THE EFFECT OF GREAT RECESSION ON EUROPEAN LIFESPAN INEQUALITY

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Abstract. This paper investigates the impact of the Great Recession on Lifespan Inequality across 26 European countries, aiming to clarify the contrasting views between pro-cyclical and counter-cyclical mortality patterns within business cycles. By analyzing mortality data from 2004-2019 and categorizing countries based on the GR's severity, our study employed a Difference-in-Differences methodology to estimate the year-to-year Average Treatment effect on the Treated and the Overall Treatment Effect. We leveraged Callaway and Sant'Anna's (2021) Difference-in-Differences strategy, in order to perform causal effect estimation through their doubly-robust estimators (and also employing their did R library). The findings demonstrate a significant, negative short-to-medium-term impact of the Great Recession on Lifespan Inequality, especially in countries most affected, signifying a beneficial outcome in mortality distribution. These findings were confirmed through two robustness checks, analyzing the effects in separate groups and over the full period. Beyond offering a nuanced perspective on the relationship between economic downturns and Lifespan Inequality, this study underscores the overarching political implications. As economic downturns loom larger and more recurrent, the integration of public health, economic policy, and social justice becomes paramount, especially in strategies promoting equality, inclusivity, and sustainable growth.

1. Introduction

Discussions have reignited about the ties between business cycles and mortality rates, an idea first highlighted by Ogburn and Thomas (1922), who noted that mortality increases (decrease) during economic growth (crisis), a concept named the pro-cyclical pattern. Although overshadowed for a while, this research area was revived by Eyer (1977), coining the "Thomas effect".

However, some scholars suggest that unemployment periods degrade individual health, hinting at a counter-cyclical pattern. This disagreement arises from the simultaneous existence of pro-cyclical (macro-level) and counter-cyclical (micro-level) trends. We propose that these diverging outcomes could stem from differences in the effects on employed and unemployed populations during studies, potentially leading to an overall benefit at the macro level.

Ruhm (2000) reaffirmed Thomas's notion that major causes of death rise with economic growth and fall with recessions. Research across continents has consistently found the 'Thomas Effect', though counter-cyclical patterns have been noticed in France, Sweden, and Australia.

Despite these findings, some remain sceptical of the pro-cyclical connection.

The 2008 Great Recession (GR) allowed a fresh investigation of this, and numerous studies affirmed the pro-cyclical trend, including a causal study by Salinari and Benassi (2022).

Several key reasons emerge for this behavior: the reduced cost of time during a crisis, the health benefits of economic downturns like reduced pollution and stress, and the decreased mobility reducing accident rates and infectious diseases. However, in the long-term or in growing economies, the association may reverse, as seen in India and China.

Our research builds upon Salinari and Benassi's (2022) work, addressing criticisms around the potential existence of an ecological fallacy, i.e., the notion that better average lifespan can coexist with worsened disparities within countries. In this hypothetical situation, it is conceivable that individuals with initially lower mortality rates could possibly benefit from the crisis, thereby consolidating their pre-existing advantage over those with higher initial mortality rates, who might face additional deterioration. This hidden mechanism, undetectable through Life Expectancy (LE), could misattribute a beneficial effect to the Great Recession (GR), disguising inherent harm. An ecological fallacy could thereby challenge the prevailing concept of pro-cyclical mortality trends.

To gain a deeper understanding of economic crises' effects on inequality, our study shifts focus from mortality levels to mortality distribution within countries. We adopt Lifespan Inequality (LI) as our measure, quantifying lifespan variations within a population, to examine the GR's impact on LI in Europe. By investigating whether GR reduces (rises) LI, signifying decreased (increased) dispersion and enhanced (weakened) equality, we aim to uncover if a pro-cyclical link between economy and mortality exists not only "absolutely" but also benefits inequality reduction. In the realm of public health, in fact, the implications of economic downturns extend beyond mere mortality figures. It is imperative to discern whether such crises, while potentially resulting in generalized health benefits, also play a role in bridging the gap of health inequalities. If the GR not only led to reduced mortality rates but also acted as a levelling force, diminishing disparities in health outcomes, then it would offer a more profound testament to the 'Thomas Effect'. This study, thus, seeks to delve deeper into this dimension. By juxtaposing overall mortality benefits with shifts in health inequalities, our research aims to unravel a more holistic view of economic crises' impact on public health.

