

# What changes in Life expectancy 2011-2020 reveal about US racial mortality inequality

Replication and extension of the paper: “Decomposing changes in life expectancy: Compression versus shifting mortality”

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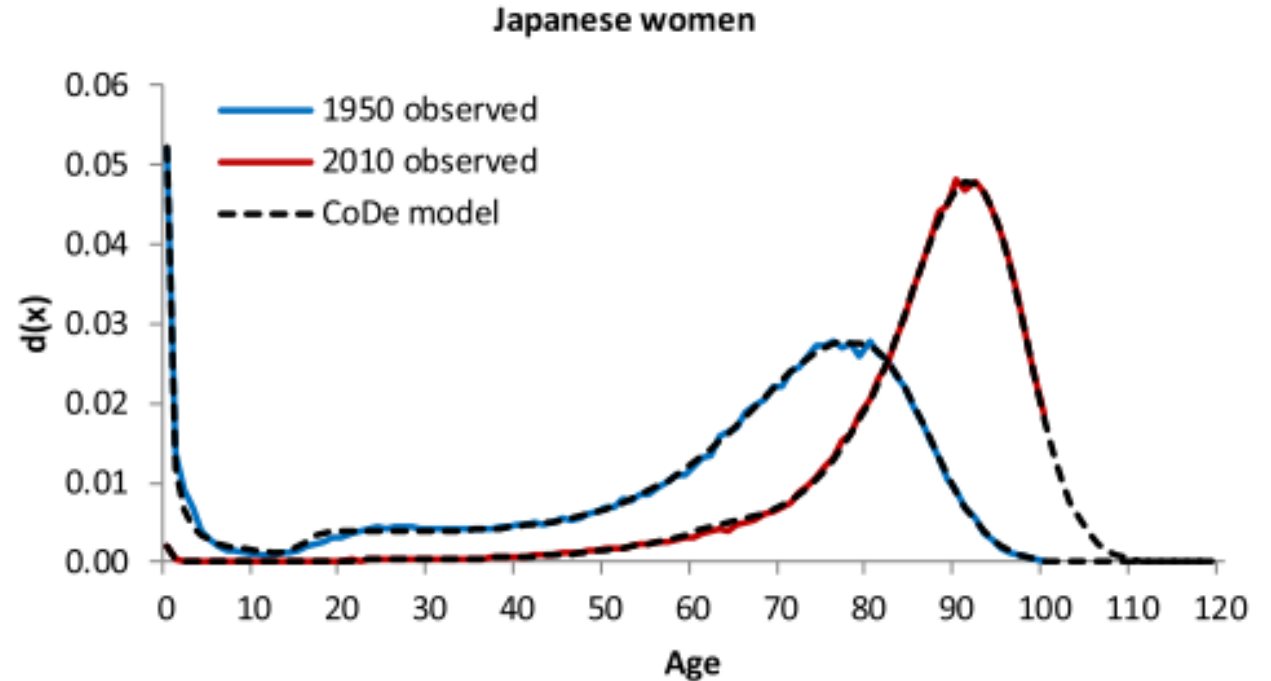
# Life expectancy

**Geek Version:** The average years of life a hypothetical population would live if they follow the mortality of a given year at each age

