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The great recession and lifespan inequality: causal insights from the European laboratory

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Abstract
This paper investigates the pro-cyclical relationship between business cycles and Lifespan Inequality, specifically focusing on the causal effect of the 2008 Great Recession on this measure across 26 European countries. To the best of our knowledge, the research is the first to prioritize economic crises as a key determinant in assessing life expectancy disparities. The study employed a Difference in Differences methodology, categorizing countries into treatment and control groups based on their exposure to the Great Recession, measured through variations in unemployment rates. This analysis revealed a significant, beneficial effect of the Great Recession on Lifespan Inequality for approximately three years, signifying a reduction in lifespan disparities and suggesting potential health benefits in affected countries (in line with the so-called Thomas Effect). The manifestation of this effect aligns congruently with the intensity of the crisis endured by individual countries.

Keywords Lifespan inequality · Population inequality · Great recession · Difference in differences · Thomas effect · Business cycle

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1 Introduction

The relationship between business cycles and mortality has been debated for more than a century (Cohen and Felson, 1979; Kasl, 1979; Gravelle et al., 1981; Wagstaff, 1985), since the seminal contribution of Ogburn and Thomas (1922). This literature documents a predominantly pro-cyclical pattern, whereby mortality tends to increase during economic expansions and decline during recessions. Eyer (1977) later conceptualized this phenomenon as the "Thomas Effect", a finding that was subsequently corroborated by Ruhm (2000), who showed that mortality from major causes rises in periods of economic growth and falls during downturns.

Over the past three decades, a large body of empirical evidence has confirmed the existence of this relationship across advanced economies, using a variety of data sources and methodological approaches. In Europe, pro-cyclical mortality patterns have been documented in Germany (Neumayer 2004), Spain (Tapia Granados 2005), France (Buchmueller, Jusot, and Grignon, 2007), and England and Wales (Tapia Granados 2012). Similar evidence has emerged from studies on South Korea (Khang et al. 2005), Japan (Tapia Granados 2008), the Asia–Pacific region (Lin 2009), the United States (Tapia Granados and Diez Roux 2009), Canada (Ariizumi and Schirle 2012), and New Zealand (Greenaway-McGrevy 2021). At a more aggregated level, the Thomas Effect has also been observed in cross-country analyses covering OECD nations (Gerdtham and Ruhm 2006) and the European Union as a whole (Toffolutti and Suhrcke 2014).

The 2008 Great Recession provides a particularly informative setting to revisit the Thomas Effect, due to the significant heterogeneity in its intensity across countries. A growing empirical literature has documented pro-cyclical mortality patterns during this period (Toffolutti and Suhrcke 2014; Regidor et al. 2016; Tapia Granados and Ionides 2017; Baumbach and Gulis 2014; Ballester et al. 2019; Cervini-Plá and Vall-Castelló, 2021). Focusing on the European context, Salinari and Benassi (2022) showed that the mortality decline associated with the Great Recession persisted beyond the immediate crisis years. Recent evidence for the United States further shows that the Great Recession was causally linked with significant mortality declines and welfare gains (Finkelstein et al. 2024 and 2025).

Despite its counter-intuitive nature, the Thomas Effect has been rationalized through several complementary mechanisms operating at both the individual and macroeconomic levels. During economic downturns, reductions in working hours and job intensity may lead to lower work-related stress and more time allocated to health-promoting activities such as medical care, rest, and physical exercise (Tapia Granados 2005; Catalano et al. 2011). These behavioural adjustments have been linked to short-term declines in mortality, particularly from cardiovascular causes (Ruhm 2000, 2008). Recessions are also associated with reductions in risky behaviours, including smoking and alcohol consumption, as well as fewer workplace and traffic accidents. At the macro level, lower economic activity tends to reduce environmental pollution, contributing further to mortality declines. In this regard, recent evidence for the United States attributes an important share of the Great Recession mortality decline to reductions in air pollution and traffic-related externalities (Finkelstein et al. 2024 and 2025), patterns that appear broadly consistent with evidence from the COVID-19 period across several countries (Basellini et al. 2021; Santos et al. 2021; Antonio-Villa et al. 2022; Díaz Ramírez et al. 2022).

Although the empirical evidence for advanced economies largely supports the Thomas Effect, the literature is not unanimous. Some studies, in fact, have reported counter-cyclical mortality patterns in high-income settings, including France (Brüning and Thuilliez 2019), Sweden (Gerdtham and Johannesson 2005), and Australia (Khemka and Roberts 2015). However, counter-cyclical relationships appear more frequently in developing countries, where institutional contexts and baseline health conditions differ substantially; evidence from India (Bhalotra 2010) and China (Sun et al. 2021) suggests that economic downturns in these settings do not translate into the same mortality dynamics observed in advanced economies.

Beyond these mixed empirical findings, the Thomas Effect has also been subject to sustained criticism. A first line of critique stems from micro-level evidence showing that economic downturns are associated with worsening health and psychosocial outcomes among unemployed individuals and other vulnerable groups (Falagas et al. 2009; Stuckler et al. 2009; Kentikelenis et al. 2011; Stuckler and Basu 2013; Karanikolos et al. 2013). These findings appear, at first glance, to conflict with aggregate-level evidence of declining mortality during recessions. However, as noted by Tapia Granados (2005), analyses focusing exclusively on the unemployed may suffer from selection bias and fail to capture health dynamics affecting the population as a whole, particularly among those who remain employed.