2. The link between mortality and Lifespan Inequality in the existing literature

Before diving into the nitty-gritty, we should clarify LI's role in tracking life length variations within countries. LE refers to the expected years left for a population at a certain age, usually birth. However, it can hide significant disparities. As conceptual example, overlooking LI while considering only LE might reveal that, despite males generally having lower LE and higher mortality rates, they can outlive females in specific cases (Bergeron-Boucher et al. 2022).

Between 1950 to 2015, LI consistently decreased globally, aligning with the global LE increase; however, there are considerable population and temporal variations (Németh 2017). Some studies point to a positive association between mortality and LI, others suggest a negative correlation (Vigezzi et al. 2022).

In demography and epidemiology, the focus is often on how mortality shocks influence LI, but rarely in the context of economic crises. We know, however, that changes in mortality rates can happen independently from economic cycles, like during drug crises, wars, or natural disasters (Wilmoth et al. 2011; Case and Deaton 2020). Vigezzi et al. (2021) noted that in mortality crises, relative LI often increases but absolute variation decreases, quickly reverting post-crisis.

At the end of the story, there's a lack of research on LI fluctuations in economic cycles.

On the other hand, there have been efforts to explore the link between social health inequalities and the GR, yet these studies mainly looked at socioeconomic health inequality indicators (Heggebø et al. 2019), but rarely used LI as a health inequality measure nor used a causal approach, with some interesting exceptions.

For example, Khang et al. (2005) found no surge in geographic inequalities in mortality post-economic crisis in South Korea. Laliotis and Stavropoulou (2018) identified a non-linear response of mortality to unemployment during Greek crises.

Most literature shows an increase in health inequalities during crises (Bacigalupe and Escolar-Pujolar 2014), though these findings are not definitive. The link between crises and mortality inequality is complex, influenced by the crisis type, socioeconomic indicators, and age groups studied. Bacigalupe and Escolar-Pujolar also state that multidisciplinary efforts can bridge knowledge gaps in understanding crisis and health equality relationships.

In summary, there's a gap regarding the effect of economic crises like the GR on LI dynamics, especially in European context. Our study aims to fill this gap by examining the GR's effects on LI using a causal approach (Difference in Differences – DiD – methodology), focusing on European countries to deepen understanding of how major economic crises may shape LI patterns.

3. Data, peculiarities of the European context, and methodology

We sourced LI metric data from the Human Mortality Database (HMD).

The study focuses on 26 European[1] countries excluding Romania, Luxembourg, Malta, and Cyprus due to data issues and small size. It spans 2004-2019, starting later than the possible 2001 to avoid interference from the 2000-2001 economic crisis (our focus is only on GR).

A key research facet is differentiating countries based on GR impact. Following the categorization proposed by Tapia Granados and Ionides (2017), we used unemployment rate changes from 2007-2010 to classify countries into three groups: Group 1 (GR not experienced or mild, unemployment rate change <2%), Group 2 (moderate GR, rate change 2%-4%), and Group 3 (severe GR, rate change >4%). Group 1 was the control group, while groups 2 and 3 were treatment groups.

The study aims to estimate the impact of the GR on LI in Europe by comparing the control group (Group 1) to the combined treatment groups (Groups 2 + 3).

Note that the outcome should be seen as a conservative measure since some countries belonging to Group 1 might have mildly affected countries.

Lastly, the unemployment rate helped identify the crisis's onset in 2009. Comprehensive checks by Salinari and Benassi (2022) confirmed the validity of this framework.

