility depends on distinguishing *no change* from *some change*



testing for a *decline in war*

if data are plentiful + well-behaved + low variance
detecting a *change* is easy

pre-war



T H T T T H H H T H H H H H H T T T T T H T H H H T H H H H T T T T T H H T T T T

post-war



TTTTTTHHTTHTTTHHHTTTTHHTHTTTTTTTTTTTHTTTHHHTT

testing for a *decline in war*

but, big wars are rare + messy + highly variable

detecting a change is hard

we will need special, powerful statistical tools

pre-war



TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTH

?
↓
?

post-war

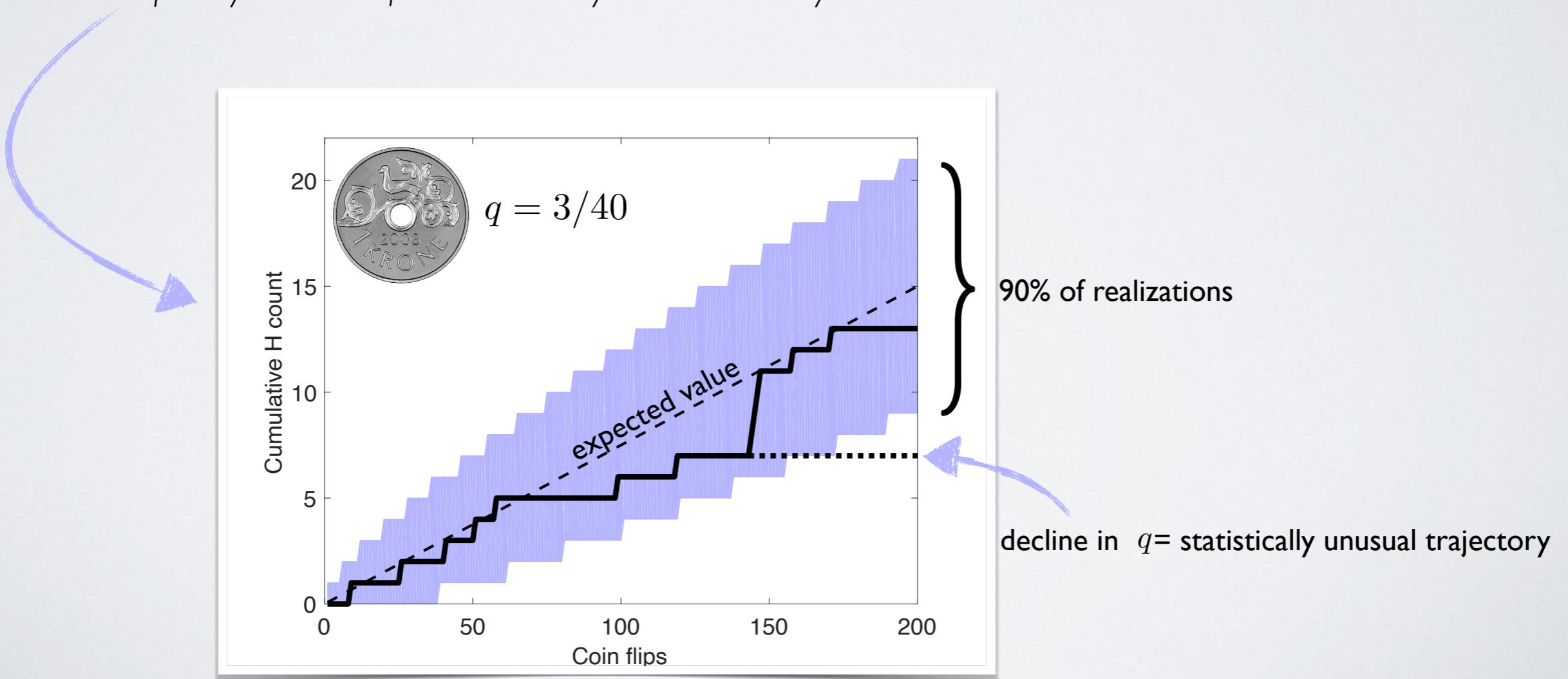


TTTTH

testing for a decline in war

our approach:

- focus on measurable variables:
 - war severity (battle deaths) x
 - war frequency (time to next war) t
 - fixed time of change: 1940 (pre- vs. post-war)
 - model full distributions: $\Pr(x)$ and $\Pr(t)$ and $\Pr(x, t)$
 - explicitly account for uncertainty and variability



testing for a *decline in war*

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- model full distributions: $\Pr(x)$ and $\Pr(t)$ and $\Pr(x, t)$
- use ensembles to capture uncertainty

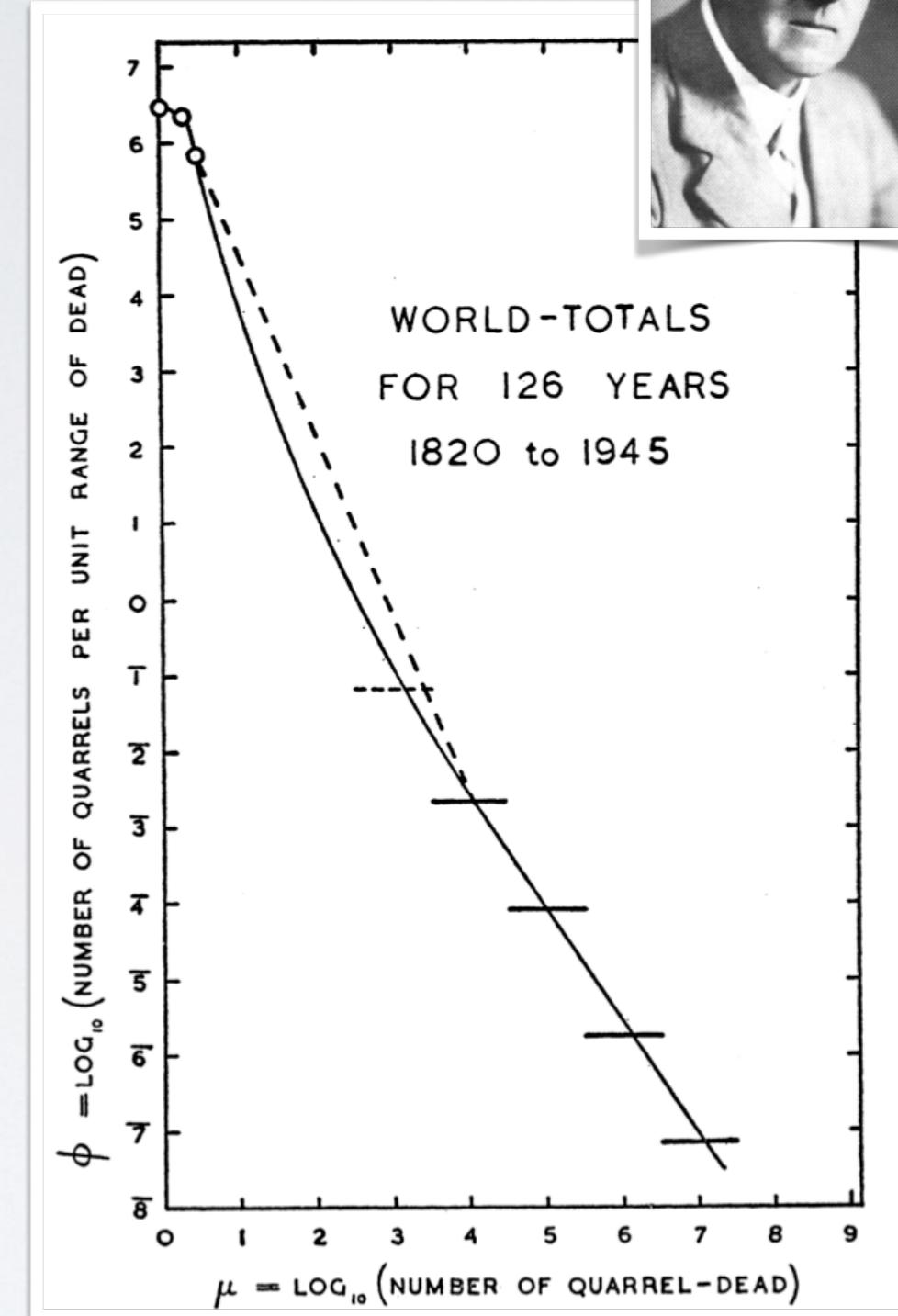
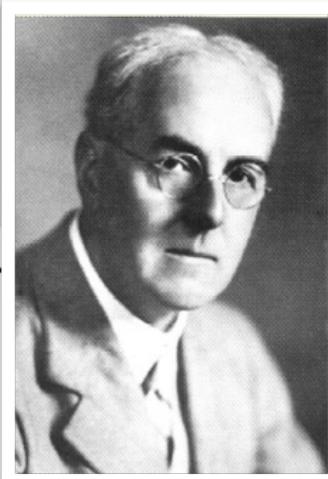
research questions:

- does war severity $\Pr(x)$ change at 1940 ?
- does war frequency $\Pr(t)$ change at 1940 ?
- do severe wars change frequency at 1940 ?

history : Lewis Fry Richardson

grandfather of complex systems

- English polymath (1881–1953)
- pacifist and ambulance driver in WWI
- discovered fractals
- nearly discovered chaos in weather
- simple models of wars:



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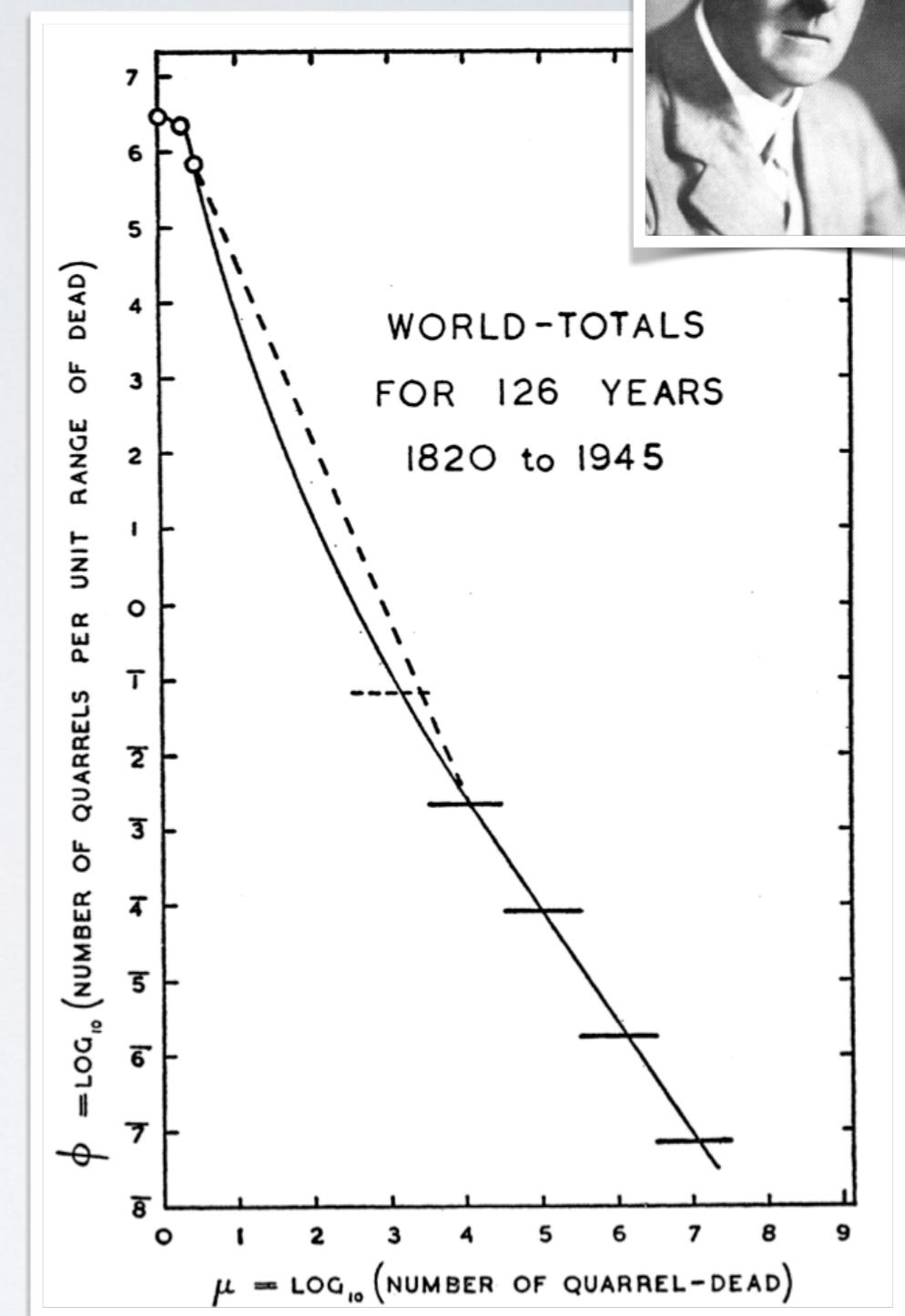
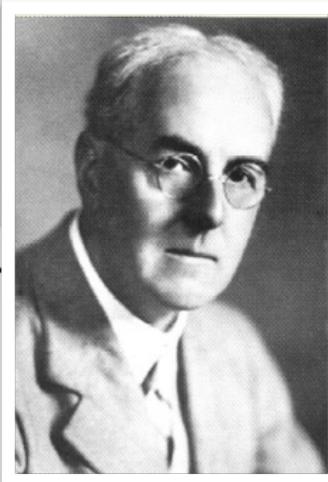
1. sizes of wars follow power-law distribution