A second and closely related criticism concerns the potential presence of an ecological fallacy (Catalano and Bellows 2005), which is closely connected to our work. Aggregate associations between economic conditions and mortality may conceal heterogeneous effects across socioeconomic groups, such that improvements in overall mortality could coexist with deteriorating health outcomes among disadvantaged subpopulations. In this case, procyclical mortality patterns observed at the macro level would not necessarily imply broad-based health benefits of recessions. However, existing evidence on this issue remains mixed. While some studies suggest that the health effects of economic downturns vary across socioeconomic strata, others find that mortality reductions during recessions are not confined to specific groups but instead affect the population more broadly, with differences emerging mainly in the magnitude rather than in the direction of the effect (Regidor et al. 2016; Stevens et al. 2015). As a result, the extent to which the Thomas Effect reflects a genuine population-wide phenomenon or an artefact of aggregation remains unresolved. This unresolved debate motivates our work.

A central contribution of our approach lies in the choice of the outcome variable, which is explicitly designed to capture distributional changes in mortality rather than shifts in average levels alone. In particular, we focus on Lifespan Inequality, a measure of the variability in the number of life years lost at death, computed at birth, which summarizes how unequally longevity is distributed within a population. By doing so, we provide indirect but informative evidence on whether health improvements during economic downturns were broadly shared across the population or concentrated among specific groups.

This analysis is conducted within the European context, which offers a particularly informative setting insofar as the Great Recession unfolded as a common macroeconomic shock across countries sharing broadly comparable institutional and welfare arrangements, while exhibiting marked heterogeneity in the severity of the economic contraction.

Our primary objective is therefore to assess the impact of the Great Recession on Lifespan Inequality across European countries. Exploiting cross-country variation in crisis severity within a Difference-in-Differences framework, we examine whether—and in which

direction—the crisis reshaped lifespan disparities, thereby contributing new evidence to the debate on the population-wide nature of the Thomas Effect.

2 Lifespan inequality as a measure of inequality in life expectancy: a brief overview

Life expectancy represents the average number of years remaining for a given cohort at a specific age (typically at birth). While valuable, focusing solely on this metric can overlook lifespan disparities within the population. An increase in life expectancy could exacerbate inequality if survival improvements mainly benefit groups with already longer lifespans. Conversely, a reduction in inequality might occur if disadvantaged groups experience significant survival improvements. To fully understand mortality dynamics during crises, exploring Lifespan Inequality is crucial.

Since the 1950s, there has been a consistent global decline in Lifespan Inequality, despite occasional opposite trends, especially in elderly populations (Edwards and Tuljapurkar 2005; Permanyer and Scholl 2019). This decline aligns with the well-established pattern of global life expectancy growth, as, generally, the relationship between life expectancy and Lifespan Inequality is negative (Wilmoth and Horiuchi 1999; Kannisto, 2001; Vaupel, Zhang and van Raalte, 2011; Colchero et al. 2016; Sasson 2016; Brønnum-Hansen 2017), even though the picture is more complex: men and lower socioeconomic groups have higher variation than women and higher social groups, different socioeconomic groups show divergent trends of lifespan variation over time, as well as high income and middle-low income countries and areas characterised by different deprivation levels (Wilmoth and Horiuchi 1999; Edwards and Tuljapurkar 2005; Smits and Monden 2009; Engelman et al. 2010; Vaupel et al. 2011; Gillespie et al. 2014; Sasson 2016; Permanyer, 2018; Seaman et al. 2019; Aburto et al. 2020). The relationship between life expectancy and Lifespan Inequality might differ even by historical contexts (Smits and Monden 2009) and characteristics of the data source (Németh 2017). Recent findings reveal positive correlations in isolated cases, linked to specific age-specific mortality changes during crises and improvements in old age (van Raalte et al. 2018; Aburto et al. 2020). Additionally, variations in mortality trends may be independent (Aburto and van Raalte 2018). Finally, a multifaceted relationship emerged during mortality crises like epidemics and famines (Vigezzi et al. 2022).

In this paper, we focus on Lifespan Inequality during *economic* crises, a topic that, to the best of our knowledge, has received limited attention in existing literature. Most studies examine mortality or health disparities across social groups (e.g. employed vs. unemployed, rich vs. poor; Marmot, 2005) during economic downturns. These studies generally conclude that inequality rises during such periods (Yun et al. 2005; Brønnum-Hansen et al. 2015; Maynou and Saez 2016; Heggebø et al. 2019), with some exceptions (e.g. Palència et al. 2020).

However, this approach emphasizes disparities between different groups but overlooks inequalities within each group. For example, if we compare the health status of highly educated individuals with that of less educated ones and find that the gap widens during a crisis, it doesn't necessarily mean overall population inequalities are increasing. It's possible that within-group inequality is decreasing simultaneously.

To address this, here we examine Lifespan Inequality across the entire population. Indices such as Lifespan Inequality provide a comprehensive assessment of how mortality inequality is evolving across the entire population. In this context, our study investigates the impact of the Great Recession on Lifespan Inequality using the Difference in Differences methodology. By focusing on European countries, we aim to fill the literature gap and to contribute to a better understanding of how economic crises shape Lifespan Inequality patterns.