We leveraged the age at death standard deviation, designated LI_x, as the LI measure, formally:

$$LI_x = \sqrt{\sum_{j=x}^{\omega} \frac{d_j}{l_x}\left(j + a_j\right)^2 - (x + e_x)^2}\,. \tag{1}$$

This was rooted in Shkolnikov and Andreev's formula (2010). Here, ω is the maximum age at death observed in the life table, d_x represents the count of observed deaths between the age interval of x and $x + 1$, l_x denotes the count of individuals who have survived up to age x. The term $x + a_x$ represents the age at death, the variable on which we are computing the LI, for individuals who die at age x (with a_x denoting the lifespan at age x for those individuals), and e_x represents the average life expectancy at age x. In accordance with the standard approach used on studies concerning lifespan inequalities, we have opted for LI at birth. From now on, therefore, we will refer to LI as LI_0.

The assignment mechanism $W(i)$ connects each country i to a treatment indicator (0 or 1), establishing whether it underwent a GR or not. For every country i at time t, we define the counterfactual $LI_t^{W(i)}$, showing LI's distribution at t for countries exposed or not exposed to the GR. To infer the unobserved potential outcome, we

[1] Europe is here intended as a continent.

employ the Parallel Trend Assumption (PTA), which suggests that the missing counterfactual distribution (the one of treated countries during the post-treatment period) are identical to those observed in untreated countries in the same periods. Using this, we can calculate the Average Treatment effect on the Treated (ATT), namely:

$$ATT = E(LI_t^1 - LI_t^0 | W = 1) = \\ E(LI_t - LI_{t-1} | W = 1) - E(LI_t - LI_{t-1} | W = 0) \quad (2)$$

In terms of estimation of ATT, our study explores Callaway and Sant'Anna's (2021) novel DiD strategy that accommodates treatment effect heterogeneity and different initiation timings. The ATT becomes dependent on the treatment's starting year and the estimation period, yielding $ATT(g, t)$ or the Group-Time Average Treatment Effect. In our case, nevertheless, the advantage of using this methodology does not lie in this, since all countries start being treated in the same year (2009). Rather, the real feature that motivated us to use Callaway and Sant'Anna's technique is the estimation method, which differs from the more traditional approach (the so-called Two-Way Fixed Effects). We are referring to the Doubly-Robust (DR) estimation. We therefore estimate $ATT(2009, t)$ via DR estimators.

We also integrate a measure capturing the Overall Treatment Effect (OTE) as an arithmetic mean of all $ATT(2009, t)$ calculated post-treatment.

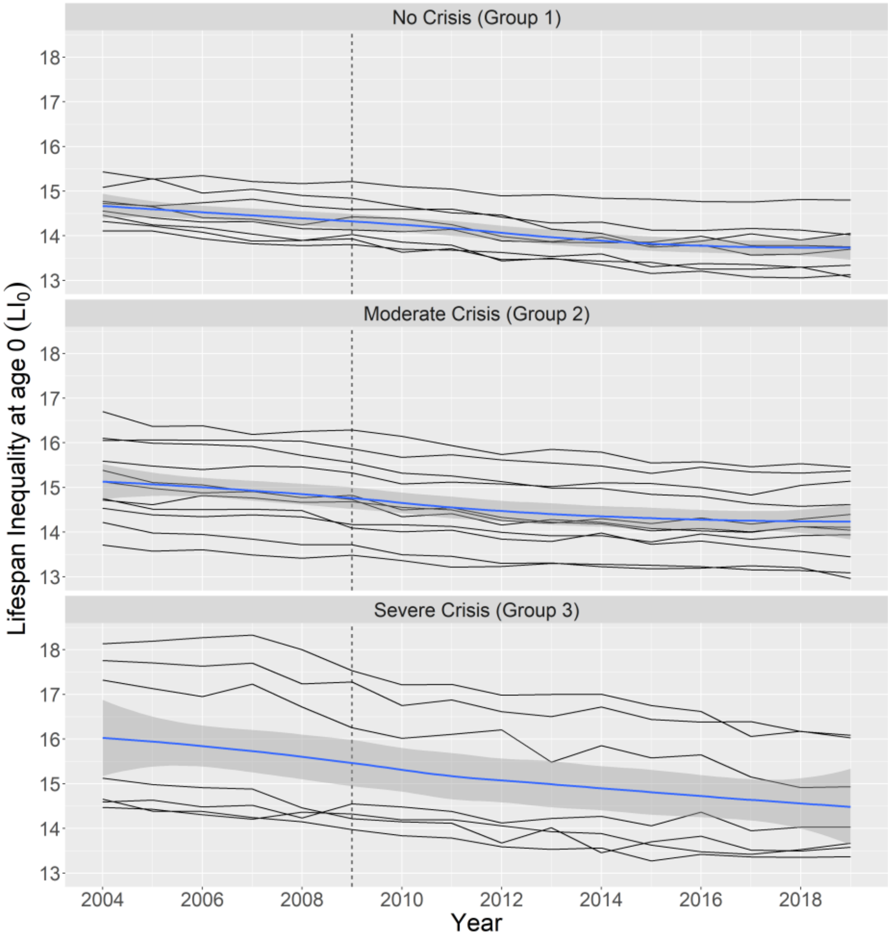
Confidence intervals on both $ATT(2009, t)$ and OTE are constructed through bootstrapping as suggested by Callaway and Sant'Anna (2021). We use their R did library for our analysis.

