Increasing mortality of white Americans, a systematic deviation from Gompertz law, and a trend break in cohort health

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Motivation

Case and Deaton (2015) — increased mortality of non-Hispanic white Americans ages 45-54 since 1999

- opioid epidemic
- economic factors?

Case and Deaton (2017) and Lleras-Muney (2017) — hint at potential role of cohort factors

- "cumulative disadvantage" beginning at labor market entry

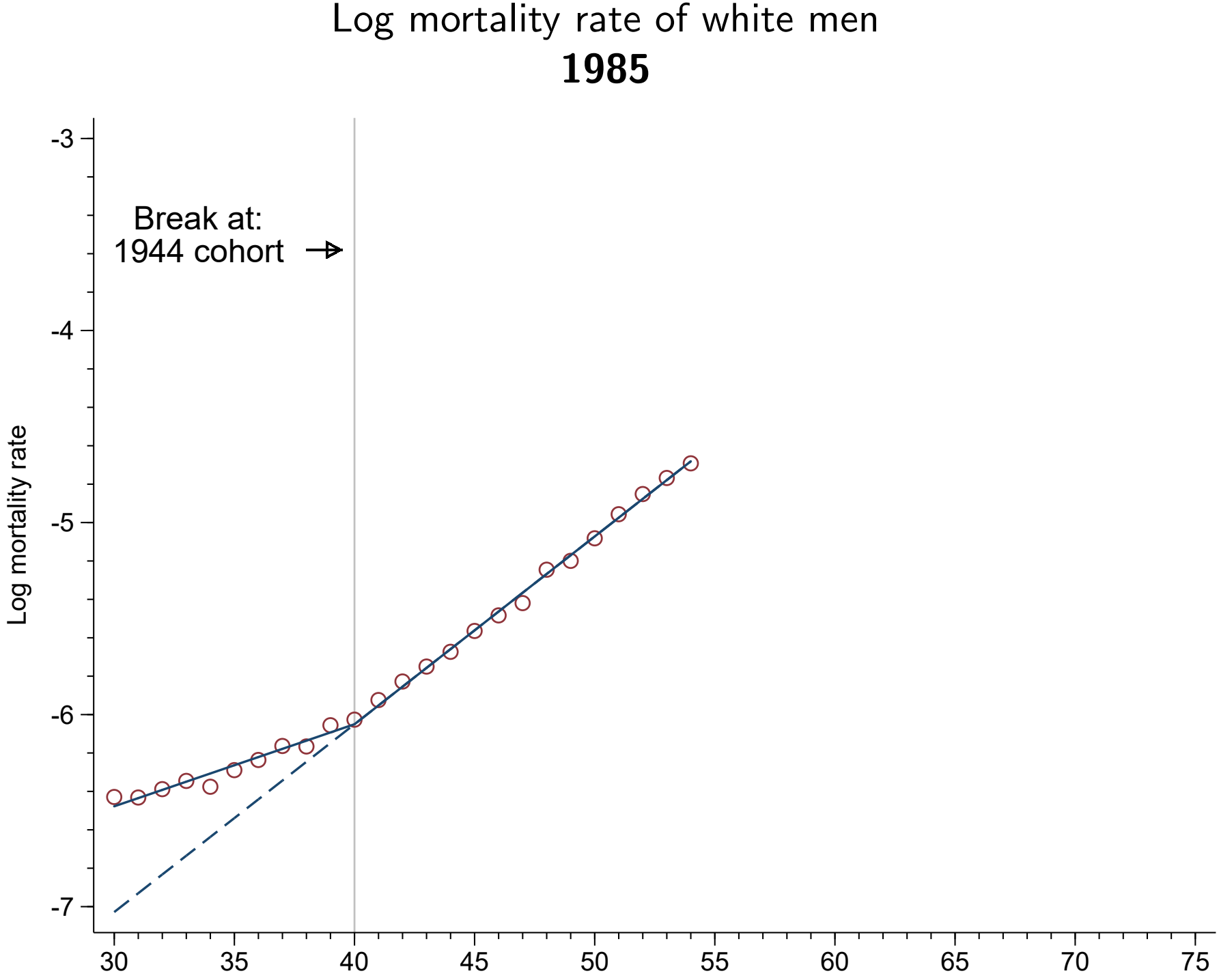
Masters et. al (2017) and Zang et. al (2018) — using additive Age-Period-Cohort models also find important role for cohort factors

My paper

- systematic deviations of mortality of white American men and women from log-linearity
  - eg. from Gompertz law
- change in slope of log mortality by age, which occur at same cohort in each year between 1985 and 2015
  - elevated mortality for post-1946 cohorts of men, post-1949 cohorts of women, relative to prior trend
- consistent with decline in cohort health as important driver of recent mortality increases
  - underlying cause predates opioid epidemic

Data

- deaths by race-age-year from U.S. Vital Statistics MCD File
- mid-year population by race-age-year from SEER/Census Bureau
- cohort $\equiv$ year $-$ age $-$ 1
- years 1980-2015, ages 30-75, cohorts 1930-1965