$$\Pr(x) \propto x^{-\alpha}$$

2. outbreak of wars is a Poisson process

$$\Pr(\text{war at time } t) = q$$

a simple *no-change* model of conflict



war severity

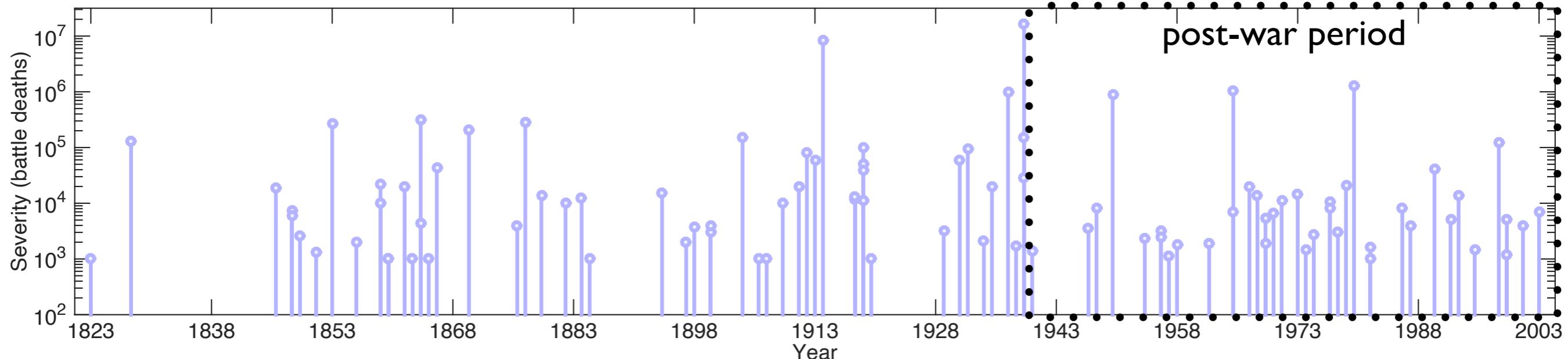
Correlates of War, inter-state wars

- 95 conflicts spanning 1823-2003
- largest: WWII, $x = 16,634,907$ (battle deaths)
- smallest: $x = 1000$ (by definition)

war severity

Correlates of War, inter-state wars

- 95 conflicts spanning 1823-2003
- largest: WWII, $x = 16,634,907$ (battle deaths)
- smallest: $x = 1000$ (by definition)
- what shape is the severity distribution $\Pr(x)$?

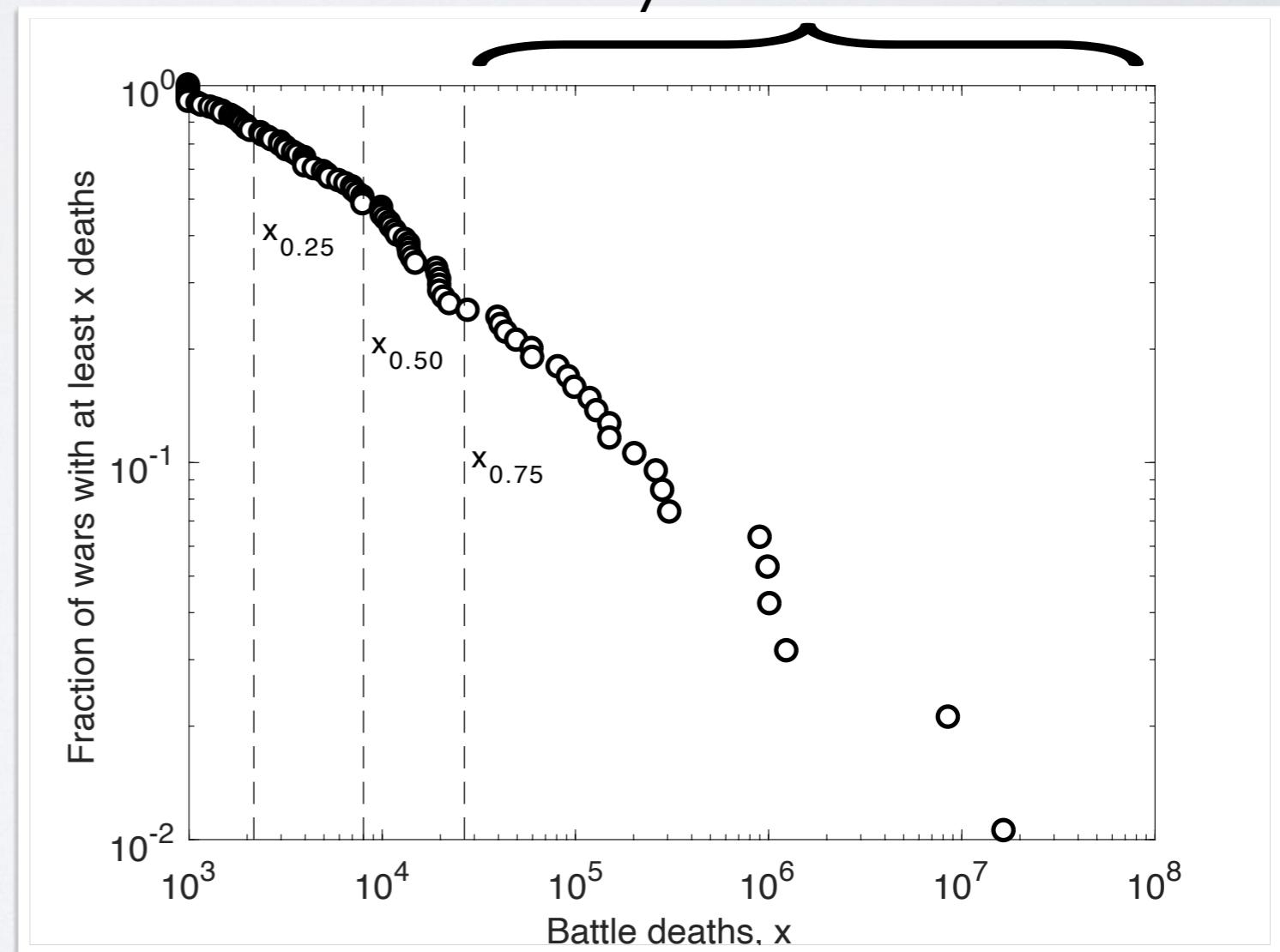


war severity

all conflicts (1823–2003)

- fraction of wars with at least severity x

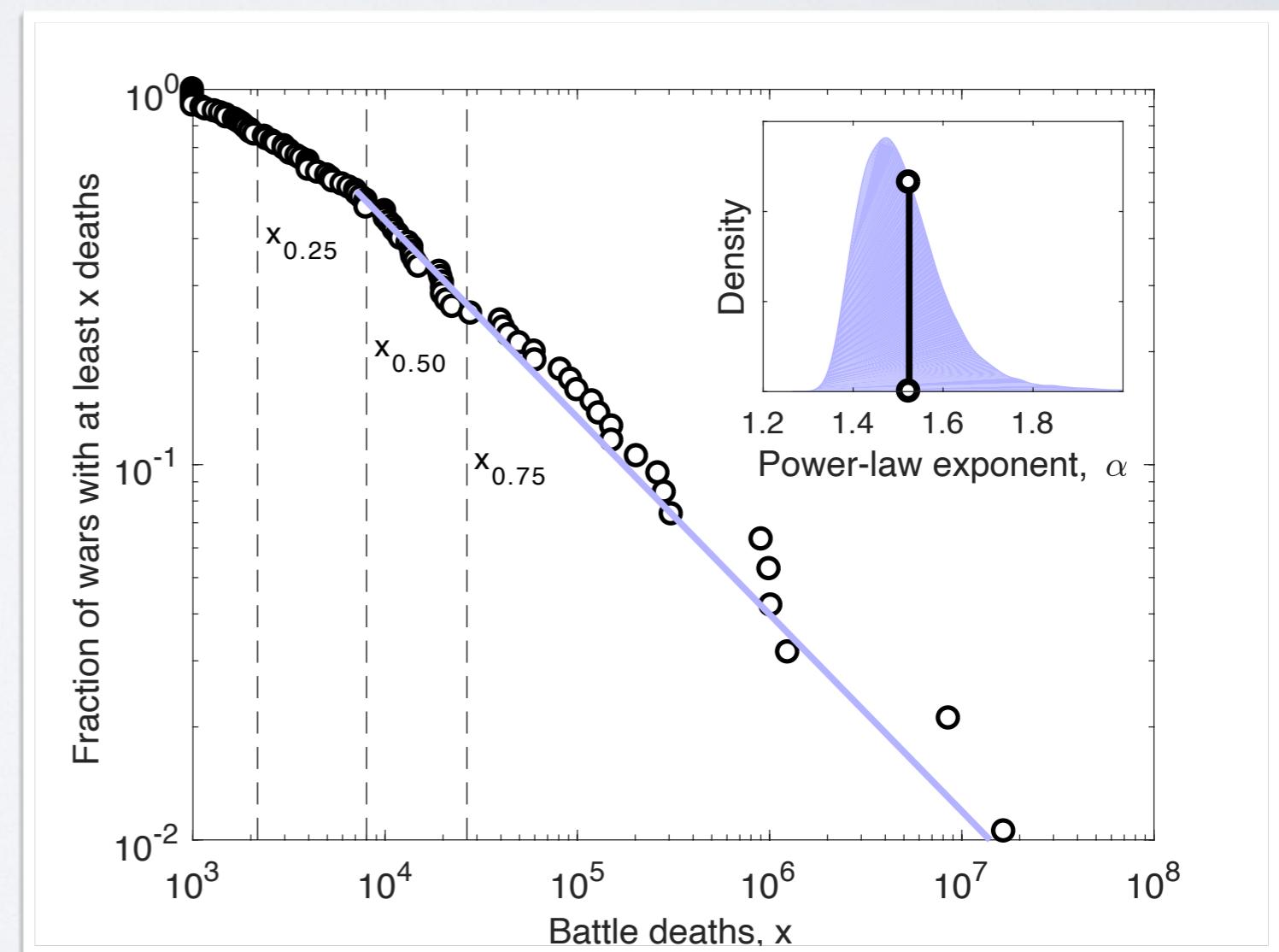
very severe conflicts



war severity

all conflicts (1823–2003)