3 Analysis' strategy and methodological aspects

3.1 Measuring lifespan inequality and the data

Lifespan Inequality can be measured using various indexes, each with distinct properties. Despite differences, these measures are strongly correlated and show similar sensitivity patterns across age groups (van Raalte and Caswell 2013). We chose to employ Lifetime losses, denoted as e-dagger ($e_x^\dagger$), to measure Lifespan Inequality for a specific age x. This measure, rooted in Keyfitz"s (2005) idea that every death shortens life, emerged from a novel decomposition of life expectancy changes by Vaupel and Romo (2003). E-dagger not only serves as an index of life-table dispersion but also holds significant implications for public health because it represents the average life expectancy losses due to death. It is expressed formally as:

$$LI_x = e_x^\dagger = \frac{1}{l_x}\sum_{y=x}^{\omega-1}\left[d_y\left(e_{y+1}+1-a_y\right)\right] + \frac{l_\omega}{2l_x}e_\omega, \tag{1}$$

where ω is the maximum age at death observed in the life table, l_x denotes the count of individuals who have survived up to age x, d_x represents the count of observed deaths between the age interval of x and x+1, a_x is the average number of years lived within x and x+1 for people dying at age x and e_x represents the average life expectancy at age x.

To address our research question, we compared Lifespan Inequality at age 0 (LI_0 or $e_0^\dagger$) between control (no crisis) and treatment (crisis) groups using the Difference in Differences strategy. From now on, we"ll refer to LI_0 as LI. Data were extracted from the Human Mortality Database (HMD, 2023). The analysis included 26 European countries, excluding Romania due to data unavailability and Luxembourg, Malta and Cyprus due to small size. We analysed data from 2004 to 2019, starting in 2004 to mitigate potential disruptions caused by the 2000–2001 economic crisis while ensuring an adequate number of pre-treatment observations.

3.2 Country classification according to the crisis severity

We start by differentiating the countries into treatment and control groups based on the severity of the Great Recession"s impact. Following Tapia Granados and Ionides (2017), we classified countries using the variation in unemployment rate between 2007 and 2010 and we divided them into tertiles to enhance comparability among the three groups. Group 1 (Austria, Belgium, Finland, France, Germany, the Netherlands, Norway, Poland and Switzerland) experienced no or mild recession, Group 2 (Bulgaria, Croatia, the Czech Republic,

Italy, Portugal, Slovenia, Sweden and Great Britain) faced moderate recession and Group 3 (Denmark, Estonia, Greece, Hungary, Ireland, Latvia, Lithuania, Slovakia and Spain) endured severe recession.

In our analysis, we will first compare the evolution of Lifespan Inequality in Group 1, our control group, with that of the two remaining Groups (2 and 3), which together form our treatment group. We will then make our analysis more specific by comparing Group 1 with Group 2 alone and then Group 1 with Group 3 alone. These two subsequent analyses will serve to assess the robustness of our conclusions. The countries belonging to group 3 have, in fact, been hit harder by the crisis. We therefore expect the effects on Lifespan Inequality to be more intense here.

It"s important to note that in Group 1, some countries may have experienced mild effects of the crisis. Therefore, the effect measured in our analysis should be interpreted conservatively. Furthermore, the unemployment rate serves as a valuable indicator for pinpointing the crisis"s onset in the countries studied, specifically in 2009.

The use of unemployment as the main indicator of crisis severity is consistent with the literature on business cycles and mortality (Laliotis and Stavropoulou, 2018). The unemployment rate is particularly well suited to our research design because it captures the point at which an economic crisis translates into labour-market disruption and, more broadly, into population-level socioeconomic exposure. This is especially relevant in studies of population health and mortality, where the timing and intensity of the shock as experienced by the population are central. Moreover, unemployment is a lagged indicator of the business cycle: it typically rises after the initial downturn and declines only gradually during the recovery (Mitchell 1923; Hamilton 2005). For this reason, it may capture the diffusion of the crisis to the population more directly than indicators reacting earlier to financial or output contractions. This rationale is also supported by Salinari and Benassi (2022), who explicitly assessed the validity of unemployment as a discriminating variable for classifying European countries according to the severity of the Great Recession.

However, to assess whether our findings are sensitive to the choice of unemployment as the indicator of crisis severity, we repeated the full analysis using an alternative GDP-based treatment definition, constructed according to the same tertile-based logic described above. This exercise is intended to test the robustness of the estimated effects to an alternative measure of macroeconomic exposure (see the *Supplementary Materials section* for details).

3.3 The difference in differences approach

To investigate our research question, we employed the Difference in Differences (DID) methodology to compare Lifespan Inequality (LI) before and after the Great Recession, distinguishing between treated and control groups. This methodological approach allows us to mitigate the influence of confounding factors. By comparing pre- and post-crisis LI changes, we estimate the Average Treatment Effect on the Treated (ATT), relying on the Parallel Trend Assumption, which assumes that treated countries would follow a trend similar to controls if not for the crisis.