Log mortality rate of white men
1985
Break at:
1944 cohort
Log mortality rate
-3
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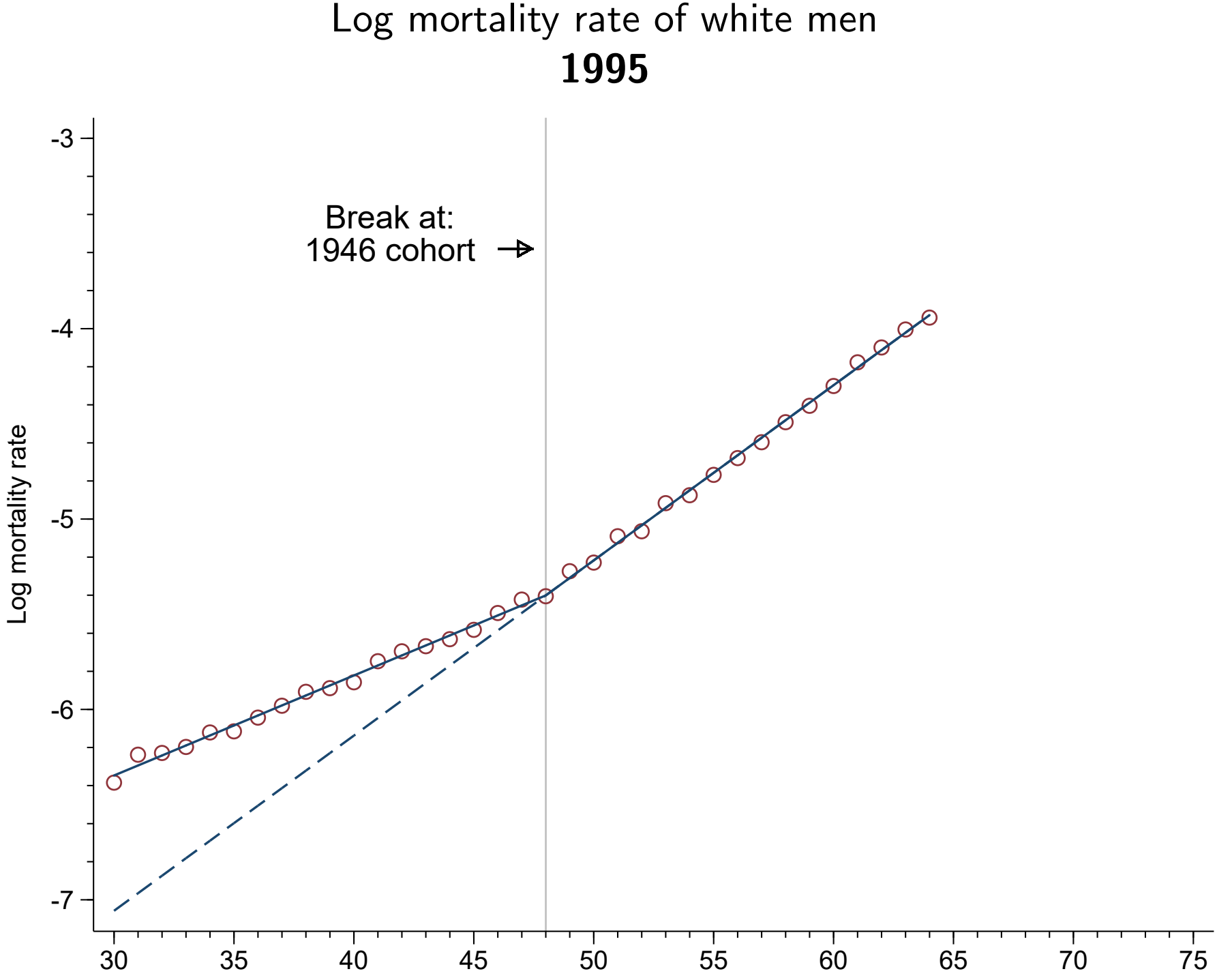
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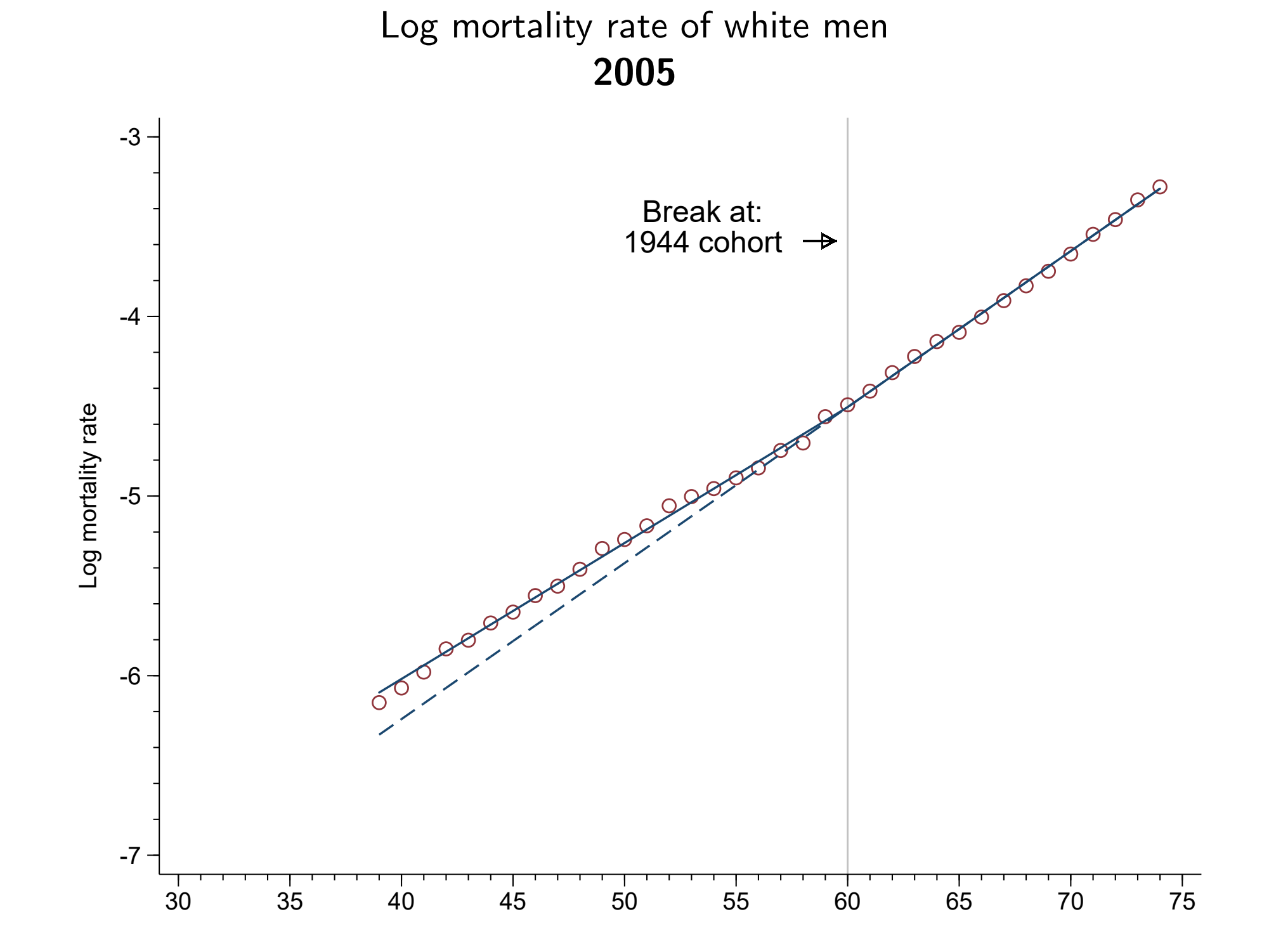