**Plain Version:** Measures population health (mortality) at a given year in years

$$e_0 = \int_0^{\omega} l_x dx$$

$$l_x = \exp\left(-\int_0^x \mu_a da\right)$$



$$\mu_{a,t} \approx c_t + \beta_t \exp(\beta_t(x - M_t))$$

Gompertz-Makeham Model

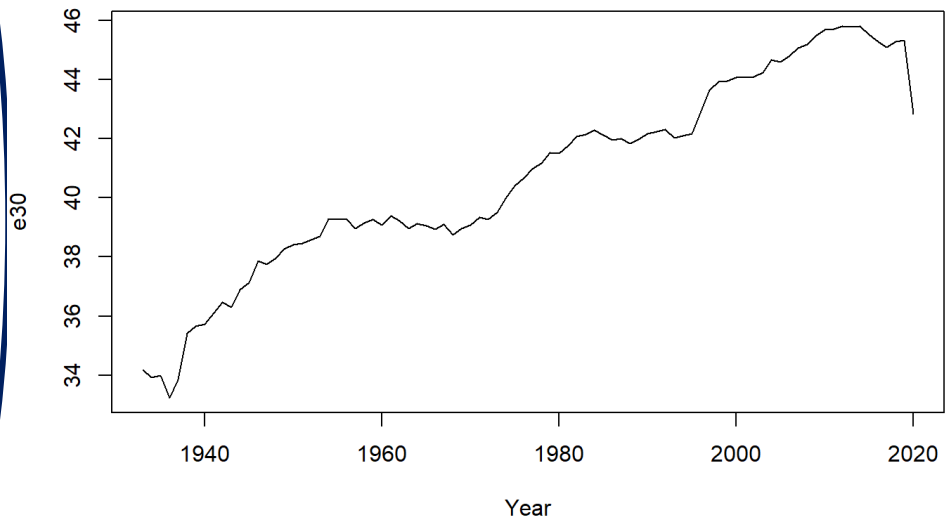
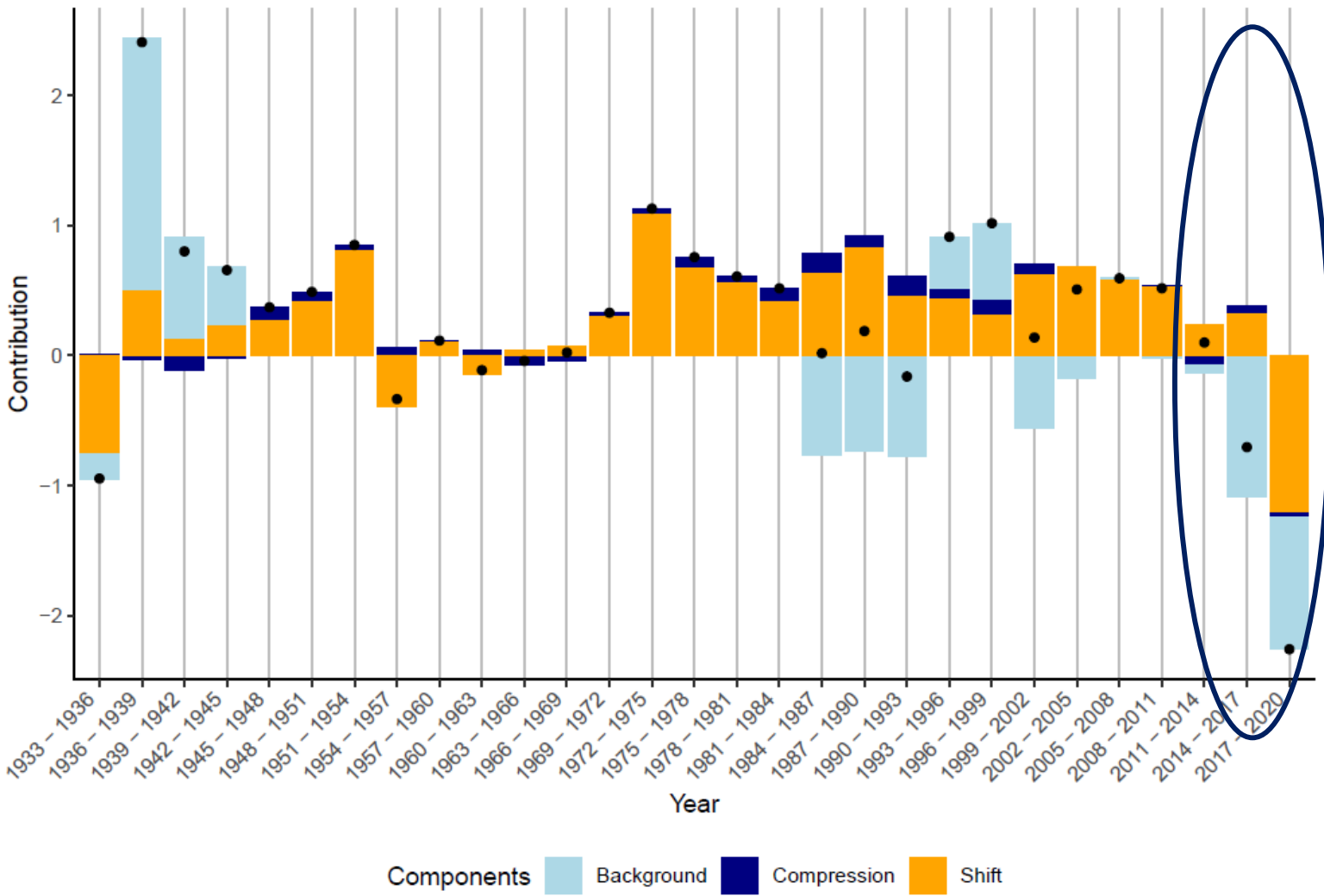
Parametric Fitting with Maximum Likelihood

Changes in life expectancy can be traced to:

1. the changes in age-independent mortality (Background)
2. the changes in the age-dependent mortality (Compression)
3. the changes in shift of mortality (Modal age at death)

Question 1: For the United States, which component takes the lead over the years?