In recent years, Two-Way Fixed Effects models have gained popularity in analysing inequality (see, among others, Rao et al. 2014; Engzell, Frey and Verhagen, 2020; Yu and Chang, 2021). A traditional Two-Way Fixed Effects model typically divides the period into pre- and post-treatment phases to estimate the ATT. However, since we aim not only to

gauge the ATT but also to understand its temporal evolution, we employ a modified Two-Way Fixed Effects Model capable of assessing the Dynamic Effect of the Great Recession on LI. The model is specified as follows:

$$LI_{c,t} = \alpha + \varphi_c + \lambda_t + \sum_{t=2005}^{2019} \delta_t GR_{c,t} + \varepsilon_{c,t} \tag{2}$$

where α is the intercept, φ_c are country fixed effects, λ_t are period fixed effects, $GR_{c,t}$ is a binary variable that takes 1 if country c experienced the crisis and the country is observed in year t, and δ_t is the ATT measured in year *t*, which we refer to as the Dynamic Effect of the Great Recession on European Lifespan Inequality. In such a model, a reference year is necessary to compare Lifespan Inequality. We use 2004, the first year of the series, as the reference year. If no significant differences between the control and treatment groups existed prior to the crisis but emerged thereafter, it suggests that both groups were following similar trends before the crisis, which diverged afterward. Such a scenario would support the Parallel Trend Assumption and strengthen the validity of our results. To further validate our findings, we employed clustered standard errors and conduct robustness checks separately on Group 2 and Group 3.

4 Results

4.1 Descriptive insight and main result

Figure 1 illustrates the evolution of Lifespan Inequality from 2004 to 2019 across the three country groups under scrutiny: those experiencing mild, moderate and severe crises. A first descriptive insight emerging from the figure is that Lifespan Inequality exhibits a broadly smooth and approximately linear downward trend over time in all three groups. This pattern suggests the absence of abrupt changes or structural breaks in the pre-crisis period and indicates that long-run dynamics in lifespan dispersion were already in place before the onset of the Great Recession. At the same time, some differences across groups are visible. In particular, countries belonging to Group 3 (severe crisis) display a higher degree of variability around the common trend, both before and after the crisis. This greater dispersion likely reflects the stronger heterogeneity in economic conditions and demographic responses among countries more severely affected by the Great Recession. While such graphical evidence cannot formally validate the identifying assumption underlying the difference-in-differences framework, it offers an intuitive justification for modeling the evolution of Lifespan Inequality using linear time trends and for interpreting subsequent deviations from these trends in the post-crisis period.

Figure 2 shows, for each year, the estimated causal effect of the Great Recession on Lifespan Inequality (δ_t), together with the corresponding confidence intervals (indicated by solid horizontal error lines for 95% confidence and dashed lines for 90% confidence). The corresponding estimates are also reported in Table 1. The analysis contrasts countries that were not significantly affected by the crisis (Group 1) with those that experienced the Great Recession either moderately (Group 2) or severely (Group 3). The coefficients should be