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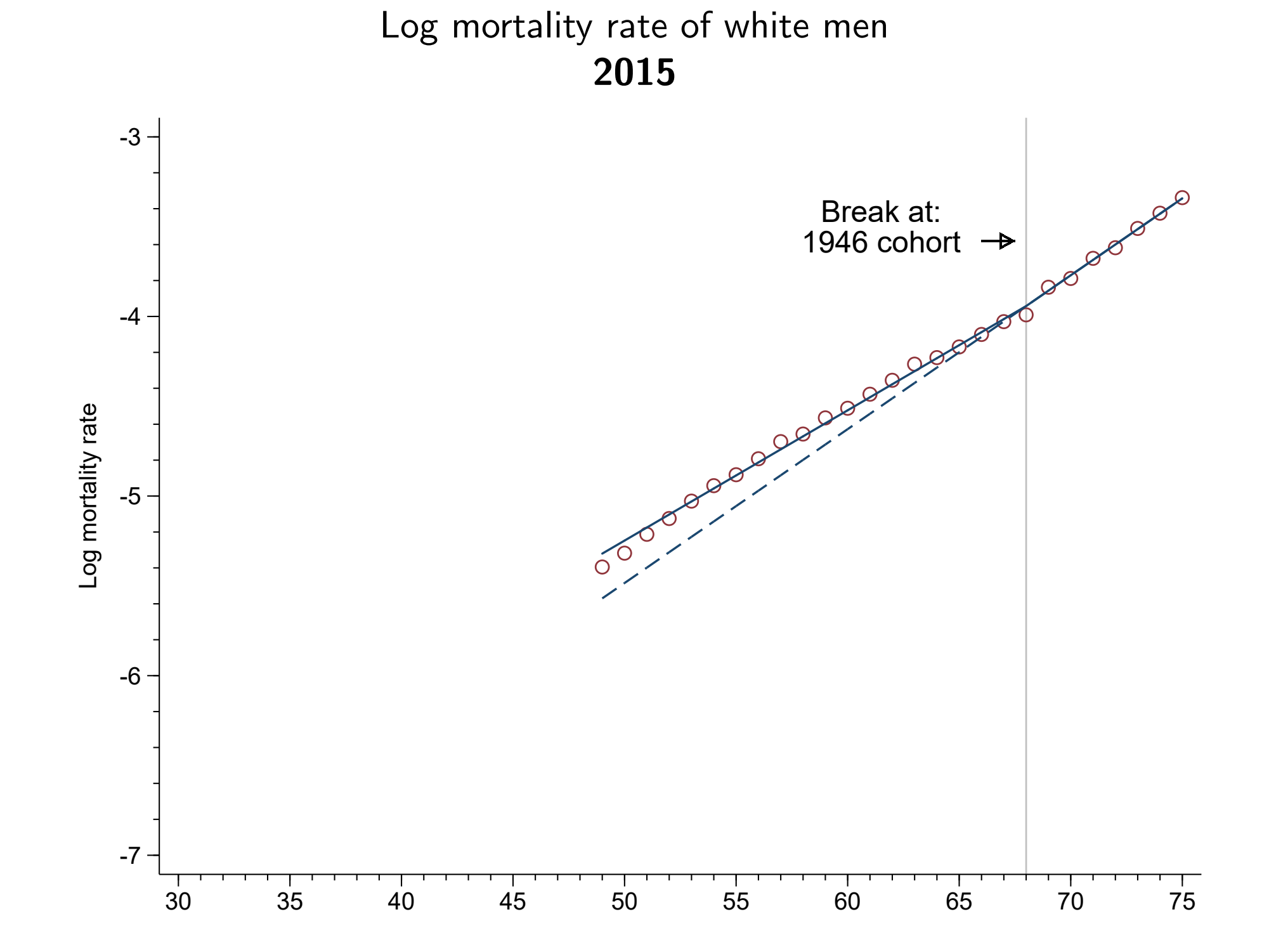
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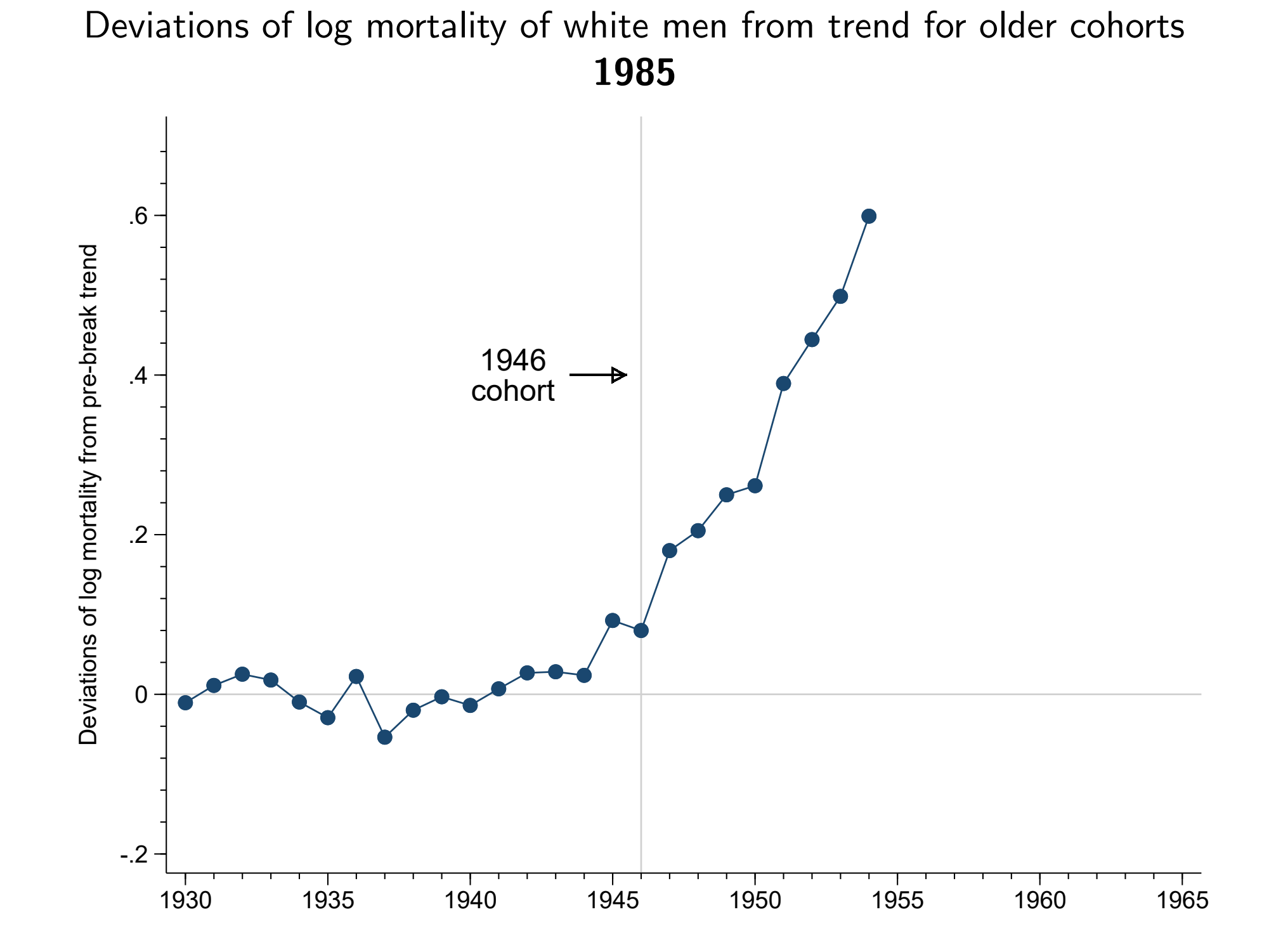
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Deviations