The Impact of Covid-19 on Cohort Survival

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Long Abstract

The Covid-19 pandemic has generated sizeable increases in mortality in countries around the world.[1,2] Among 32 countries included the Human Mortality Database, 24 countries experienced drops in life expectancy in 2020 relative to 2019, with the United States experiencing the largest drop of 1.89 years.[3] Among 18 countries that have data for the year 2023, 11 have regained their pre-pandemic levels, but seven, including the United States, haven't.

To date, studies assessing the impact of Covid-19 on mortality have almost exclusively adopted a period approach, relying as above on standard indicators such as period life expectancy.[1] A period approach becomes problematic in the context of the Covid-19 pandemic (or any other mortality shock). The issue is that period life expectancy refers to what mean life span would be if a hypothetical ("synthetic") cohort were exposed to the age-specific mortality risks in a given period. In the context of Covid-19, no actual cohort spent all of life under pandemic mortality conditions but instead faced higher mortality only during the portion of life affected by the pandemic. While trends in period life expectancy are useful for evaluating period fluctuations in mortality in an age-standardized fashion, they are not well-suited to the task of assessing how actual cohorts were affected by mortality shocks such as Covid-19.

The purpose of this paper is to evaluate the impact of Covid-19 on indicators of cohort mortality. We will assess the degree to which Covid-19 has offset or reversed pre-pandemic improvements in cohort mortality by using the Cross-Sectional Average Length of Life (CAL), an indicator that summarizes cohort survivorship in a given population.[4,5] We will obtain credibly causal evidence on the extent to which pre-pandemic improvements have been offset or reversed by comparing pre- and post-Covid mortality conditions: (1) under a no-Covid CAL counterfactual obtained from a cohort discontinuity design ("control" condition) with (2) observed mortality conditions as summarized by CAL since 2020 ("treatment" condition).

CAL is the sum across all ages of proportions of cohort survivors at a given time:

$$CAL(t) = \int_0^{\omega} p^c(x, t-x)\, dx$$

where $p^c(x,\ t-x)$ is the probability of surviving from birth to age x for the cohort aged x at time t (= born x years ago). Thus CAL trends summarize changes over time in cohort survival probabilities. For example, a decrease in CAL between t and t+1 means that at

least one cohort is experiencing a *decline* in cohort survival from birth to age x when compared to its counterpart born one year earlier.

CAL is well suited to study the impact of a period shock on cohort survival precisely because it summarizes cohort survival probabilities in a population. By contrast with cohort life expectancy, which requires forecasts when considering cohorts that are not yet extinct, CAL does not rely on forecasts when estimating current levels.[6] This is advantageous for the purpose of our study given uncertainties about future mortality patterns in the post-Covid era.

In this paper, we will apply this approach to countries of the HMD that have sufficient historical data to calculate CAL, including Australia, Belgium, Canada, Denmark, Finland, France, Iceland, Italy, Norway, Spain, Sweden, Switzerland, the UK, and the US.