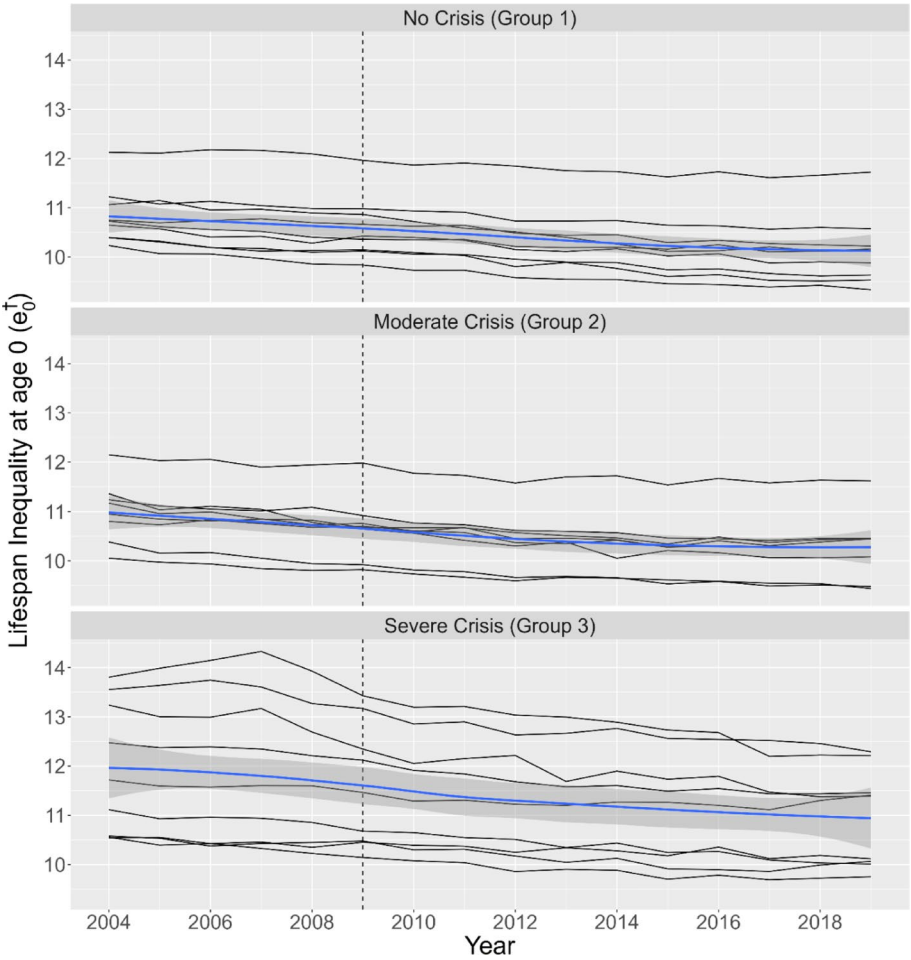

Fig. 1 Evolution of Lifespan Inequality at age 0 from 2004 to 2019 in 26 European countries. *Note*: Countries have been classified into three main groups (No Crisis, Moderate Crisis and Severe Crisis) based on the change of unemployment rate across the Great Recession: Group 1 below the first tertile; Group 2 between the first and second tertiles; Group 3 above the second tertile. The vertical dashed line indicates the initial year of the crisis (2009). The blue dashed line has been estimated through local polynomial regression (LOESS), whereas the grey area represents the 95% confidence interval around this estimate. Negative estimates indicate a stronger decline in Lifespan Inequality in treated countries relative to the control group. *Source*: Our elaboration based on Human Mortality Database (HMD)

interpreted as year-specific difference-in-differences estimates: negative values indicate that Lifespan Inequality declined more in the treated countries than in the control group (good), whereas positive values would indicate a relative increase in Lifespan Inequality among treated countries (bad).

A clear temporal pattern emerges from the figure. In the pre-crisis period, the estimated coefficients are small in magnitude, statistically insignificant, and display no systematic trend, suggesting similar evolutions of Lifespan Inequality across the different groups of countries, irrespective of the fact that these groups would later experience the crisis with

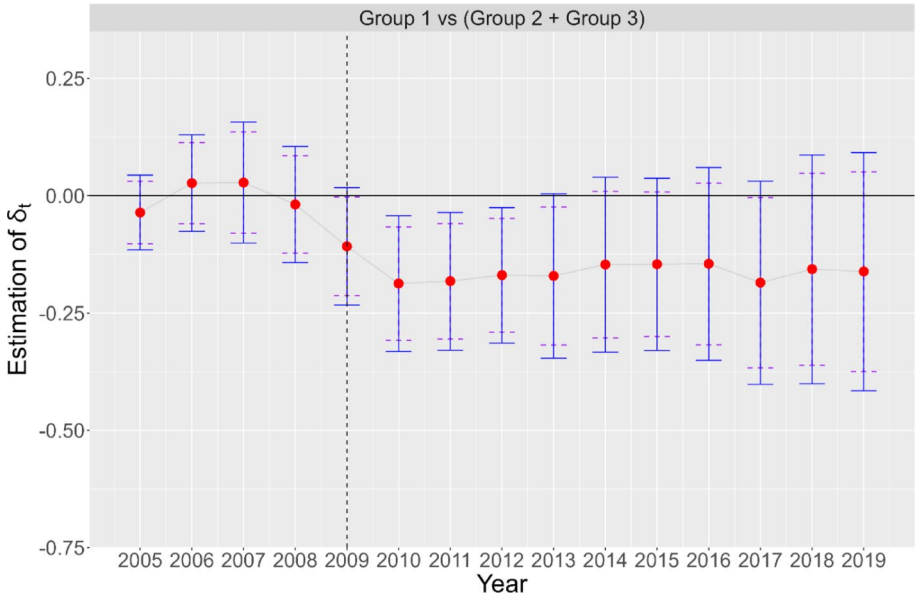

Fig. 2 Main Result. The Dynamic Effect of the Great Recession on the European Lifespan Inequality. *Note*: Estimation of the Average Treatment Effect on the Treated (ATT, i.e. δ_t of Model 2). Countries have been classified into three main groups (No Crisis, Moderate Crisis and Severe Crisis) based on the change of unemployment rate across the Great Recession: Group 1 below the first tertile; Group 2 between the first and second tertiles; Group 3 above the second tertile. The vertical dashed line indicates the initial year of the crisis (2009). Horizontal error lines: Solid 95% CI; Dashed 90% CI. Negative estimates indicate a stronger decline in Lifespan Inequality in the moderate- or severe-crisis group relative to the control group. *Source*: Our elaboration based on Human Mortality Database (HMD)

differing intensity. Following the crisis, the estimates turn negative and remain so for several consecutive years, indicating a relative reduction in Lifespan Inequality in countries more severely affected by the downturn. The fact that the post-crisis estimates are consistently negative, and statistically significant in the years immediately following the shock, represents the main empirical evidence in support of a crisis-related reduction in lifespan dispersion.

The largest estimated effects are observed in the first three post-crisis years, pointing to a short- to medium-term decline in lifespan dispersion associated with the Great Recession. Beyond this initial phase, the estimated coefficients remain predominantly negative, although they are not always statistically significant, suggesting a more persistent—but weaker—effect over time. Taken together, these results indicate that the Great Recession was associated not only with stronger reduction in average mortality, as documented in previous studies (Salinari and Benassi 2022), but also with a temporary reduction of lifespan inequality in affected countries.