of log mortality from pre-break trend
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.2
0
-.2
1946
cohort
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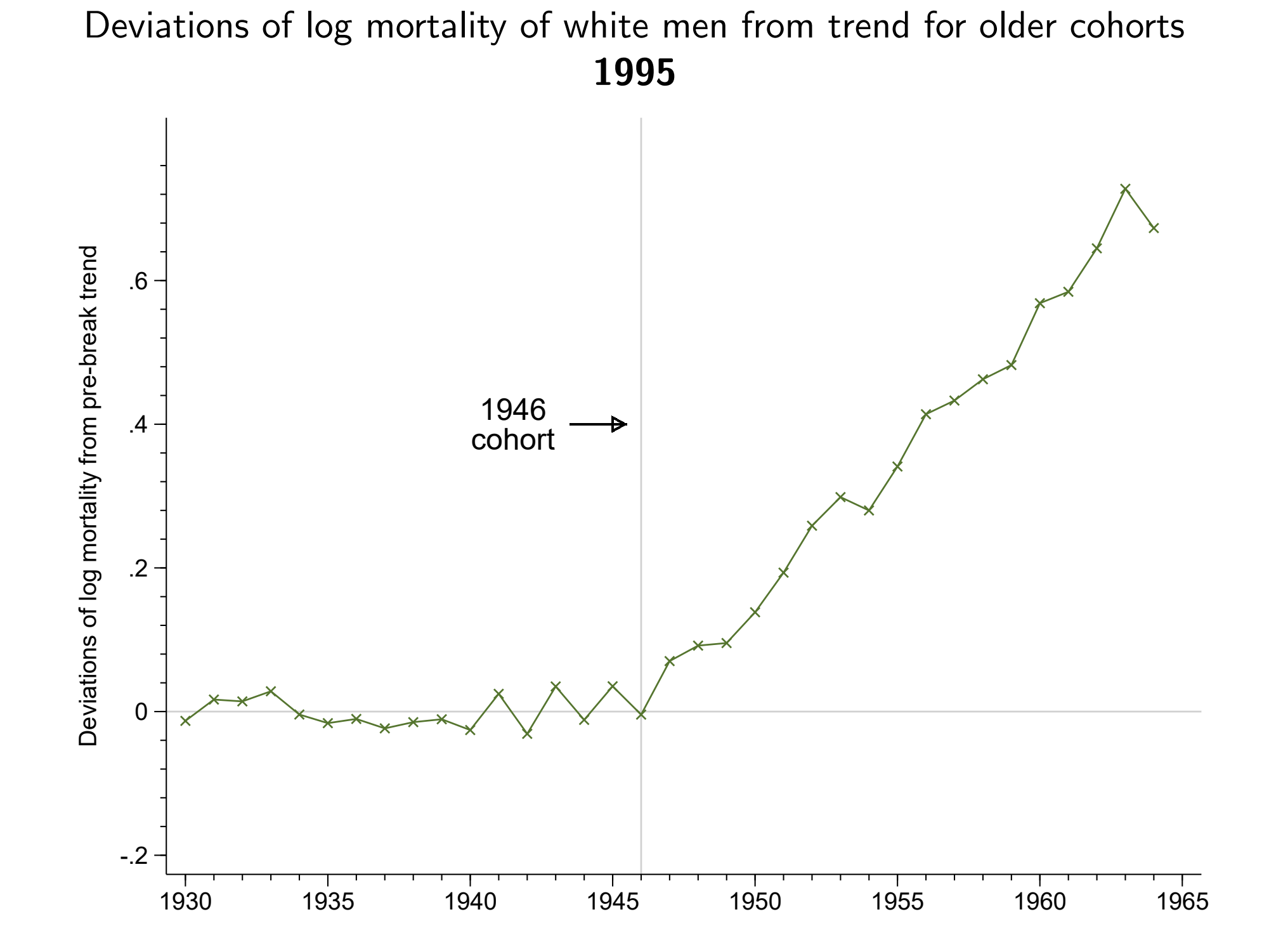
1935
1940
1945
1950