Changes in Life expectancy for the US with Gompertz–Makeham Model,  
Male 1933–2020



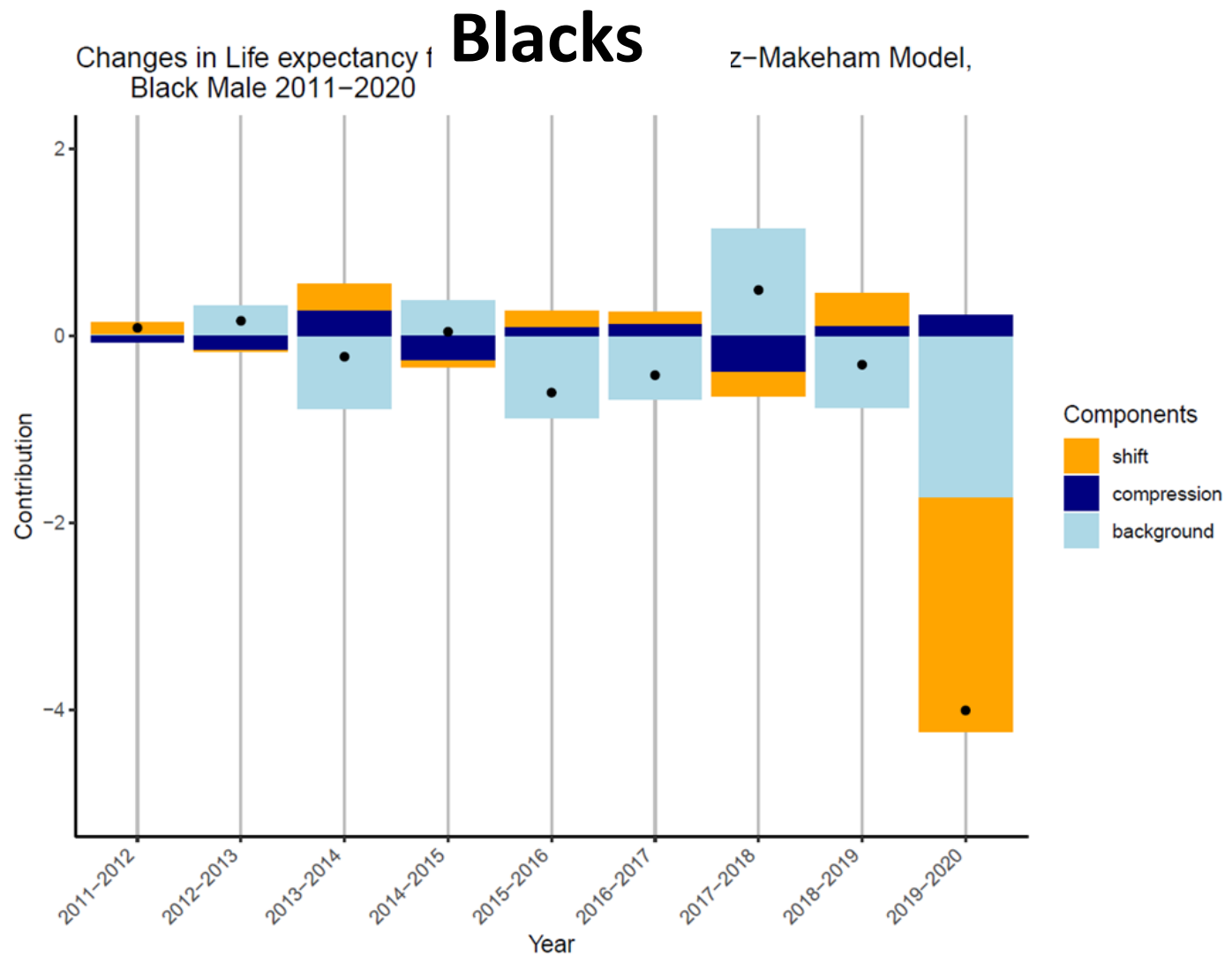
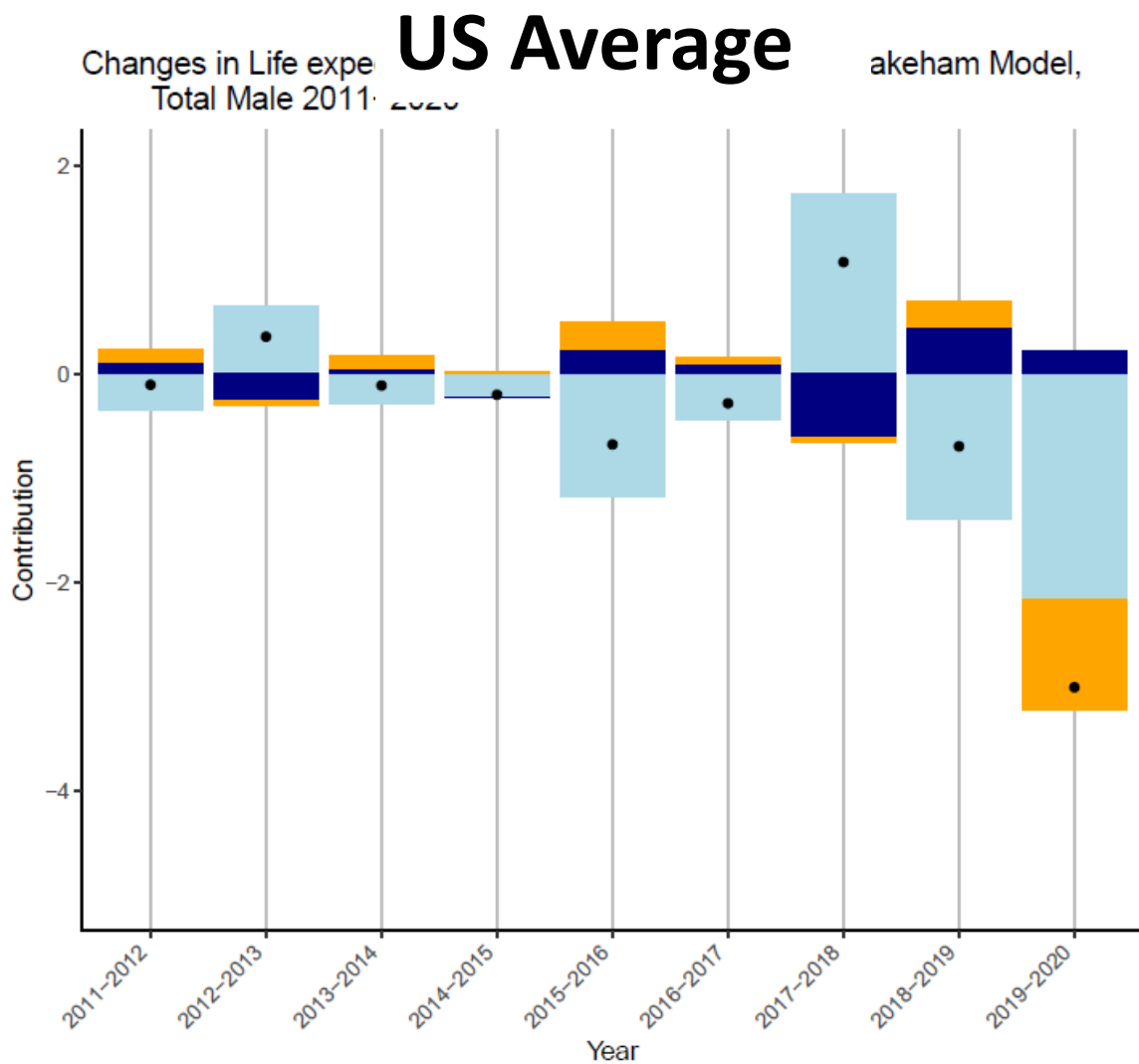
Source: Calculation based HMD (2022)