The results are consistent with the parallel trends assumption, namely the idea that, in the absence of the Great Recession, countries that were more severely affected by the crisis would have exhibited an evolution of Lifespan Inequality similar to that observed in less affected countries. While this assumption is inherently untestable, the absence of statistically significant differences and systematic patterns in the estimated coefficients during the pre-

Table 1 Main Result

TimeLabel	Year	ATT	p_value	LCI_95	UCI_95	LCI_90	UCI_90
Time −4	2005	−0.04	0.38	−0.12	0.04	−0.10	0.03
Time −3	2006	0.03	0.61	−0.08	0.13	−0.06	0.11
Time −2	2007	0.03	0.67	−0.10	0.16	−0.08	0.14
Time −1	2008	−0.02	0.77	−0.14	0.11	−0.12	0.09
Time 0	2009	**−0.11**·	0.09	−0.23	0.02	−0.21	−0.00
Time 1	2010	**−0.19***	0.01	−0.33	−0.04	−0.31	−0.07
Time 2	2011	**−0.18***	0.01	−0.33	−0.04	−0.31	−0.06
Time 3	2012	**−0.17***	0.02	−0.31	−0.03	−0.29	−0.05
Time 4	2013	**−0.17.**	0.06	−0.35	0.00	−0.32	−0.02
Time 5	2014	−0.15	0.12	−0.33	0.04	−0.30	0.01
Time 6	2015	−0.15	0.12	−0.33	0.04	−0.30	0.01
Time 7	2016	−0.15	0.17	−0.35	0.06	−0.32	0.03
Time 8	2017	**−0.19**·	0.09	−0.40	0.03	−0.37	−0.00
Time 9	2018	−0.16	0.21	−0.40	0.09	−0.36	0.05
Time 10	2019	−0.16	0.21	−0.42	0.09	−0.37	0.05

The Dynamic Effect of the Great Recession on the European Lifespan Inequality

The table reports the dynamic Average Treatment Effects on the Treated (ATT) from the difference-in-differences specification comparing Group 1 (control) with the combined set of countries in Groups 2 and 3 (treated). Estimates are reported for each year relative to the onset of the Great Recession. LCI and UCI denote the lower and upper bounds of the confidence intervals, respectively, computed at the 95% and 90% confidence levels

Significance codes are defined as follows: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Source: Our elaboration based on Human Mortality Database (HMD)

crisis period provides no evidence against it. This interpretation is further supported when considering the 90% confidence intervals. By contrast, the post-treatment estimates are predominantly negative, indicating a sustained divergence in Lifespan Inequality dynamics following the onset of the Great Recession.

4.2 Dose–response robustness check

To validate our main finding and to explore whether the estimated effect varies with the intensity of the crisis, we re-estimate the annual causal effects (δ_t) by contrasting countries not affected by the crisis (Group 1) separately with countries experiencing a moderate crisis (Group 2) and with countries experiencing a severe crisis (Group 3). The resulting estimates are reported in Fig. 3.

Figure 3 should be read as a severity-specific extension of the baseline result reported in Fig. 2. The upper panel compares Group 1 with Group 2, while the lower panel compares Group 1 with Group 3. In both panels, the interpretation of the coefficients remains the same as before. The figure therefore allows us to assess whether the reduction observed in the baseline specification is driven by a general post-crisis pattern among affected countries or whether it is concentrated among countries more intensely exposed to the Great Recession.

Two main insights emerge from this exercise. First, the direction of the estimated effects is consistent across both comparisons: after the onset of the crisis, Lifespan Inequality declines in both Group 2 and Group 3 relative to the control group. This confirms that the