1955
1960
1965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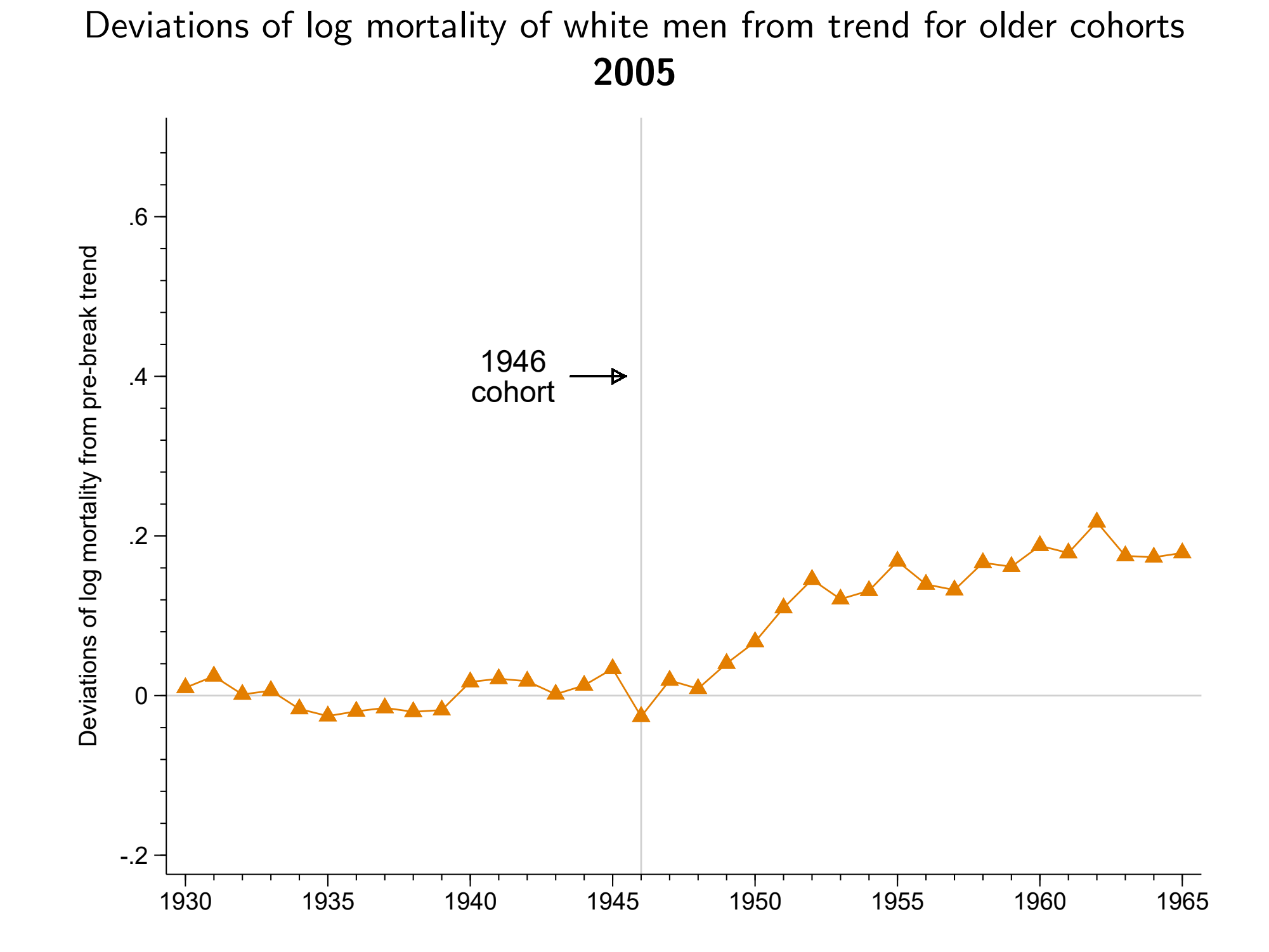
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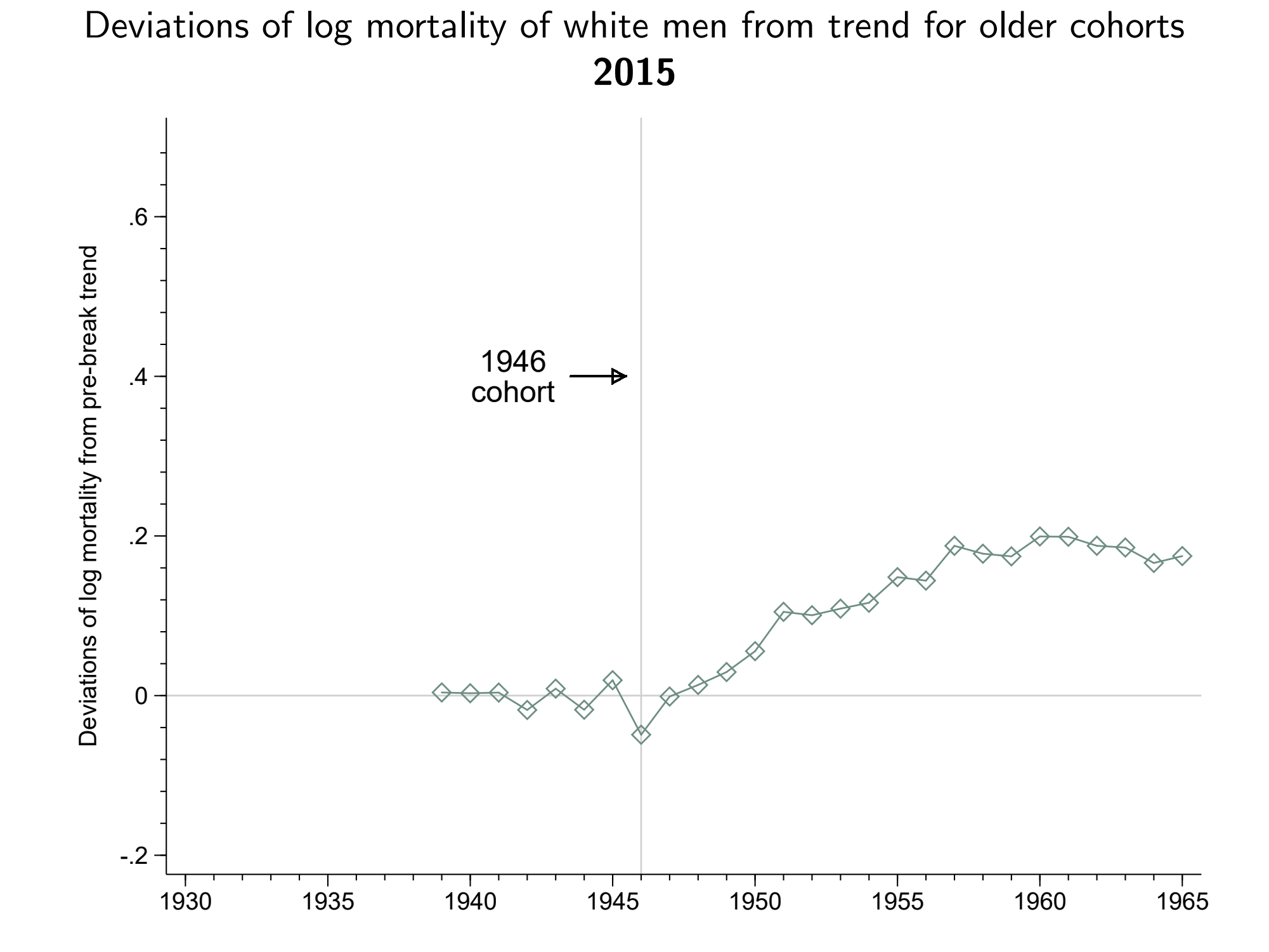
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- estimate similar trend break in each year, 1985-2015, at $\sim$1946 cohort
    - same pattern for women, but break at $\sim$1949 cohort
- motivates estimating a model with linear age effects in each year and trend break in "cohort effects"