The latest 10 years has seen a significant decrease in life expectancy.

However, does it affect different races equally?

Mid-year smoothed population counts and deaths number from age 30 to age 100 from CDC Wonder database, and the use of the decomposition with Gompertz-Makeham Model

$$\begin{aligned} \dot{e}_{0,t} = & \underbrace{-\dot{c}_t \int_0^\omega l_{a,t} a da}_{\Delta c} - \underbrace{\dot{\beta}_t \int_0^\omega l_{a,t} \int_0^a [e^{\beta_t(x-M_t)}(1 + \beta_t(x - M_t))] dx da}_{\Delta \beta} \\ & + \underbrace{\dot{M}_t \int_0^\omega l_{a,t} \int_0^a [\beta_t^2 e^{\beta_t(x-M_t)}] dx da}_{\Delta M}, \end{aligned}$$



Source: Calculation based on CDC WONDER



Population	Background	Compression	Shift	Total
Average	-1.5 (-3.6)	0.1 (0.3)	0.7 (-0.3)	-0.6 (-3.7)
Blacks	-1.2 (-3.0)	-0.3 (0)	0.7 (-1.8)	-0.8 (-4.8)
Non-Hispanic Whites	-1.8 (-4.3)	0.2 (0.5)	0.7 (0.1)	-1.0 (-3.7)
Native Americans	-1.8 (-3.3)	-0.4 (-0.8)	1.5 (-1.1)	-0.7 (-5.1)

\* Parenthesis marks the 2011-2020 level, while the text marks 2011-2019 level



# Discussion

1. Mortality inequalities across different races, especially during 1<sup>st</sup> year of COVID-19 pandemic.
2. Positive future for longevity growth (shift component), however, there are big setbacks from younger age mortality (age - independent).

# Shortcomings

1. Discrepancies caused by grouping of the race/ethnicity, and under counting of deaths in CDC compared to HMD (Categorical error)
2. Relative simplistic parametric model, more complexity will infer more insights