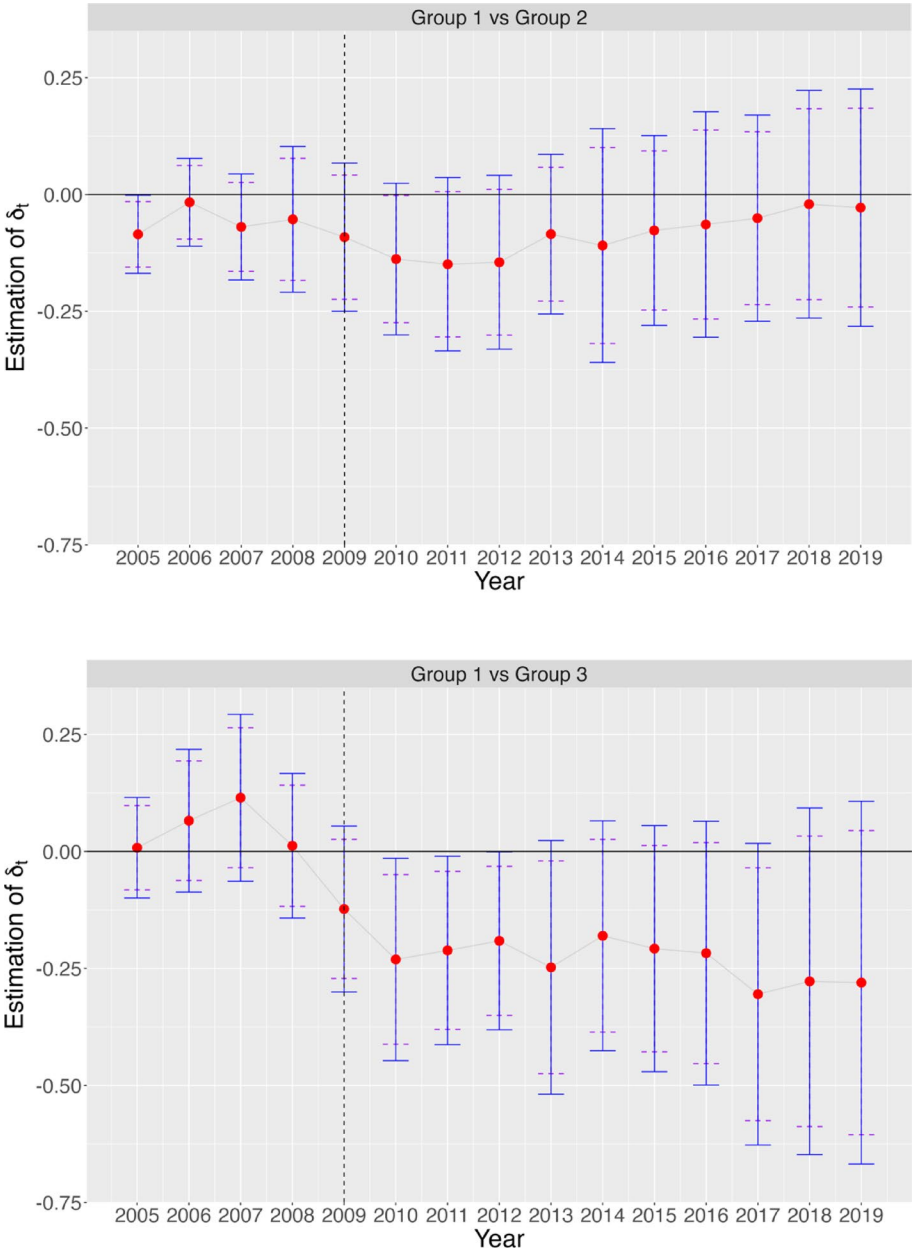

Fig. 3 Dose–response Robustness Check. The Dynamic Effect of the Great Recession on the European Lifespan Inequality according to the severity of the crisis. *Note*: Estimation of the Average Treatment Effect on the Treated (ATT, i.e. δ_t of Model 4), according to the intensity of the crisis. Countries have been classified into three main groups (No Crisis, Moderate Crisis and Severe Crisis) based on the change of unemployment rate across the Great Recession: Group 1 below the first tertile; Group 2 between the first and second tertiles; Group 3 above the second tertile. The vertical dashed line indicates the initial year of the crisis (2009). Horizontal error lines: Solid 95% CI; Dashed 90% CI. *Source*: Our elaboration based on Human Mortality Database (HMD)

reduction in lifespan dispersion observed in the baseline specification is not merely an artefact of pooling countries with different levels of exposure to the crisis.

Second, and more importantly, the magnitude and persistence of the estimated effects vary consistently with the severity of the crisis. In the comparison between Group 1 and Group 2, the post-crisis coefficients are generally negative but relatively small and tend to weaken over time. By contrast, in the comparison between Group 1 and Group 3, the estimates are larger in absolute value and remain negative for a longer period. This pattern is consistent with a dose–response interpretation: the stronger the economic shock, the more pronounced and persistent the reduction in Lifespan Inequality. Differences in statistical significance across the two comparisons should be interpreted with caution, as the two exercises rely on smaller subsets of countries. Nonetheless, the consistency in the sign, timing, and relative magnitude of the coefficients reinforces the conclusion that the Great Recession was associated with a reduction in Lifespan Inequality, particularly in countries most severely affected by the crisis.

4.3 Additional robustness checks

As additional robustness exercises aimed at assessing the stability and exploring potential heterogeneity underlying the aggregate estimates, we extended the analysis along several dimensions (Full methodological details and results are reported in the Supplementary Materials).

First, we replicated the analysis using the standard deviation of age at death as an alternative measure of Lifespan Inequality. The resulting estimates closely reproduce the timing and direction of the baseline findings, indicating that the main result is not driven by the specific measure of lifespan dispersion adopted.

Second, we replaced the unemployment-based classification of crisis severity with an alternative classification based on changes in real GDP. The main empirical pattern remains substantively unchanged when GDP variation is measured over both the 2007–2010 and 2007–2009 periods, suggesting that the findings are not sensitive to the macroeconomic indicator used to classify countries.

We also explored heterogeneity by sex and age. Sex-specific estimates indicate that the reduction in Lifespan Inequality is more pronounced among women, whereas the corresponding estimates for men are smaller and generally not statistically significant. Moreover, when Lifespan Inequality is measured at age 65 rather than at birth, no statistically significant effects emerge. This result is consistent with the interpretation that the observed reduction in lifespan dispersion is primarily associated with mortality dynamics occurring before older ages.

Finally, we re-estimated the baseline model including the median age of the population as a time-varying demographic control. The main pattern remains unchanged, suggesting that the estimated effects are not driven by differential population ageing across countries. Nevertheless, the specification without time-varying controls remains our preferred one, since such covariates must be introduced cautiously in a difference-in-differences framework when they may potentially be affected by the treatment itself (Rosenbaum 1984).

Taken together, these analyses provide broad support for the robustness of the main findings, while also qualifying their scope. The estimated reduction in Lifespan Inequality is stable across alternative measures, country classifications, and model specifications,

but appears to be concentrated mainly among women and in mortality dynamics occurring before age 65.