- fraction of wars with at least severity x
- well modeled by a power-law distribution $\Pr(x) \propto x^{-\alpha}$ with parameter $\hat{\alpha} = 1.53 \pm 0.07$ (extremely high variance)



war severity : post war

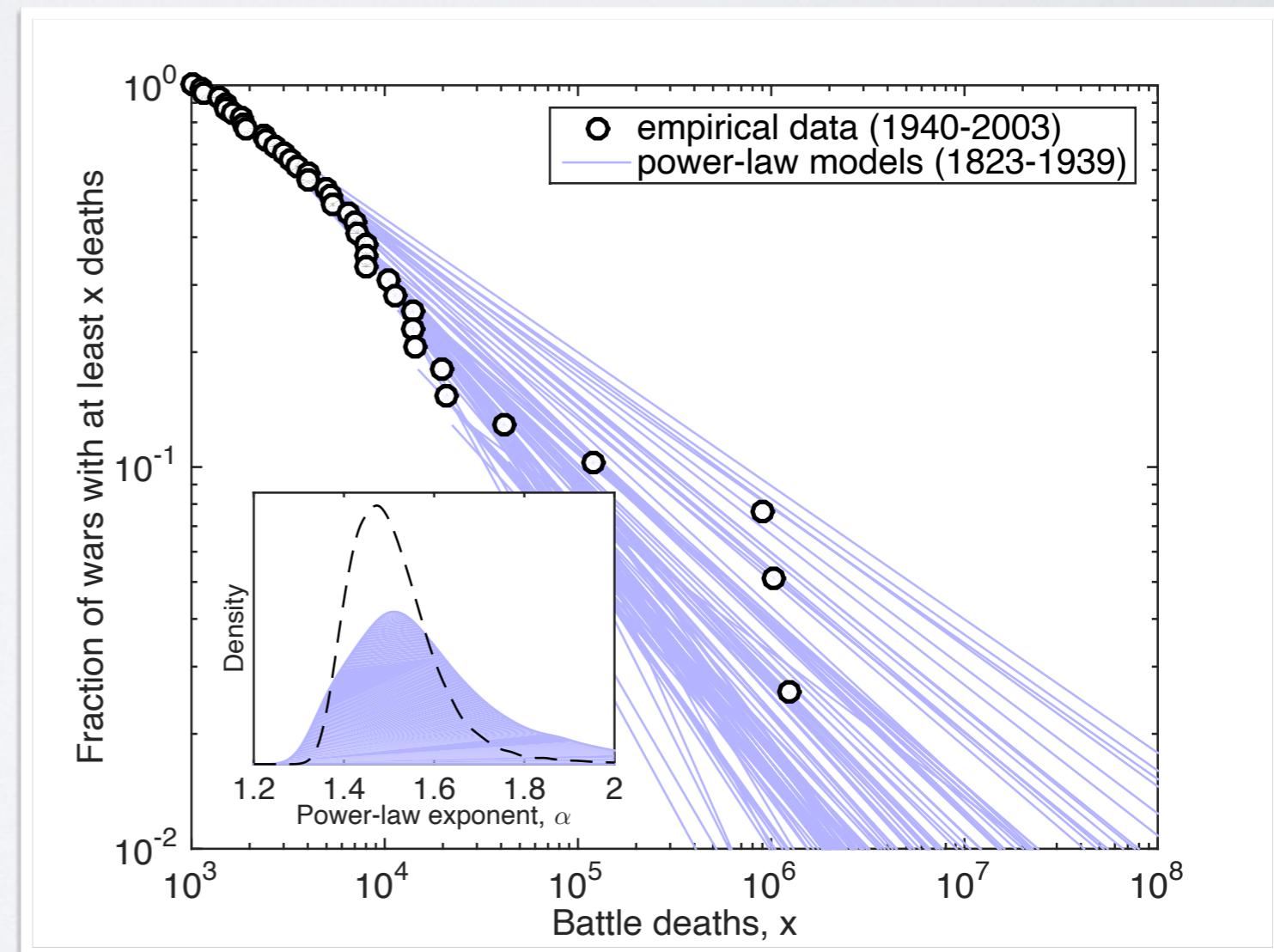
does $\Pr(x)$ change at 1940?

- compare pre-war (1823–1939) and post-war (1940–2003) severities

war severity : post war

does $\Pr(x)$ change at 1940?

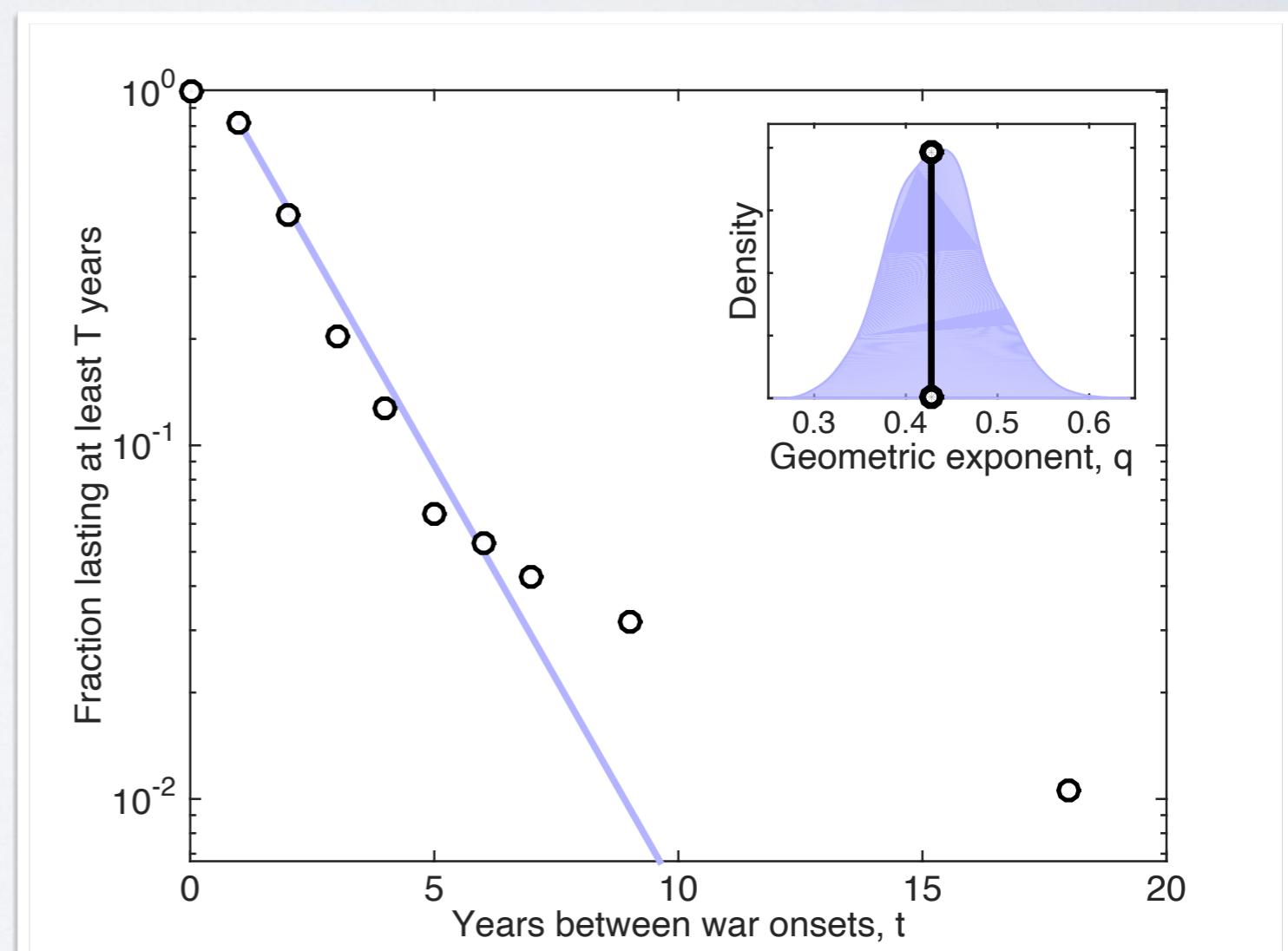
- compare pre-war (1823–1939) and post-war (1940–2003) severities
- post-war data *not* significantly different from pre-war model, $p = 0.92 \pm 0.03$
- post-war models very *similar* to pre-war models
- no evidence of a change



war frequency

all conflicts (1823–2003)

- fraction of wars with at least onset delay t (years)
- well modeled by a Poisson process, with rate $\hat{q} = 0.43 \pm 0.01$



fitted with methods of Clauset et al. SIAM Rev. (2009)

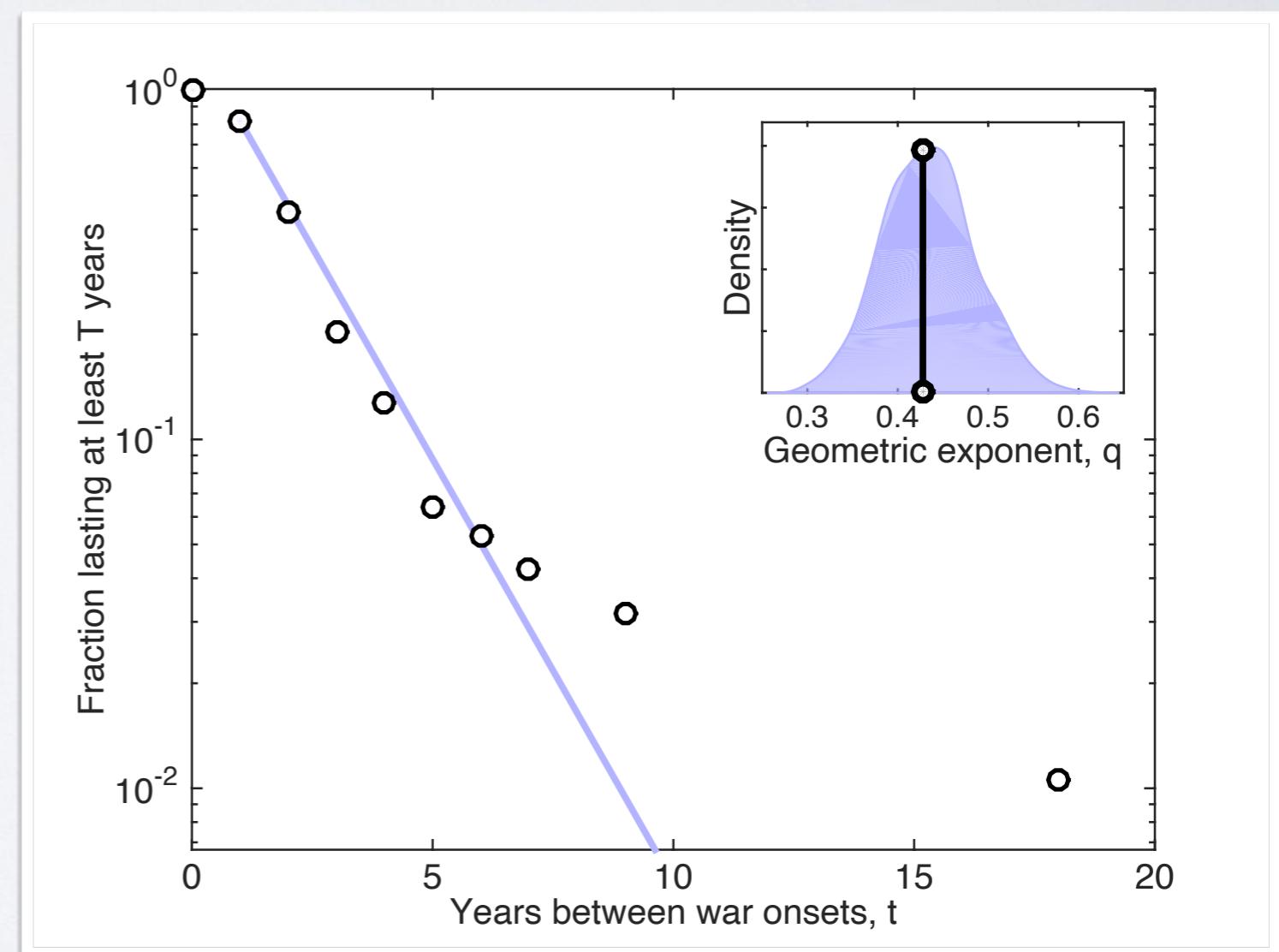
largest 5: First Russo-Turkish, Lithuanian-Polish, Second Central American, Franco-Thai, Franco-Prussian wars; all

$t \geq 1941$

war frequency : post war

does $\Pr(t)$ change at 1940?