Lastly, we performed two robustness checks following $ATT(2009, t)$ estimation between Group 1 and Groups 2 + 3. First, we separately assessed the average treatment effect on Group 1 versus Group 2, and Group 1 versus Group 3 (Robustness Check 1, RC1). Second, we aimed to validate the year-over-year findings by examining estimations across the full period computing OTE (Robustness Check 2, RC2). We anticipate comparable causal effects across these checks and variations in the effect's strength based on whether Group 2 or 3 is the treatment group.

4. Results

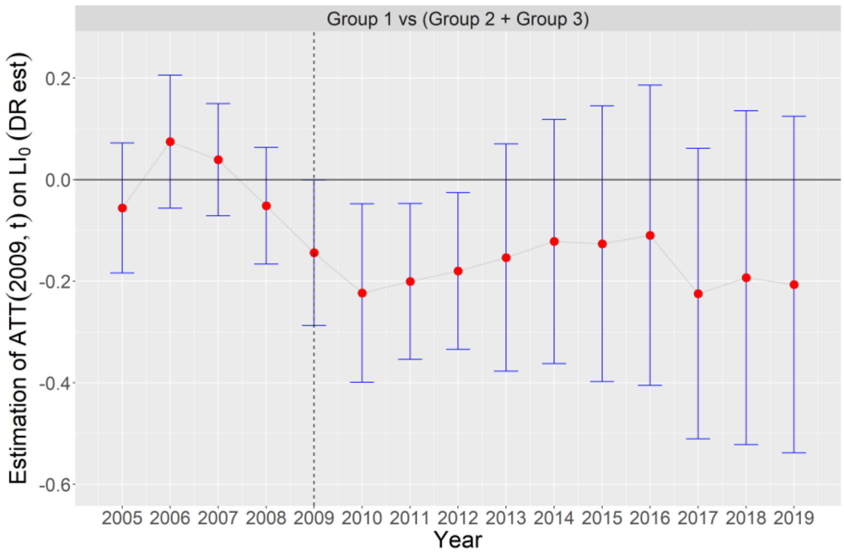
Our study aims to examine a specific phenomenon over time, as shown in Figure 1. The consistent time trends across all groups reaffirm the non-rejection of PTA and reflect common patterns in life expectancy. Differences in LI levels among the groups, non-random across European nations, justify the use of DiD strategy. Group 3, though smaller and variable, will offer valuable insight for robustness checks.