Model

$$ln(mort_{apc}) = \delta^p_{1,c} \cdot c + \underbrace{\delta^p_{2,c} \cdot 1_{c \geq \gamma} \cdot (c - \gamma)}_{\text{trend break at cohort } \gamma} + \underbrace{f^p(a)}_{\text{time varying age effect}} + \epsilon_{apc}$$

- location of trend break γ is parameter to be estimated
  (follow Hansen, 1999)
- $f^p(a)$ linear in baseline model
- experiment with separate higher order polynomials in each year
  - allows age to have smooth effect on mortality which *v*aries by year
- report average size of break, $\delta^p_{2,c}$, across years

White men, cohort trend break in log mortality

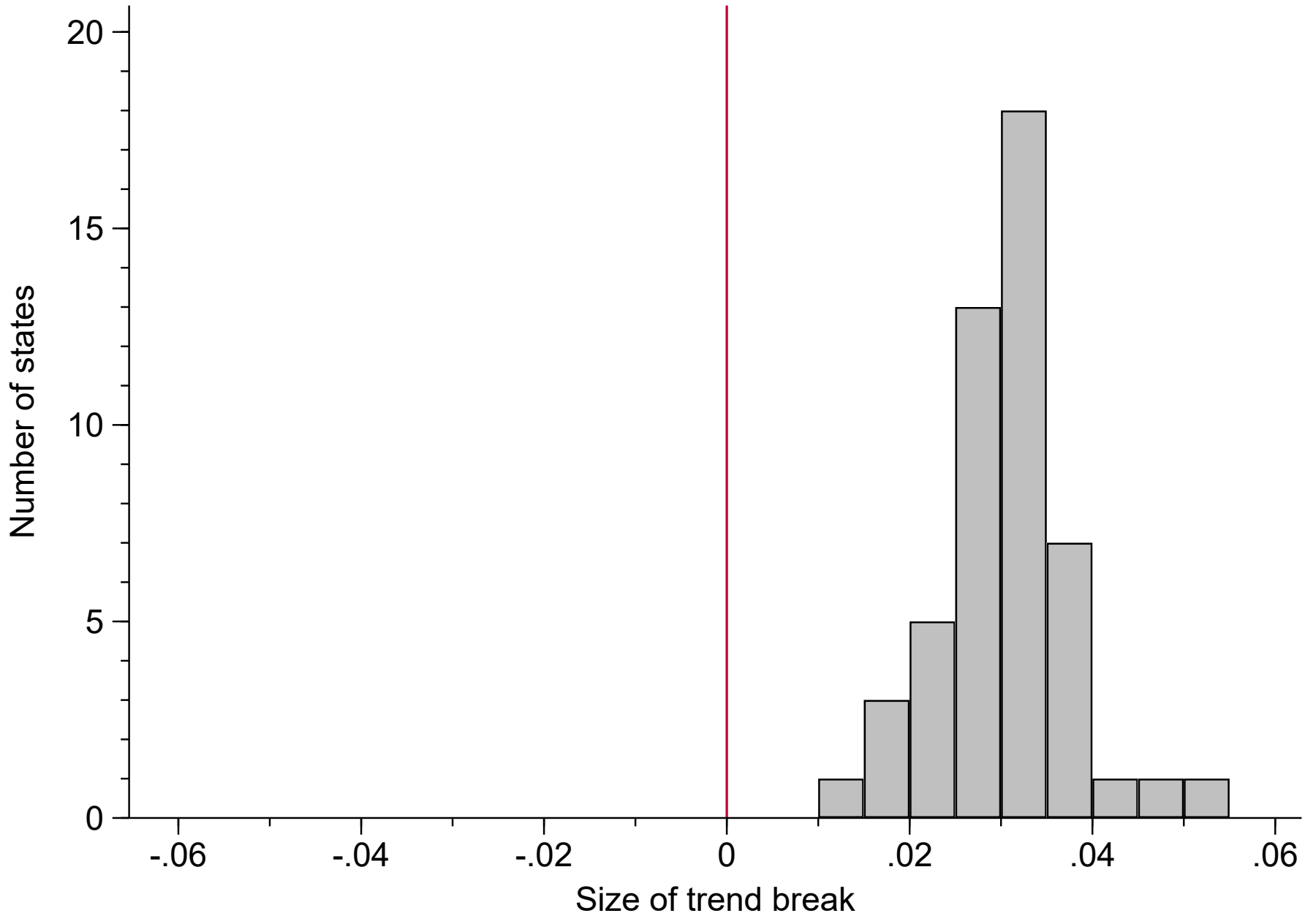
	(1)	(2)	(3)
Break size	0.026	0.029	0.025
	(0.001)	(0.001)	(0.002)
Break location	1946	1946	1946
	[1946, 1946]	[1946, 1946]	[1946, 1946]
P-value, break exists	$< .001$	$< .001$	$< .001$
Linear-age-by-year	Yes	Yes	Yes
Quadratic-age-by-year	No	Yes	Yes
Cubic-age-by-year	No	No	Yes