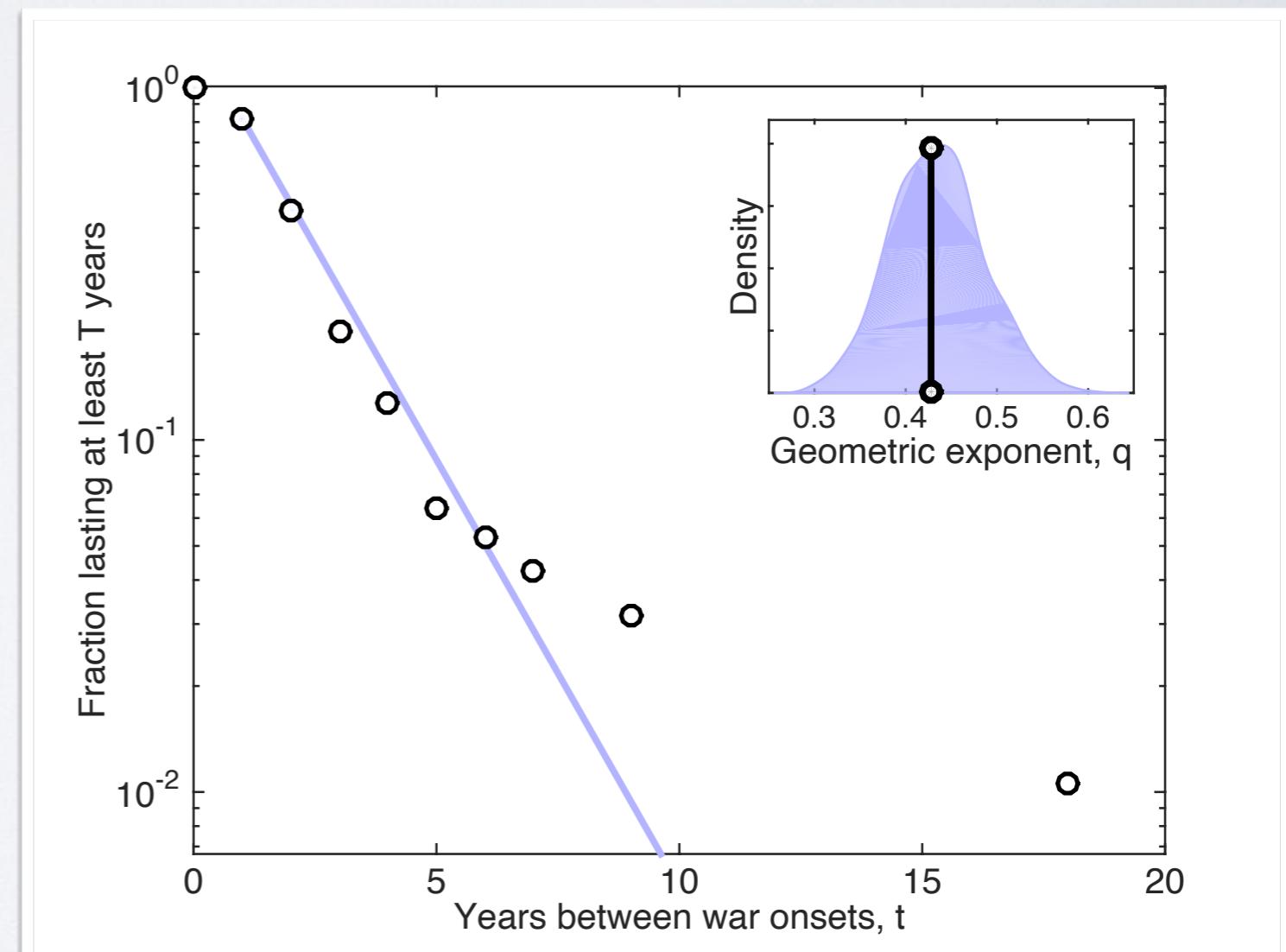
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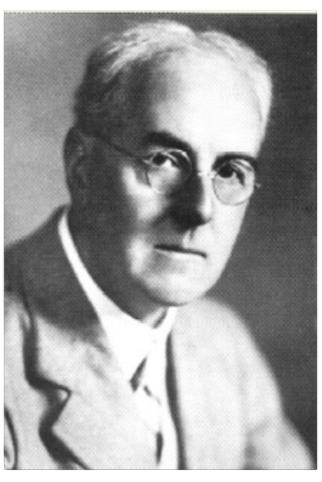


war frequency : post war

does $\Pr(t)$ change at 1940?

- compare pre-war (1823–1939) and post-war (1940–2003) onset delays
- post-war data *not* significantly different from pre-war data, $p = 0.99$
- post-war models very *similar* to pre-war models
- no evidence of a change





taking stock

- no evidence for change in war severity in post-war period
- no evidence for change in war frequency in post-war period
- data are consistent with a *stationary* process 1823–2003
- L.F. Richardson looking pretty smart...

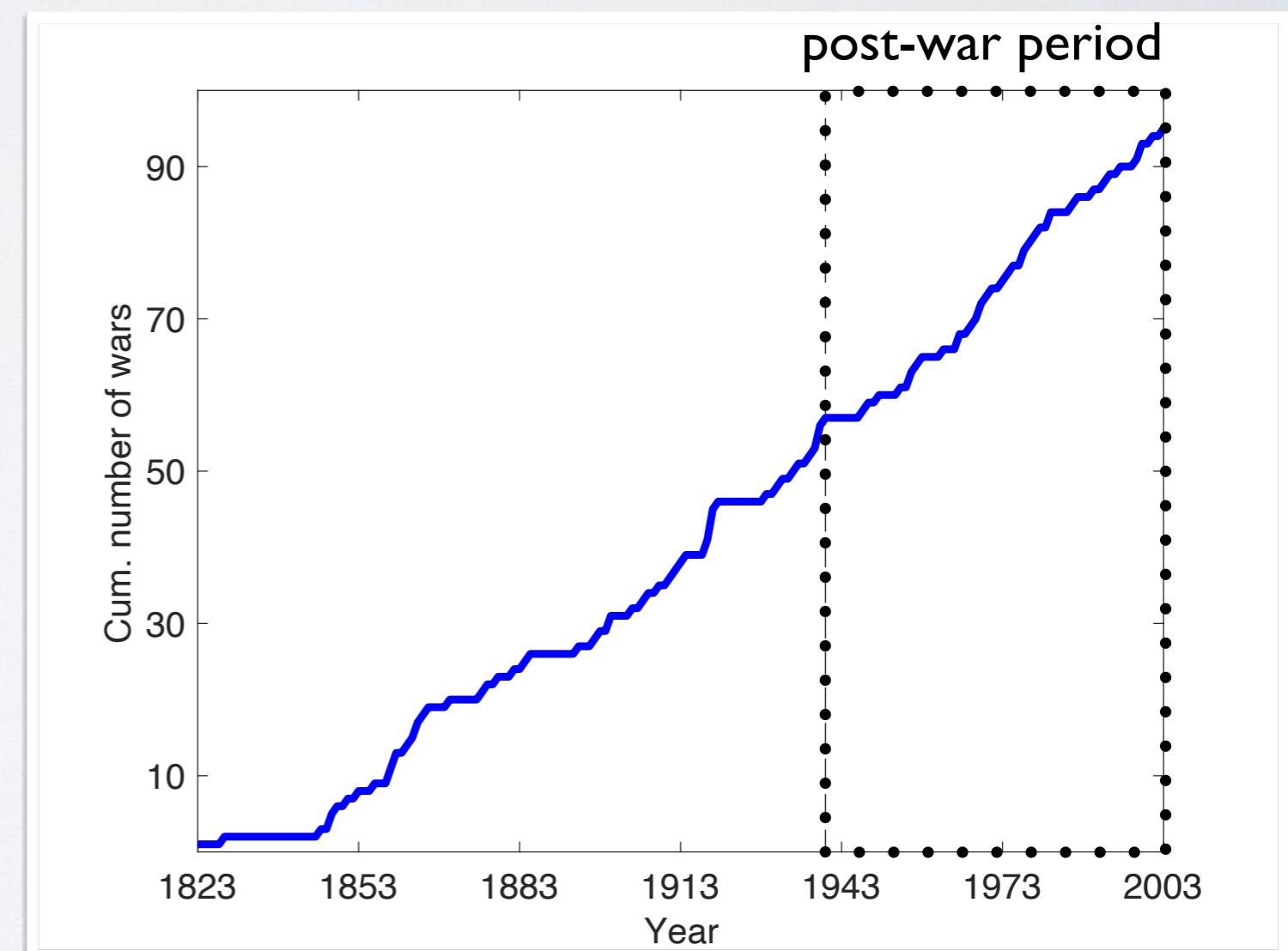
but, but, but:

- we modeled frequency and severity separately
- perhaps the rare but large wars are in decline?
- need to examine the *accumulation* of wars of different sizes

war frequency & severity

cumulative count of wars, by size:

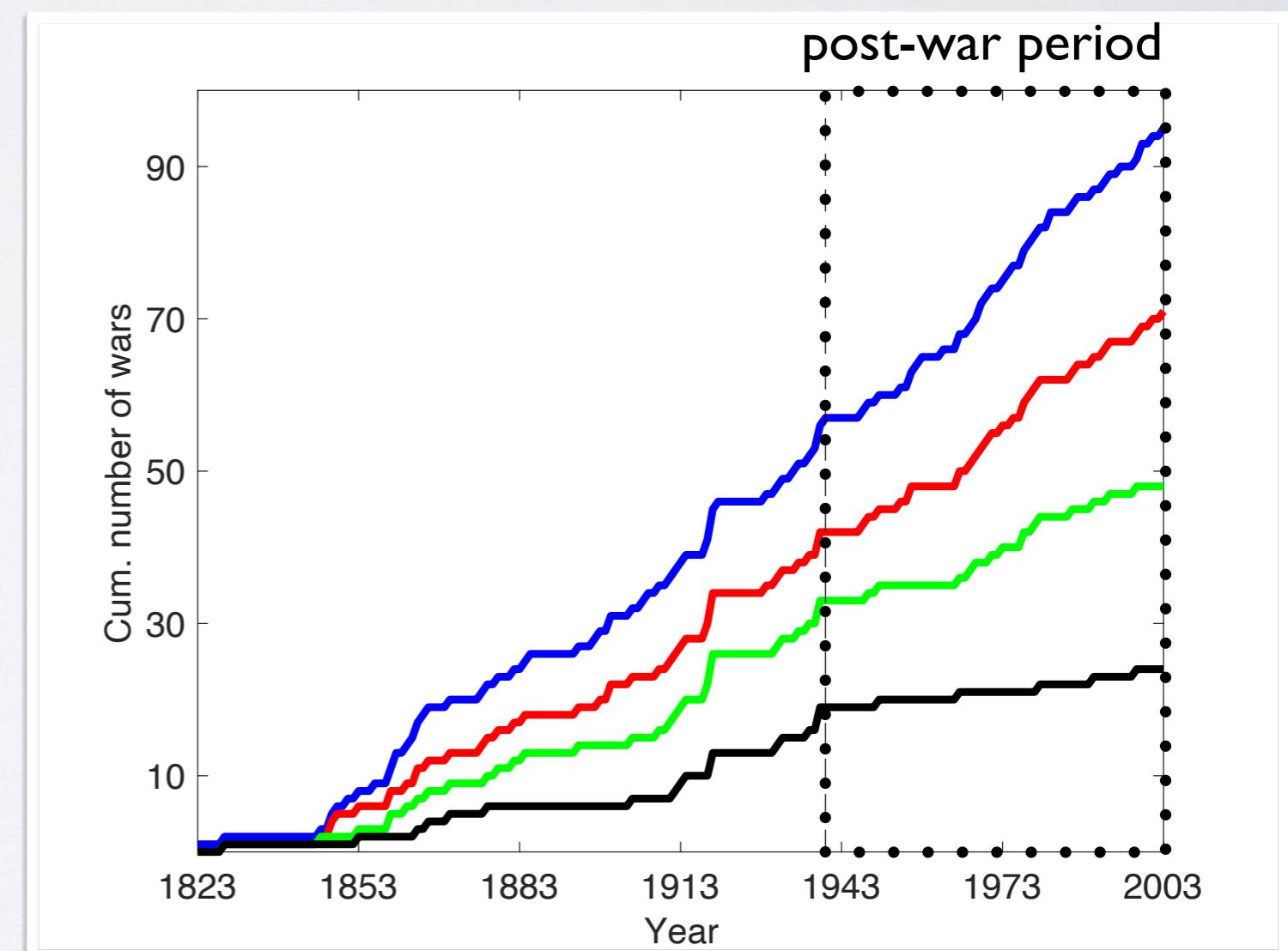
- all wars
- upper 75% of severities
- upper 50% of severities
- upper 25% of severities



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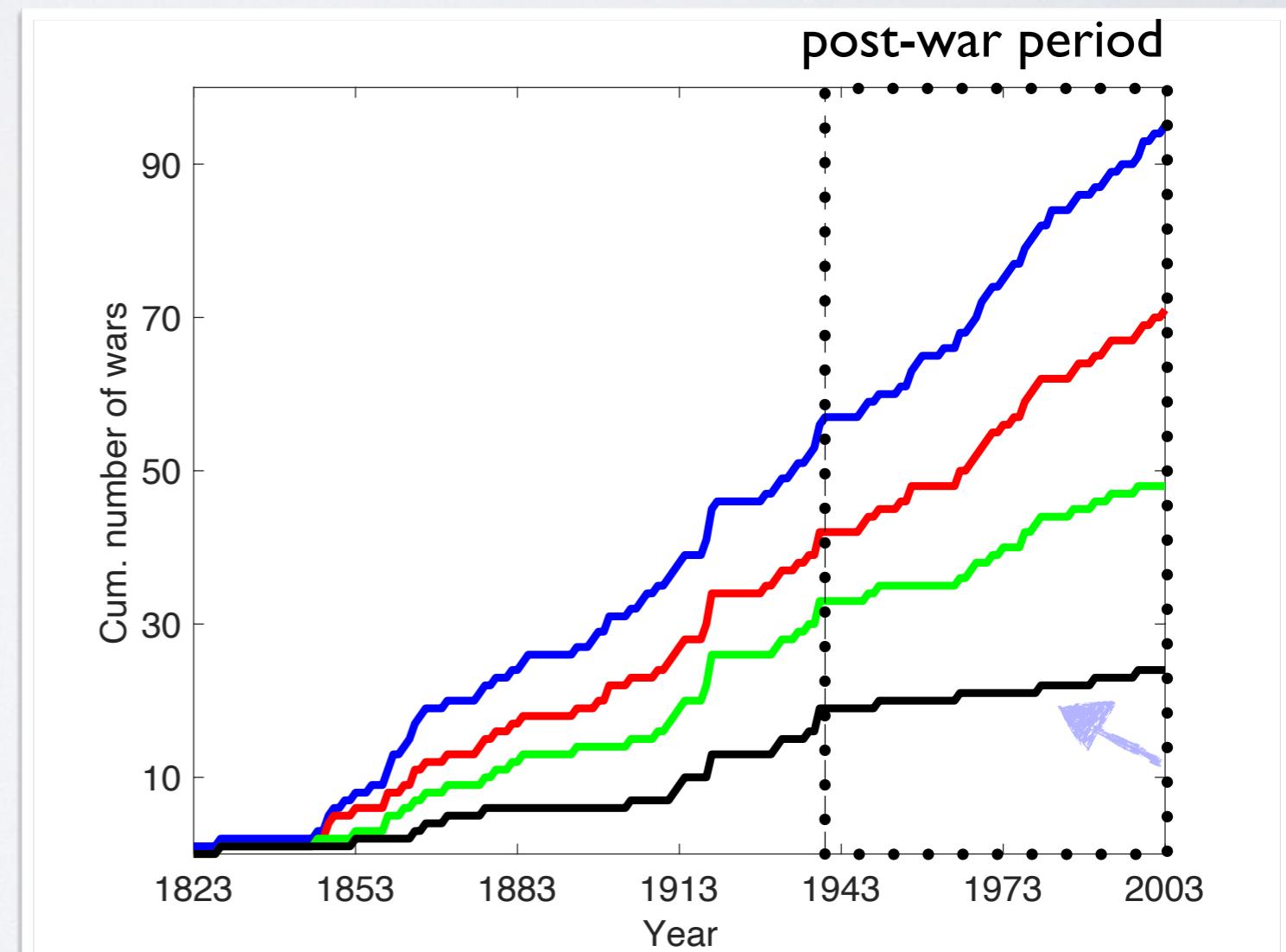
the *long peace* is real
onset rate of most severe wars,
1823–1939 : every 6.2 years
1940–2003 : every 12.8 years

while rates of other war sizes
are more stable

is this a trend or a fluctuation?

the great violence is also real
onset of most severe wars,
1914–1939 : every 2.7 years

- all wars
- upper 75% of severities
- upper 50% of severities
- upper 25% of severities



trends vs. fluctuations

specify 3 stationary models of war production

each defines an envelope of variability — patterns that stay within this envelope are consistent with a stationary (no-change) process

increasing
variability

Model 1: observed onset dates, shuffled war severities

Model 2: observed onset dates, severities drawn from $\Pr(x)$ ensemble

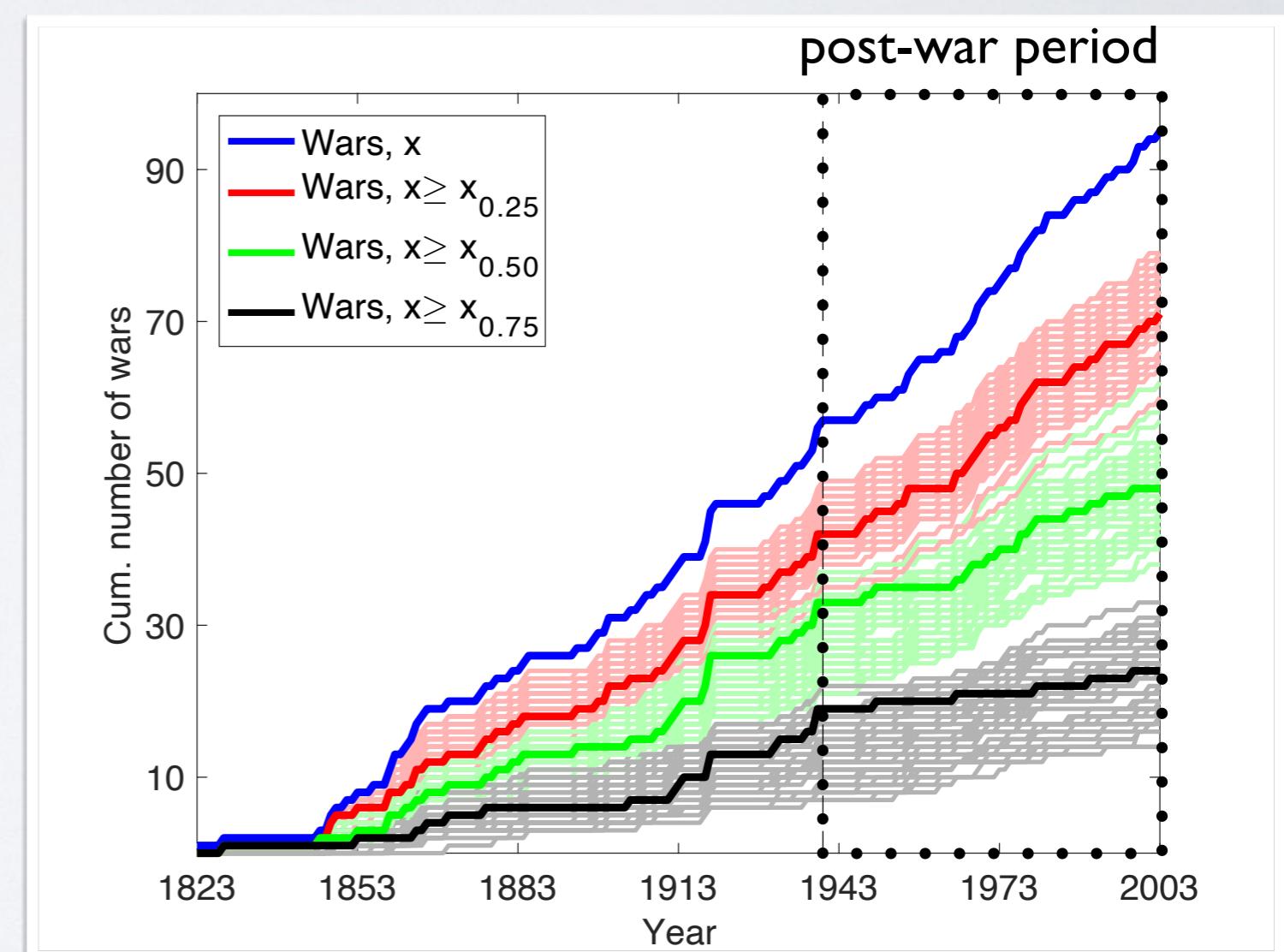
Model 3: onsets at Poisson rate q , severities from $\Pr(x)$ ensemble