Figure 1 – *Progression of Lifespan Inequality at birth from 2004 to 2019 across 26 European nations.*



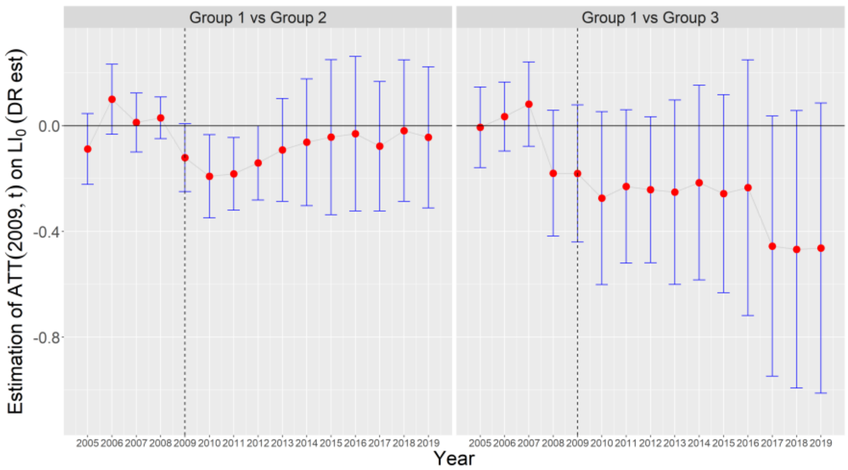
Note that countries are categorized into three groups (No Crisis, Moderate Crisis, Severe Crisis), determined by the unemployment rate shift during pre-crisis and crisis periods.
The year 2009, marked by a vertical dotted line, signifies the crisis onset.
The blue dashed line, an estimate of local polynomial regression (LOESS), provides a visual estimate, with the 95% confidence interval shown as a surrounding grey area.
Source: Author's computation on Human Mortality Database (HMD - www.mortality.org).

Figure 2 – *The year-to-year Effect of the Great Recession on the European Lifespan Inequality.*



Estimation of ATT(2009,t) with Doubly-Robust estimator.
Source: Author's computation on Human Mortality Database (HMD - www.mortality.org).

Figure 3 – *Robustness check of the year-to-year effect of the Great Recession on the European Lifespan Inequality (RC1).*



Estimations of ATT(2009,t) with Doubly-Robust estimator, according to the level of severity of the crisis.
Source: Author's computation on Human Mortality Database (HMD - www.mortality.org).

Our key finding, illustrated in Figure 2, demonstrates a significant, negative, three-year impact of GR on LI, suggesting benefits in mortality distribution for affected countries. The PTA, although untestable, doesn't reject this view, evidenced by non-significant ATT in pre-crisis years, and consistently negative post-treatment ATT. This trend cannot be purely coincidental, as its probability is less than 0.001.[2]

Robustness was assessed through a repeated analysis in which we considered Groups 2 and 3 as the treatment group separately (RC1), with results aligning with our primary outcome (Figure 3). The treatment effect was stronger in Group 1 vs Group 3 and sustained over time, while Group 2 began reverting to pre-crisis levels after three years. Regardless, no positive effect was observed post-treatment. Statistical insignificance in Group 1 vs Group 3 could be due to Group 3's smaller size and higher variability. In any case, this circumstance was also deepened through the second robustness check.

An additional robustness check (RC2), in fact, was performed to evaluate GR's long-term impact on mortality inequality (our OTE), as shown in Figure 4. Results confirm our initial finding of a significant negative effect in the primary comparison and a relationship between crisis intensity and effect magnitude. Group 3 demonstrated (weak) statistical significance, supporting our primary outcome. The non-significant comparison of Group 1 and Group 2 also substantiates our findings: although the annual effects in the primary comparison (Group 1 vs. Group 2 +3) and first RC1 test (Group 1 vs. Group 2) are significant, their brief duration limits overall significance. However, the second RC1 test (Group 1 vs. Group 3) showed greater intensity and duration (albeit not yearly significant), thus appearing significant over the entire period.