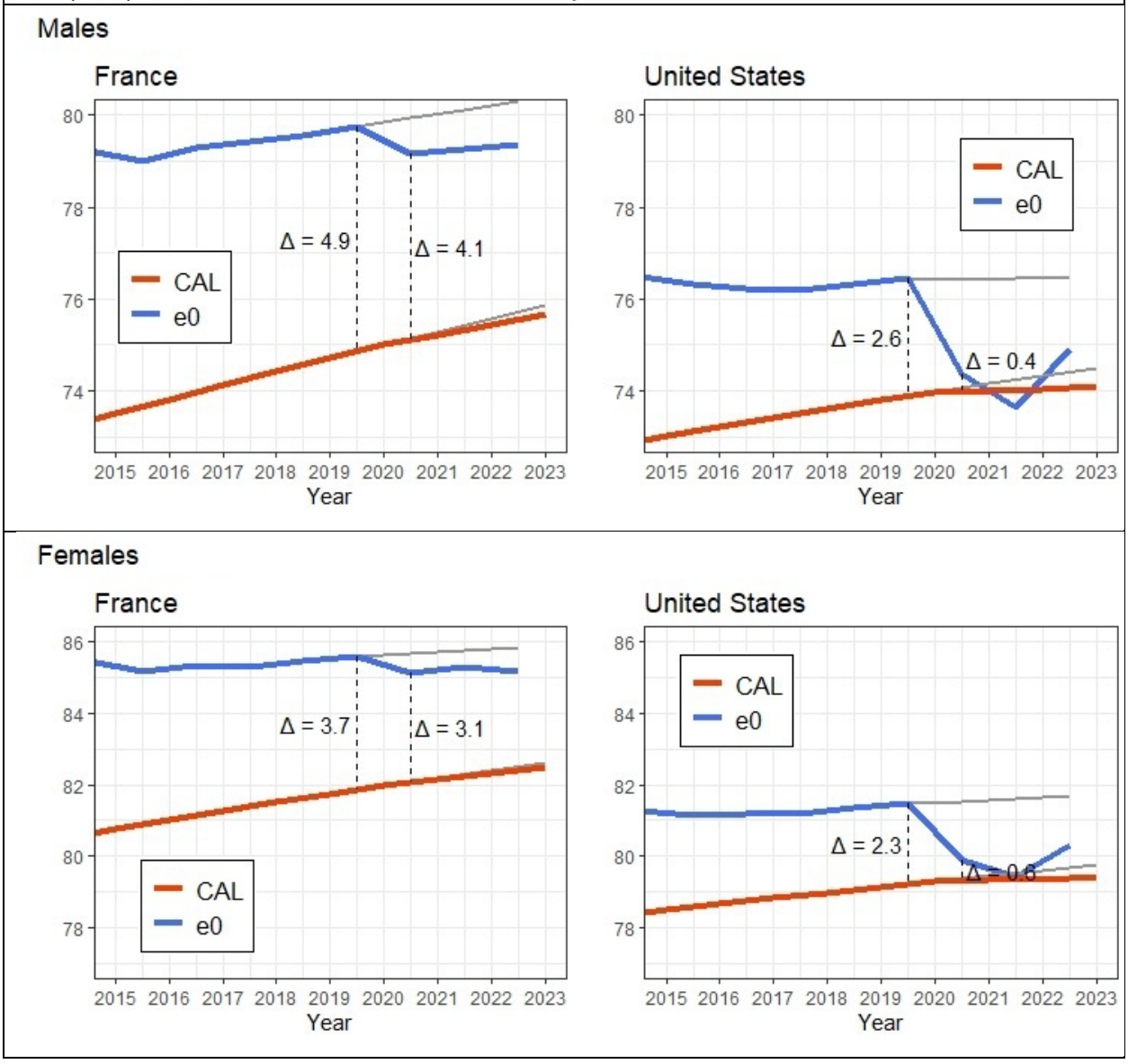
Preliminary results for France and the United States (Figure 1) show that in France, Covid-19 has slowed down progress in CAL, but its impact has not been large enough to generate stagnation or reversals in CAL. In the US, however, the drop in period life expectancy (e_0) was large enough to generate a stagnation in CAL, which means that the increase in mortality in 2020-2022 entirely wiped out past progress in cohort survival.

More broadly, these results illustrate a useful property of CAL, i.e., the fact that the gap between e_0 and CAL at a given time indicates how much drop in e_0 a population can "afford" before seeing past progress in cohort survival being wiped out by a mortality shock.[5]

In the paper, in addition to providing estimates of CAL for 13 countries of the HMD, we will provide uncertainty intervals around both e_0 and CAL central values. We will also examine trends in e_{30} and e_{60} (and their CAL counterparts), in order to provide additional foci on ages above which the impact of COVID-19 was particularly large.

Results will advance our knowledge of the impact of Covid-19 on mortality in various high-income populations, using an innovative approach that highlights the cohort context in which these period mortality shocks took place. With this cohort angle, our study provides additional evidence regarding the unusual nature of the Covid-19 mortality crisis in the United States when compared to other high-income countries.

Figure 1: Trends in period life expectancy at birth and Cross-Sectional Average Length of Life (CAL) in France and the US, 2015-2023, by sex



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