trends vs. fluctuations

Model I: observed onset dates, shuffled war severities

observation: all empirical curves well within model envelopes

conclusion: the long peace is consistent with a stationary model



trends vs. fluctuations

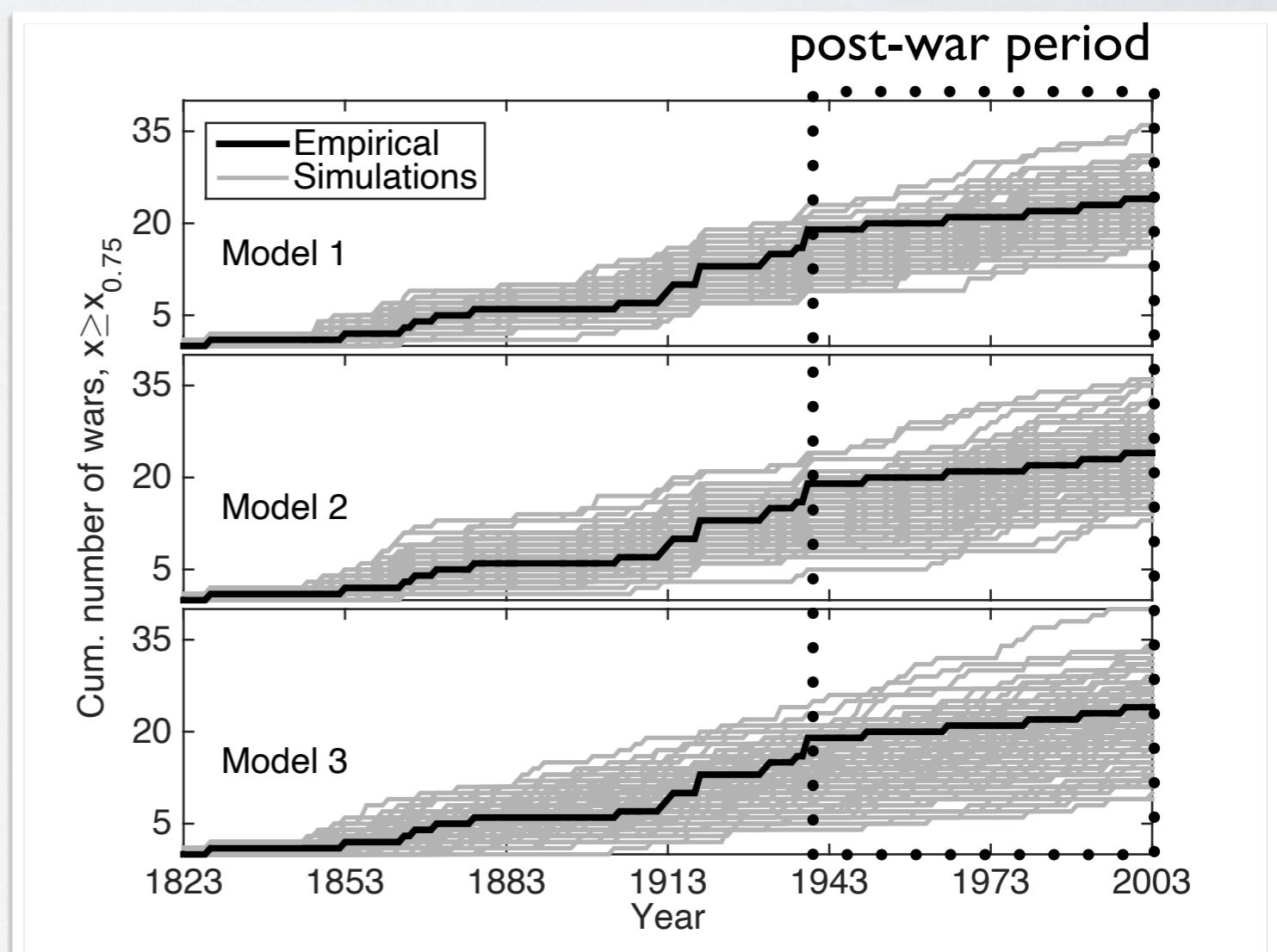
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trends vs. fluctuations

is a *long peace* pattern unlikely? ($n \leq 5$ large wars over $t \geq 64$ years)

is a *great violence* pattern unlikely? ($n \geq 10$ large wars over $t \leq 27$ years)

we can directly estimate these probabilities under Models 1-3

trends vs. fluctuations

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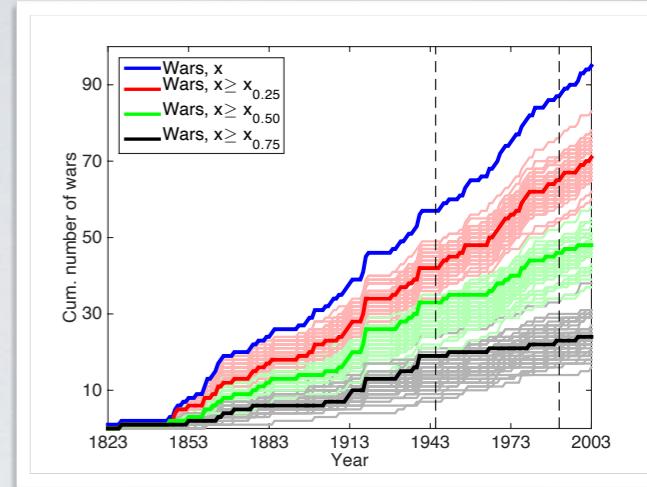
is a *great violence* pattern unlikely? ($n \geq 10$ large wars over $t \leq 27$ years)

we can directly estimate these probabilities under Models 1-3

| Empirical pattern | Model 1 | Model 2 | Model 3 |
|-------------------|----------|----------|----------|
| great violence | 0.107(1) | 0.159(1) | 0.121(1) |
| long peace | 0.622(2) | 0.569(2) | 0.681(2) |

taking stock

- no evidence for change in war severity in post-war period
- no evidence for change in war frequency in post-war period
- *long peace pattern (1940–2003)* is both *real* and *common*, even under a stationary (no-change) model of wars
- *great violence pattern (1914–1939)* is both *real* and *not uncommon*, even under a stationary model
- **these patterns are consistent with fluctuations, not trends (so far)**



okay, okay:

- how long must the "long peace" endure before it's definitely a trend?

peering into the future

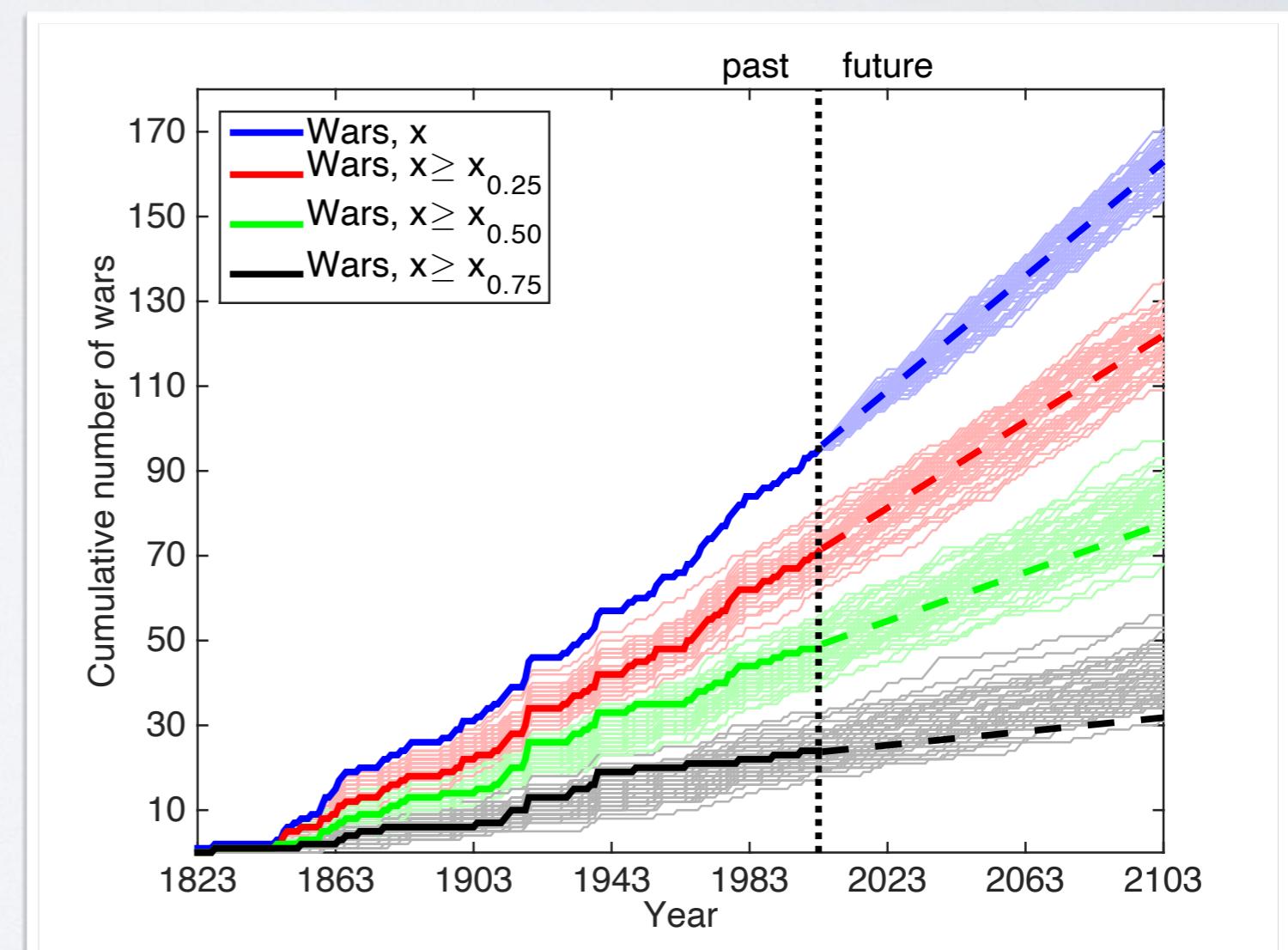
extrapolate CoW data into future under a no-change model:

- new wars, beyond 2003, occur at the empirical rate (every 1.91 years)
- each new war assigned a severity, via Model 1, 2 or 3
- defines a no-change envelope of variability for cumulative war counts
- extrapolate *long peace* pattern (new severe war every 12.8 years)
- when does this pattern have fewer severe wars than 95% of realizations?

peering into the future

extrapolate CoW data into future under a no-change model:

- when does *long peace* pattern have fewer wars than 95% of realizations?



peering into the future

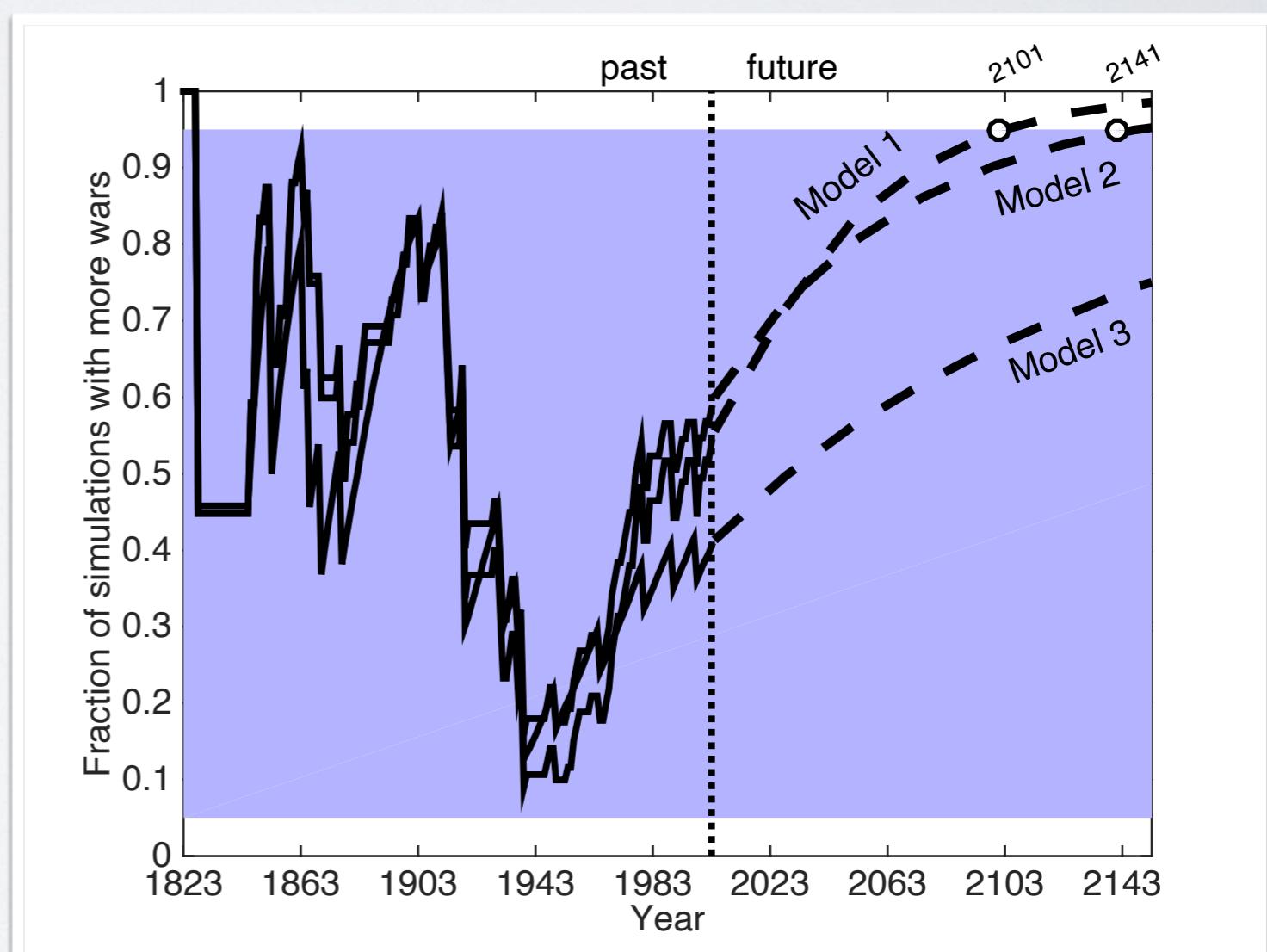
extrapolate CoW data into future under a no-change model:

- when does *long peace* pattern have fewer wars than 95% of realizations?

