Crises and mortality: Does the level of unemployment matter?

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Abstract

We study whether mortality responds non-linearly and asymmetrically to unemployment in the context of national economic crises. Although these assumptions have been challenged in other domains, they have been neglected in the mortality literature. Greece offers an ideal setting as unemployment was decreasing until mid-2008, but then it was sharply increased as a result of a severe economic crisis. Our results from regional panel data estimates (1999-2013) indicate a countercyclical total mortality, especially for the older ones, and a further deteriorating crisis effect. We provide evidence that the relationship is non-linear and asymmetric, suggesting that the effect on death rates changes for very high values of unemployment and depends on its direction. Both non-linearity and asymmetry are mainly driven by those above 65 years old. The results suggest that the mechanisms explaining these effects are likely to vary across age groups. Our findings have important methodological implications and suggest that empirical investigations on fluctuations, recessions and mortality should not ignore possible non-linear and asymmetric behaviours, especially during turbulent times.

Keywords: Mortality; Unemployment; Crisis; Non-linearity; Asymmetry; Greece

JEL classification: I10; E32; J60

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1. Introduction

The empirical literature on the relationship between mortality and unemployment has typically revolved around the assumptions of linearity and symmetry (Ruhm 2000; Ruhm 2007; Ruhm 2015). Under linearity, mortality responses are assumed to be equal regardless of the level of unemployment and under symmetry these responses are independent of the direction in which unemployment changes. Several economic applications outside the health domain have challenged the assumptions of linearity and symmetry on both theoretical and empirical grounds. Neftçi (1984) provided evidence that unemployment, like most major economic time series, exhibits an asymmetric behaviour with sudden jumps and lower drops. His findings were confirmed by later studies (Brunner 1997; Rothman 1991) leading McQueen and Thorley (1993) to argue that empirical results assuming symmetrically behaving macroeconomic indicators should be interpreted with caution. More recent research examined whether these behavioural characteristics affect the relationships of economic indicators with other variables. For example, using US panel data, Mocan and Bali (2010) unravelled asymmetric unemployment effects on criminal activity but found no evidence of non-linearities.

In the health domain, and despite the bulk of evidence with respect to economic fluctuations and mortality, the issues of non-linearity and asymmetry remain largely unexplored, especially in the context of national economic crises. Bonamore et al. (2015) provided evidence of a U-shaped relationship using regional data from 23 European countries for the period 2000-2012. They showed that an increase in unemployment at low levels reduces mortality but at higher levels, further increases are associated with increased mortality. They argued that psychological responses of individuals are not a linear function of economic conditions. Negative responses are more likely to dominate at higher levels of unemployment, and positive responses at lower levels. Lower job finding rate and longer anticipated unemployment duration make it more difficult for individuals to cope with a deteriorating economic environment. Wu and Cheng (2010) used US time series data for the period 1951-2005 to provide evidence of symmetric overall mortality but asymmetric suicide cycles. Suicide rates increase during recessions but their reduction is greater when unemployment declines. They argued that the psychological impact of unemployment is reduced during recession as job loss becomes more socially acceptable. The results are statistically significant for working-age males. Finally, a recent paper by Sameem and Sylwester (2018) examine asymmetries on the mortality-unemployment relationship using a large panel of US states; their results, however, did not provide strong evidence.

The mechanisms that explain non-linearity and asymmetry are not clear in the literature. According to the studies mentioned above they are driven by workforce-related factors, predominately job loss, although of course causality cannot be established in these types of analyses. In particular, they argue that individual perceptions regarding unemployment or unemployment risk vary with the level and the direction unemployment moves into. The empirical evidence is robust, but job loss is relevant only for certain age groups. Moreover, recent research showed that mortality variation over the business cycle is primarily driven by the elderly (Stevens et al., 2015). The impact of economic fluctuations on individual perceptions and behaviour may vary by age for a number of reasons. First, unemployment fluctuations have only an indirect effect on the elderly; changes in labour market status are more likely for those in working age groups. Second, during turbulent times both younger and older individuals are likely to suffer significant income reductions, either through job loss and wage cuts for the former or through pension cuts for the latter. However, contrary to working age groups, there is little scope for those above retirement age to compensate for their income loss. Third, the elderly are more dependent on the healthcare system which, given a deteriorating economic environment, is likely to deliver outcomes of lower quality and face lack of resources due to public sector cuts and fiscal consolidation reforms. To the extend that these policies and reforms are implemented during a relatively short and turbulent period, they should be expected to disrupt the long-run declining mortality trends (Laliotis et al., 2016) generating non-linearities and asymmetries that have been largely ignored by the literature.

Building upon these arguments, we explore the hypotheses that within a severe national crisis context the relationship between unemployment and mortality (a) behaves asymmetrically and non-linearly and (b) is not homogeneous across age groups and death causes. Greece offers an ideal setting for our investigation. Since the 2008 financial crisis unemployment skyrocketed to unprecedented levels, being the highest among all European countries. In 2010, a series of austerity measures were taken, after the country’s deficit approached 16% of GDP. In the years that followed, Greece signed three Memoranda of

Understanding in order to secure financial support from the International Monetary Fund, the European Union and the European Central Bank. The loans were conditional on the implementation of specific reforms in a number of sectors, including pensions, health systems and the labour market.