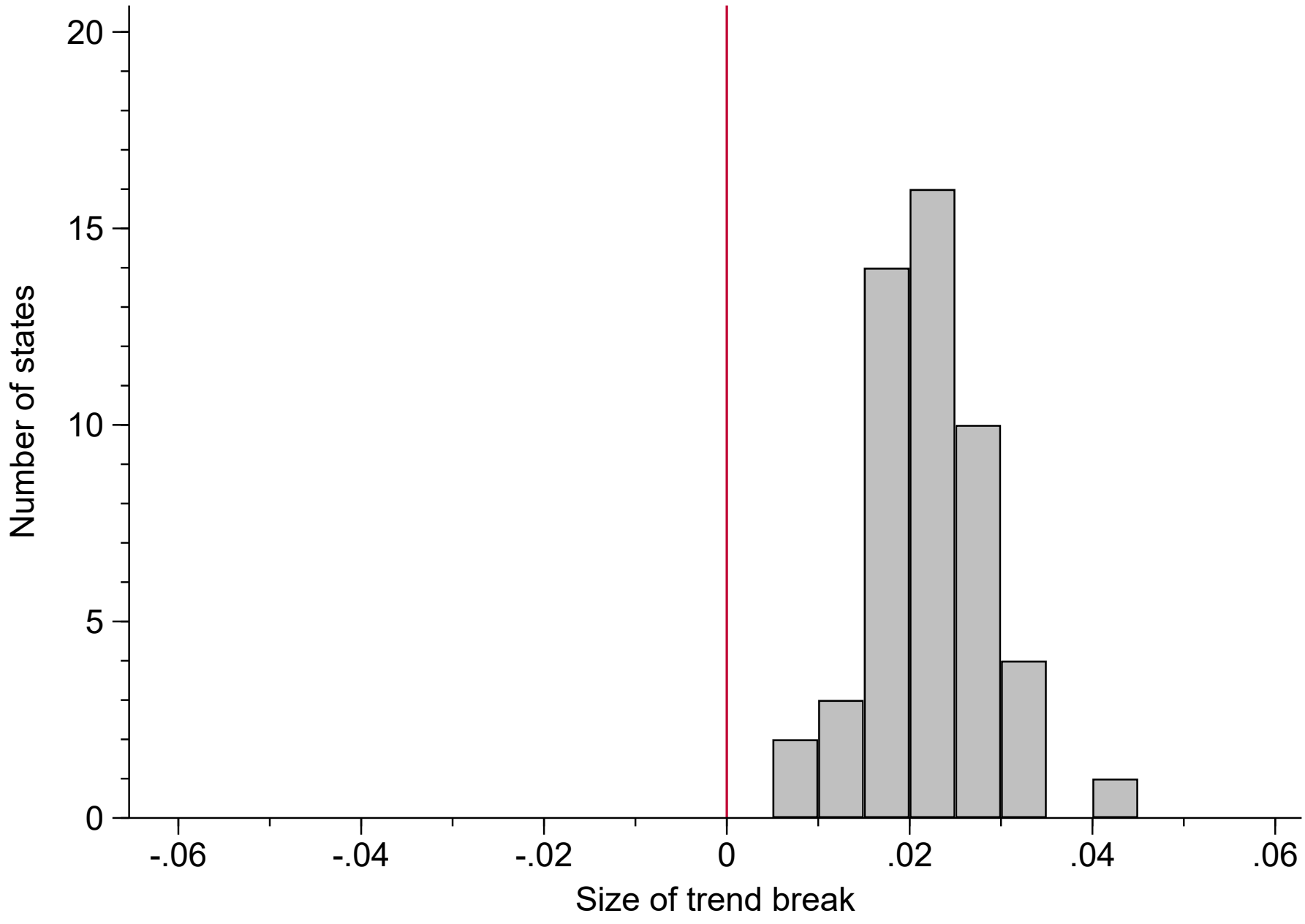
White women, cohort trend break in log mortality

	(1)	(2)	(3)
Break size	0.020	0.034	0.024
	(0.001)	(0.001)	(0.002)
Break location	1948	1949	1950
	[1948, 1949]	[1949, 1949]	[1950, 1950]
P-value, break exists	$< .001$	$< .001$	$< .001$
Linear-age-by-year	Yes	Yes	Yes
Quadratic-age-by-year	No	Yes	Yes
Cubic-age-by-year	No	No	Yes

State-level analysis

- estimate baseline model with linear age-effects separately for each of the 50 states
- yields separate estimate of average break size, $\delta^{p}_{2,c}$, *for each state*


Distribution of break sizes across 50 states, white men
Number of states
0
5
10
15
20
-.06
-.04
-.02
0
.02
.04
.06
Size of trend break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Size of trend break

Summary

- systematic cohort-based deviations from Gompertz law
- suggests decline in health of white Americans born since late 1940s
- which was important driver of recent increases in mid-life mortality

Ongoing work and next steps

- similar cohort declines in test scores, education, occupational status, income, and intergenerational effect on infant health
- tentative root cause — decline in respiratory health environment when these cohorts were infants
  - post-war rise in air pollution?
- similar pattern in other countries? (use HMD)