5 Conclusions and discussion

We found that Lifespan Inequality declined for approximately three years in the European countries most affected by the Great Recession, a pattern consistent with a short-term crisis-related effect. The results may appear surprising, as one might expect health disparities to increase following such a striking economic downturn like the 2008 Great Recession. Not only this increase failed to materialize but a decline in Lifespan Inequality was observed, instead. These results do not seem consistent with the hypothesis that the Thomas effect is due to an ecological fallacy. The faster decline in mortality in the countries most affected by the crisis, in other words, does not appear to be due to privileged groups increasing their life expectancy more rapidly. If that were the case, we would also have seen an increase in Lifespan Inequality in these countries. Instead, we observe the opposite. The joint dynamics of life expectancy and Lifespan Inequality during the crisis thus seem to indicate that there are factors linked to the economic cycle that can be harmful to health. When the economic cycle is in expansion, these factors are reinforced, while they weaken during recessions. Our findings, thus, confirms the pro-ciclical relationship between economic cycle and mortality. The results proved robust across the different sensitivity analyses. In particular, the magnitude, statistical significance, and persistence of the reduction in Lifespan Inequality varied consistently with crisis severity. The main empirical pattern also remained substantively unchanged when crisis severity was measured using changes in real GDP rather than unemployment, including when the GDP variation was calculated over the alternative 2007–2009 period. This indicates that the findings are not driven by the specific macroeconomic indicator used to classify countries according to crisis intensity. In additional robustness exercises exploring heterogeneity, we find that the reduction in Lifespan Inequality is largely driven by women, while estimates for men are smaller and generally not statistically significant. Moreover, when measuring Lifespan Inequality at age 65, the estimated effects are not statistically significant, suggesting that the observed reduction in lifespan dispersion is concentrated at younger, predominantly working ages (see below).

There may seem to be a discrepancy between our findings and those of other studies examining mortality and health inequalities during economic crises. However, upon closer examination, this discrepancy reflects a difference in the analytical perspective. While prior analyses often focus on disparities between specific subpopulations, our study aims for a comprehensive evaluation at the population level, scrutinizing the overarching trajectory of inequalities. This distinction is crucial for understanding and substantiate the differences between our conclusions and those of other scholars. Thus, our findings do not necessarily contradict existing research but rather complement and expand the ongoing discourse on health and mortality inequalities during times of economic stress.

The alignment of our results with the concept of the Thomas Effect provides evidence consistent with a causal link between the Great Recession and the reduction of Lifespan Inequality. To better understand this relationship, it is useful to introduce the concept of a “threshold age” in the analysis of Lifespan Inequality, which is sometimes employed to distinguish between premature and non-premature deaths. When mortality rates decrease

below the threshold age, leading to a compression of the age-at-death distribution, Lifespan Inequality decreases as people tend to die at more similar ages. Conversely, if death rates decrease above this threshold age, resulting in an expansion of the age-at-death distribution, the variation in ages at death and, consequently, Lifespan Inequality increases. Life expectancy, instead, consistently improves regardless of the age at which the mortality improvement occurs. Therefore, while any mortality improvement always means an increase in life expectancy, Lifespan Inequality"s increase or decrease hinges on whether these improvements occur below or above this threshold age (Vaupel, Zhang and van Raalte, 2011; Aburto et al. 2020). This interpretation is further supported by our above-mentioned robustness check in which we re-estimated the model using Lifespan Inequality measured at age 65: the absence of statistically significance at older ages is consistent with the notion that the crisis-related reduction in lifespan dispersion is primarily driven by mortality changes occurring at younger ages, i.e., below the threshold age. A different pattern—namely a significance at age 65—would have called this mechanism into question. Thus, our results suggest a potential causal link between the Great Recession and the dynamics of Lifespan Inequality, indicating that this relationship may have operated through a mortality advantage at 'young' ages, or, in any case, ages below life expectancy.

Finkelstein et al. (2025) indicates that reductions in air pollution and traffic-related externalities accounted for an important share of the mortality decline observed during the Great Recession, suggesting that environmental and structural channels may represent plausible explanations for the observed relationships. At the same time, a deeper assessment of behavioral mechanisms requires individual-level data and cannot be fully addressed within the present macro-level framework. Ongoing and forthcoming work using microdata is better suited to investigate such channels which may contribute to shaping health outcomes over the business cycle.

From a policy perspective, these findings should not be interpreted as implying that recessions are beneficial or desirable. Economic downturns produce severe social costs, especially for unemployed individuals and vulnerable groups. Rather, our results suggest that some features of economic expansions may generate health-damaging externalities that become weaker during recessions. Identifying these channels is therefore relevant for policymakers. If reductions in traffic, air pollution, work intensity, or other crisis-related changes contribute to lower mortality and reduced Lifespan Inequality, then public policy should aim to reproduce these health-protective conditions during normal economic times, without the social and economic costs of a recession. In this sense, the policy implication of our study is not to welcome economic downturns, but to better understand which components of economic activity are harmful to population health and to design interventions capable of mitigating them.

In conclusion, our research shows that the Great Recession was associated with an unexpected reduction in Lifespan Inequality in Europe and offers new insights into the intricate relationship between economic conditions and public health. More broadly, it emphasizes the importance of adopting a nuanced approach when analysing the effects of economic fluctuations on health outcomes, moving beyond conventional mortality rate assessments to include inequality and distributional dimensions. For policymakers, this means that monitoring average life expectancy alone may be insufficient: measures such as Lifespan Inequality can provide additional information on whether mortality improvements are broadly shared across the population or concentrated at specific ages or among specific groups. This per-

spective may help inform public health strategies aimed at reducing avoidable mortality and mitigating the harmful externalities of economic activity during both expansionary and recessionary phases.

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Declarations

Conflict of interest All authors declare that they have no competing or conflicting interests.

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