Models 1 and 2: 100–150 more years

(until around 2100–2150)

statistically speaking,
the *long peace* effectively just
"balances" the effect of the *great
violence*

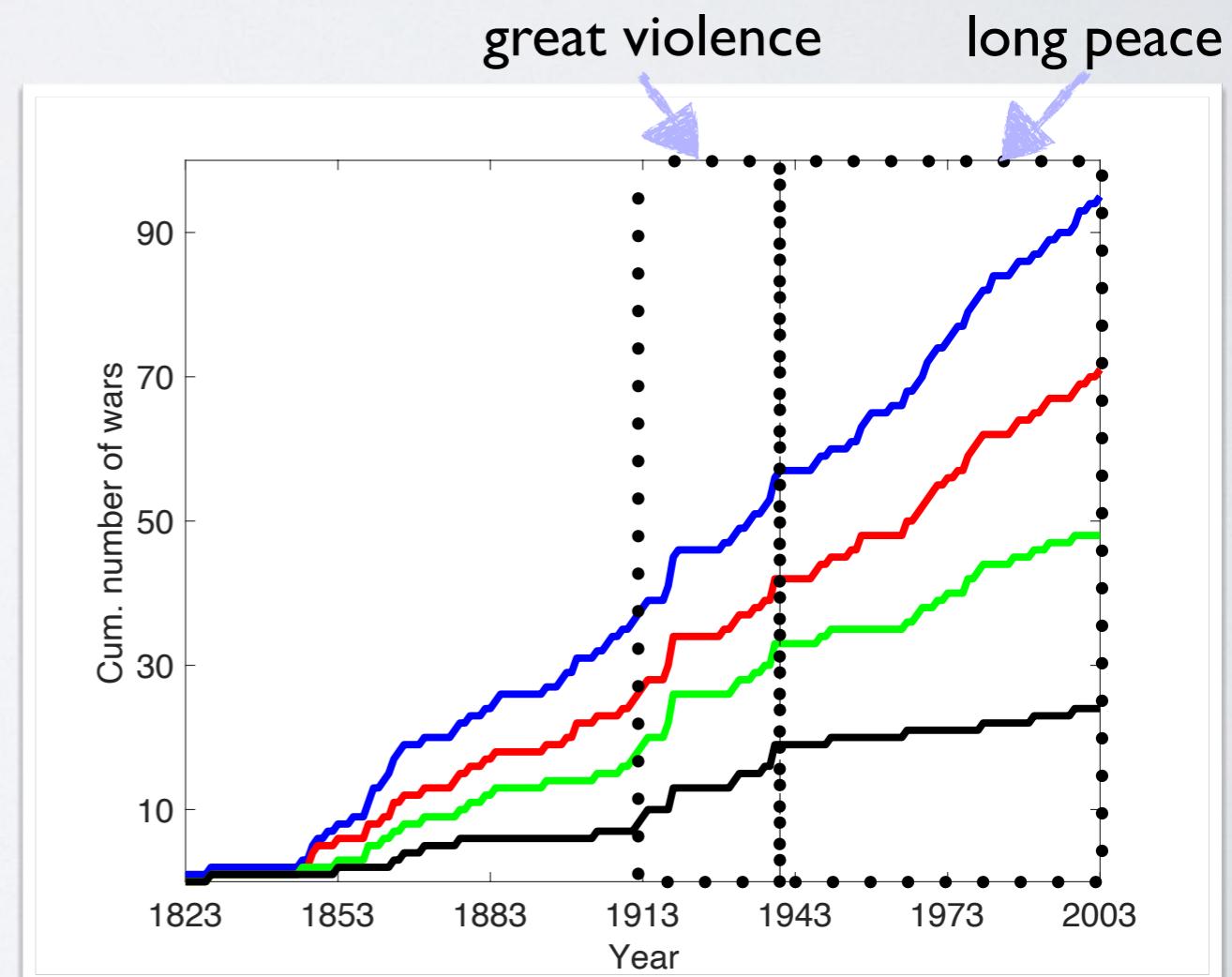


toward a more peace world?

the *long peace* is consistent with a no-change model of 200 years of war

the *great violence* is consistent with a no-change model of 200 years of war

peace-promoting work has not changed enough the global frequency or severity of interstate wars to say that war as a whole is different



toward a more peace world?

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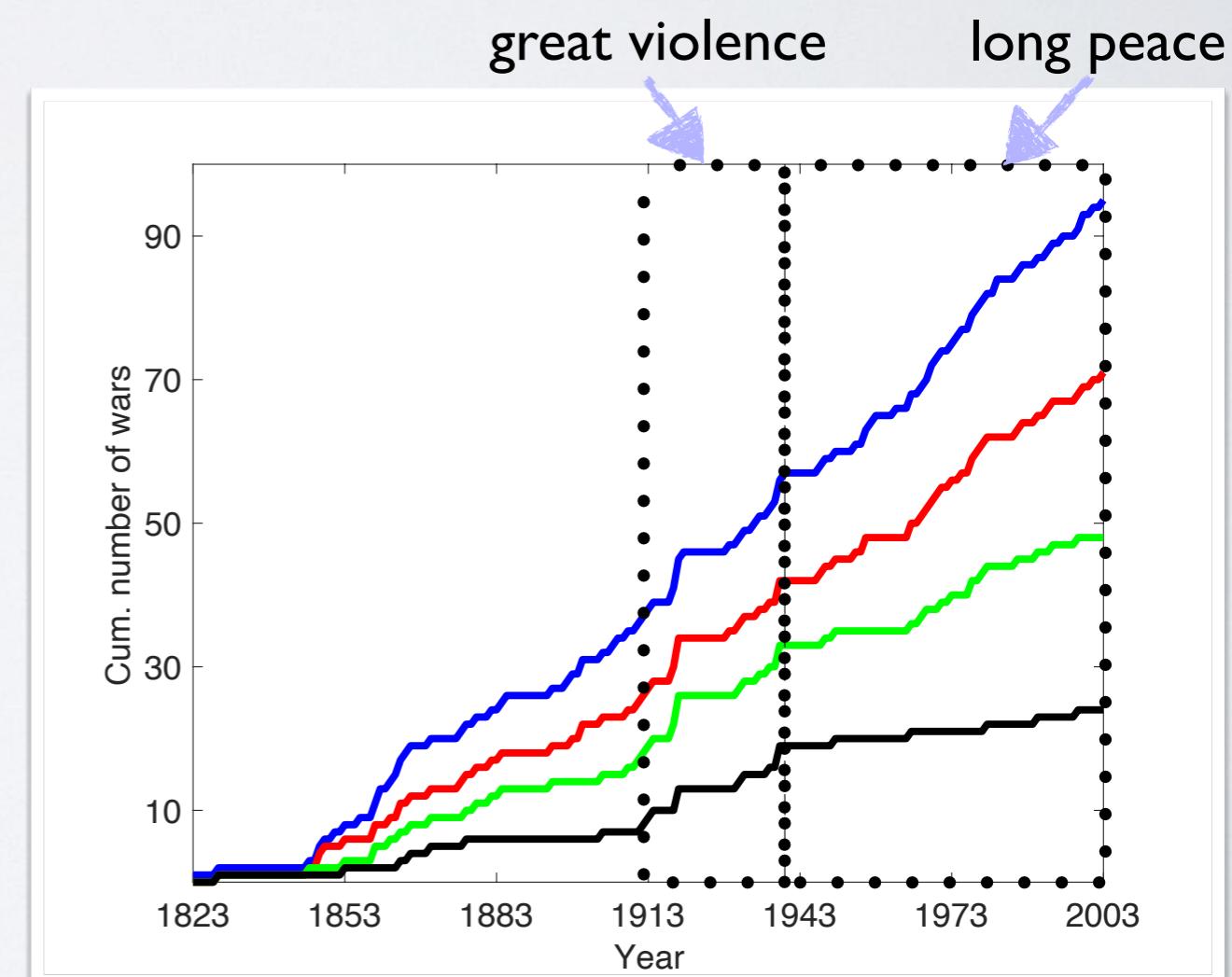
peace-promoting work has not changed enough the global frequency or severity of interstate wars to say that war as a whole is different

the *long peace* is not (yet) evidence that war has changed

because:

wars are rare events (95 wars in 181 years), and war severity is highly variable

long periods with few large wars is statistically common*



* this fact is true if wars are close to iid variables; promoting peace by limiting independence may work, but could also backfire (e.g., the great violence)

toward a more peace world?

hence, peace may be much more fragile than we think

stability of war is remarkable → population, technology, political organization, etc., are all non-stationary

most work is on mechanisms for the decline of war → like sampling the dependent variable → need more research on war-promoting mechanisms