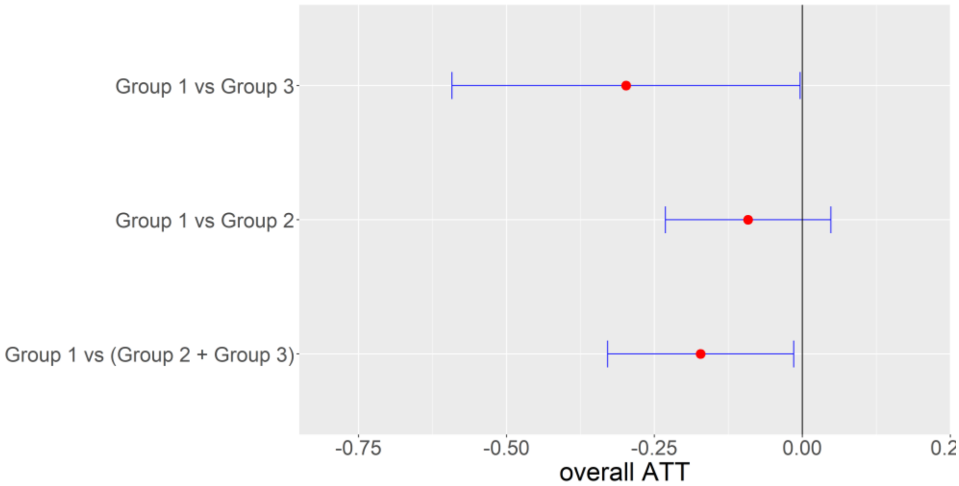
To conclude this Results section, despite group variations, GR reduced Lifespan Inequality in Europe.

5. Conclusions

Our study identifies a statistically significant, short-to-medium-term negative impact of the Great Recession on Lifespan Inequality in Europe, particularly in severely affected countries. This aligns with Salinari and Benassi's (2022) findings. "Negative" here refers to its mathematical implication, indicating beneficial health outcomes via reduced survival rate disparities. The robustness of this result was confirmed through two checks, comparing different groups of countries and analyzing the full period.

[2] Which is the result of 0.5^{11}. 0.5 is meant as the probability of obtaining a negative (positive) sign effect, such as a fair coin toss; 11 is the number of post-crisis years observed. This value is an approximation, which can be interpreted as a rough p-value, at least from an intuitive perspective.

Figure 4 – *OTE (2004-2019) of the Great Recession on the European Lifespan Inequality (RC2).*



Estimations of the overall ATT with two different models, according to the level of severity of the crisis.
Source: Author's computation on Human Mortality Database (HMD - www.mortality.org).

Our findings offer a fresh perspective on the business cycle's impact on mortality patterns, a subject often overlooked in favor of absolute mortality studies. Unlike others, our study directly addresses mortality variability, bypassing the need and risk of selecting a mediating variable connecting economic crisis and inequalities (since a potentially infinite number of socioeconomic variables could be addressed). This protects us from arbitrary choices and further technical complications, allowing to sharply focus on the causal effect of the crisis on inequalities in mortality.

Our research supports a positive correlation between mortality and lifespan inequality (thus, a negative link between LE and LI), resolving contradictions in existing literature. On top of that, we adopt a causal approach, establishing a causal link between Great Recession and Lifespan Inequality, which has withstood robustness tests, enhancing its significance.

To conclude, the realization that economic downturns can foster not only improved public health levels but also more equitable health distributions carries profound policy implications. Such insights necessitate a recalibration of economic policies, prioritizing social justice and well-being alongside pure economic growth. Given the conventional emphasis on economic growth as a prime governmental objective, these findings advocate for public health and welfare strategies that enshrine equality at their core. The intent should be to mitigate health disparities and champion universal healthcare access. Recognizing the causal interplay between economic conditions and health equity underscores the need for equitable, inclusive, and sustainable growth paradigms, linking economic cycles intrinsically to health disparities.

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