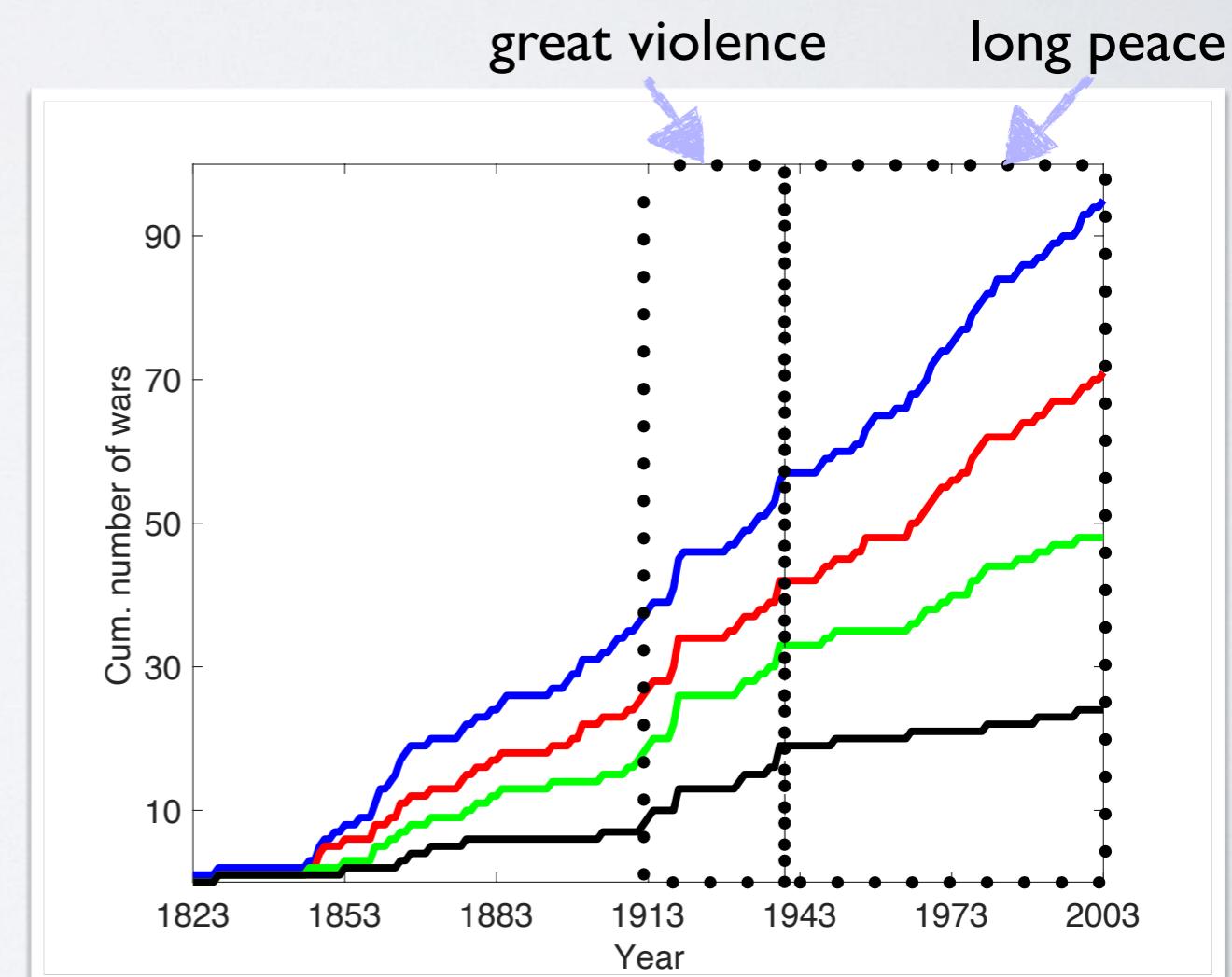
suggests meta-mechanisms:

stationarity is an emergent property

specific mechanisms come and go

but something is fundamental...

what?



a clue

consider a basketball game

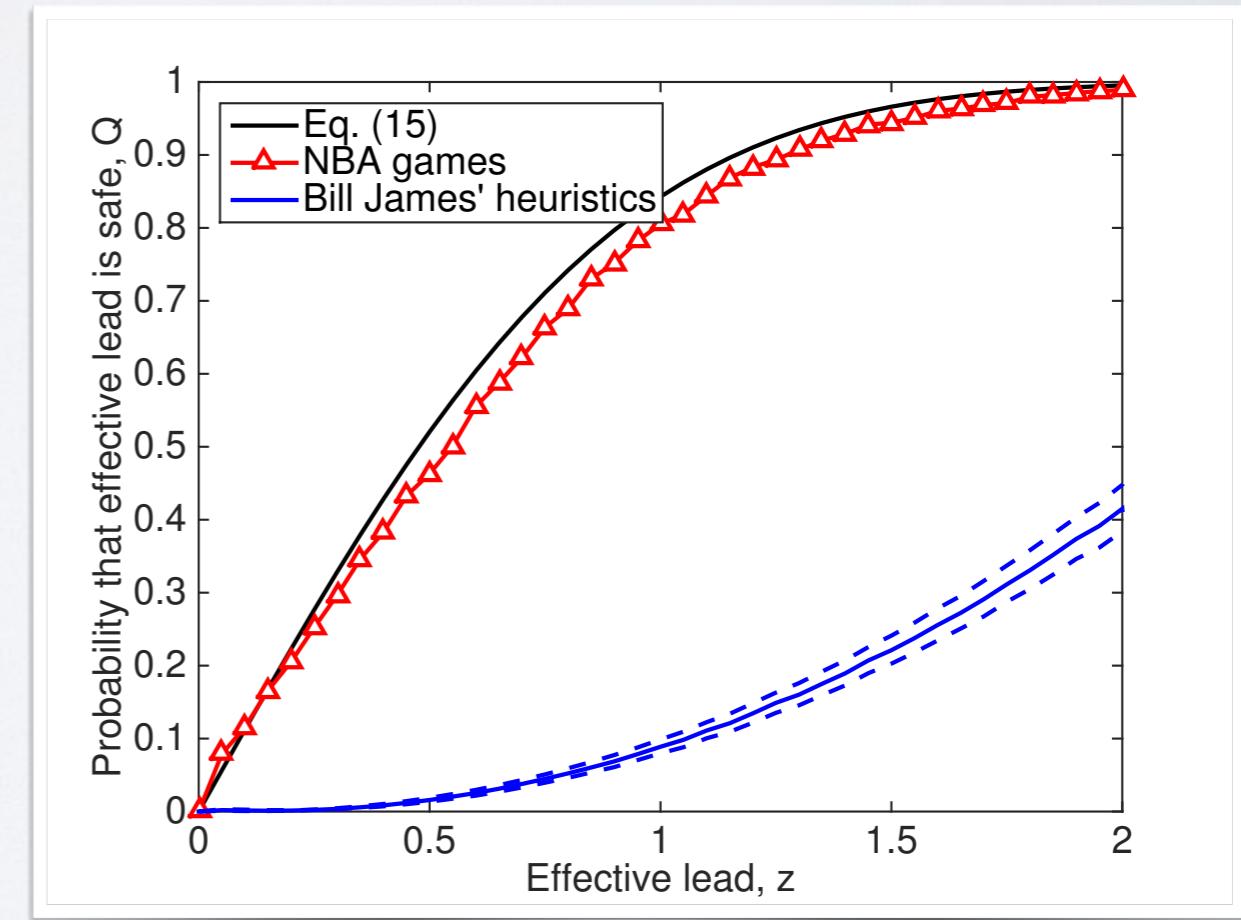
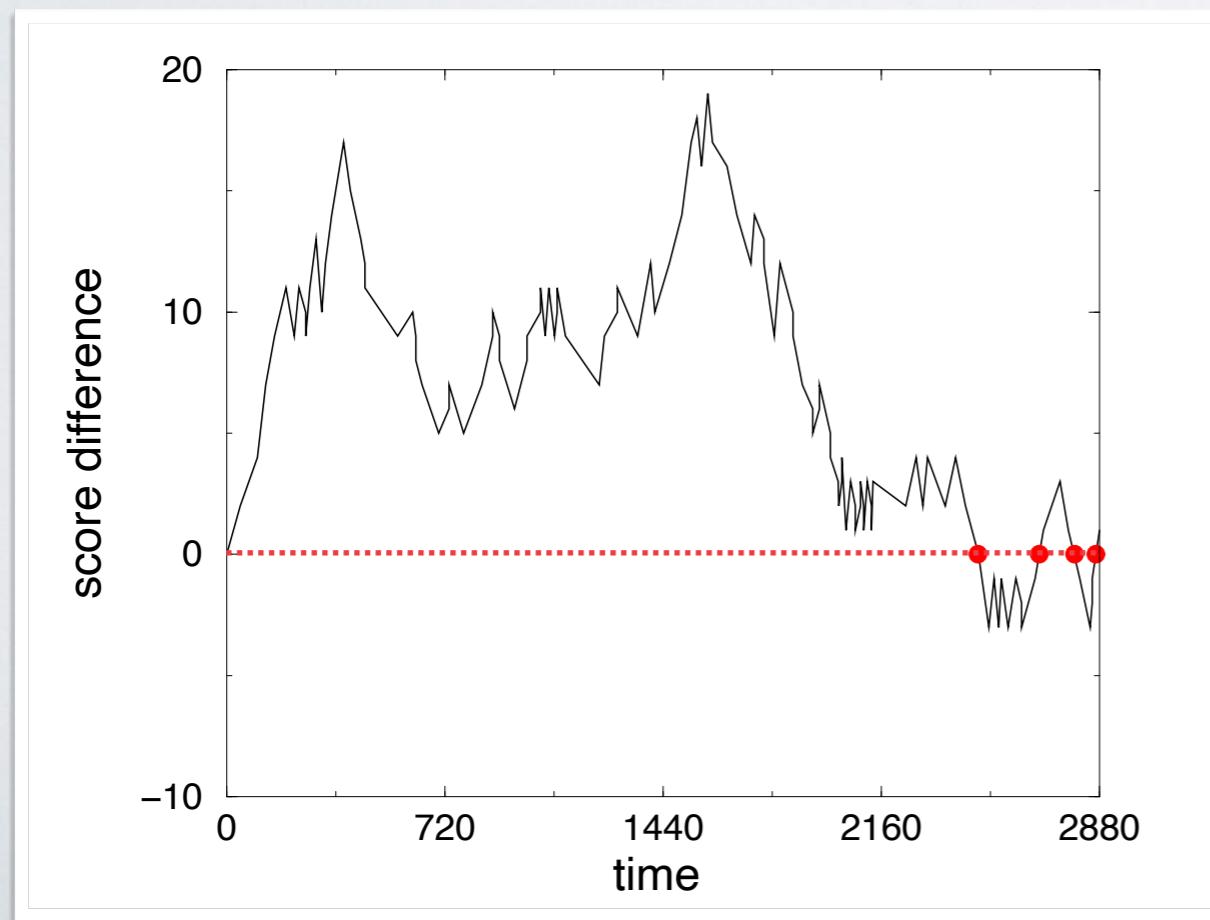
every scoring event has a reason, a mechanism

but *in aggregate*, scoring dynamics very well modeled as a *random walk*

runs of no events, clusters of many events

stationarity is an emergent property, observed only in system-level analyses

we should consider whether war has the same property



acknowledgements

- Kristian Skrede Gleditsch
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- Lars-Erik Cederman
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SCIENCE ADVANCES | RESEARCH ARTICLE

SOCIAL SCIENCES

Trends and fluctuations in the severity of interstate wars

Aaron Clauset*

Since 1945, there have been relatively few large interstate wars, especially compared to the preceding 30 years, which included both World Wars. This pattern, sometimes called the long peace, is highly controversial. Does it represent an enduring trend caused by a genuine change in the underlying conflict-generating processes? Or is it consistent with a highly variable but otherwise stable system of conflict? Using the empirical distributions of interstate war sizes and onset times from 1823 to 2003, we parameterize stationary models of conflict generation that can distinguish trends from statistical fluctuations in the statistics of war. These models indicate that both the long peace and the period of great violence that preceded it are not statistically uncommon patterns in realistic but stationary conflict time series. This fact does not detract from the importance of the long peace or the proposed mechanisms that explain it. However, the models indicate that the postwar pattern of peace would need to endure at least another 100 to 140 years to become a statistically significant trend. This fact places an implicit upper bound on the magnitude of any change in the true likelihood of a large war after the end of the Second World War. The historical patterns of war thus seem to imply that the long peace may be substantially more fragile than proponents believe, despite recent efforts to identify mechanisms that reduce the likelihood of interstate wars.

Science Advances **4**, eaa03580 (2018)

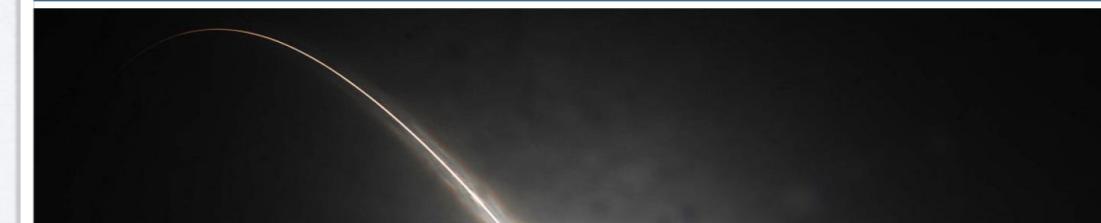
funding



or, 2017 tech report at OEF

THE ENDURING THREAT OF A LARGE INTERSTATE WAR

Aaron Clauset | 2017



fin