In order to investigate the mortality implications of unemployment and the national crisis we use quarterly regional panel data for the period 1999q1-2013q4. Although previous evidence using individual records suggested a positive link between mortality and job displacement (Sullivan and von Wachter, 2009), unemployment in this context is used as a proxy of macroeconomic conditions and is not considered to reflect the impact of job loss on individual mortality. Contrary to previous literature we find that overall mortality is countercyclical and the crisis has had an overall deteriorating effect. This result is mainly driven by the older age groups. Relaxing the linearity assumption and looking into different age groups, we show a completely different picture for older and younger age groups. Among working age individuals, especially those in the 45-64 years old group,, mortality is procyclical for low levels of unemployment and becomes countercyclical as unemployment increases. The result confirms Bonamore et al (2015) arguing that unemployment level affects individual behaviour and psychological responses in a non-linear way. A reverse picture is revealed for those above 65 years of age. The relationship is positive for low levels of unemployment and becomes negative for higher levels indicating that the underlying mechanisms are different. This is possibly due to the fact that this group is out of the labour market and can do very little to react to the reduction in pensions they may suffer, and so, they may need to adapt to the circumstances that deteriorating economic conditions bring, e.g. by adopting healthier lifestyles. At the same time, they are more dependent on the functioning and quality of the healthcare system which might also need time to adjust to the changing economic conditions, institutional reforms and needs of the population.

The hypothesis of a symmetric relationship is also rejected for total and a series of cause-specific deaths. The results show that the effect of unemployment on mortality is stronger when unemployment decreases than when it increases, and again, this is driven by those above 65 years of age. When unemployment increases and decreases are modelled as function of time, we show that their mortality implications weaken over time, pointing again towards the rejection of non-linearity. Overall, our results suggest that the mechanisms explaining the relationship between unemployment and mortality, and indeed the mechanisms of non-linearities and asymmetries, are not the same across age groups. Although a similar approach was recently adopted to test for asymmetries using US data (Sameem and Sylvester, 2018), our study contributes to the literature by being the first one to examine the mortality implications of economic fluctuations within a national crisis context departing from the typically adopted linear and symmetric framework.

The remainder of the paper is structured as follows. Section 2 outlines the empirical methodology. Section 3 presents the data. Section 4 discusses the results and Section 5 concludes.

2. Empirical methodology

The relationship between mortality and economic conditions is typically estimated using panel data methods. The effect of unemployment is assumed to be linear, symmetric and it is identified through conditional within-region variation (Ruhm 2000; 2007; 2015). Health effects of national crises are captured by recessionary period indicators, but without controlling for year fixed effects since the latter would absorb any country-wide effects (Ruhm 2016).

We start our exploration by estimating baseline mortality equations, specifying the relationship with unemployment as a linear one and controlling for time and region fixed effects, regional time trends and regional controls. However, given the rapid increase in the unemployment rate during the crisis period, we relax the linearity assumption and introduce a quadratic unemployment term. Hence, we allow the relationship between the two variables to depend on the level of unemployment. The dependent variables are mortality rates calculated as count of deaths per 100,000 population. In order not to transform the dependent variable, especially for age and cause-specific groups having zero death counts in many region-quarter cells, we run Poisson regressions on variants of the following model specification:

$$m_{rt} = \alpha + \sum_{i=1}^{2} \beta_i U_{rt}^i + \gamma^k X_{rt}^k + \mu_r + \lambda_t + \theta_t + \varphi T_{rt} + \zeta^\tau N_t^\tau + \sum_{i=1}^{2} \delta_i t^i + u_{rt} \qquad (1)$$

where m_{rt} is the death rate in the *r*-th region during period *t*. General economic conditions are captured by the regional unemployment rate U_{rt}, which is specified in a quadratic fashion. Typically, logged death rates per 100,000 population are used as dependent variables in OLS models. However, this has been shown to lead in biased estimates (Silva and Tenreyro 2006). Miller (2009) and Mocan and Bali (2010) have used Poisson and negative binomial models instead. The X vector contains k time-varying regional characteristics. Region fixed effects, μ_r, control for time-invariant disparities across areas, e.g. lifestyle differences, geographical isolation etc. Year fixed effects, λ_t, capture common time effects across regions and quarter fixed effects, θ_t, control for seasonal variation. Unobservable time-varying confounders are captured by region-specific linear time trends, T_{rt} and any residual variation is in the error term, u_{rt}. So far, this is a widely adopted specification to model mortality and we report results with unemployment specified in either a linear or a quadratic form.

To examine whether national economic crises affected mortality we replace year fixed effects with N_t^{τ}, a set of τ indicators regarding the recessionary period and two subsequent sub-periods. More specifically, there is a post-2008q3 binary variable indicating the crisis period, i.e. when national and regional unemployment rates started to rise. A post-2010q1 variable indicates the implementation period of the first wave of fiscal consolidation policies (e.g. public sector pay cuts). A post-2012q1 dummy indicates the period when further austerity measures were introduced (e.g. legislative reduction of the national minimum wage by 32%, substantial restructuring of the labour relations framework). These binary variables are switched on during periods with increasing unemployment rates. Their estimated coefficients will signify any mortality effects due to the recession beyond those expected from unemployment fluctuations. Year fixed effects, λ_t, are excluded in this case due to perfect collinearity with the recessionary indicators (Ruhm, 2016). However, we include a general time trend, t, (in linear and quadratic form) so the coefficients of interest can be estimated net of the fact that mortality can be declining or growing over time (depending on the sign and magnitude of $\hat{\delta}$) for reasons that are common across regions and unrelated to the other variables.

In this framework the association between mortality and economic conditions is given by $\vartheta m_{rt}/\vartheta U_{rt} = \hat{\beta}_1 + 2\hat{\beta}_2 U_{rt}$ and it is evaluated at the mean and across the unemployment rate distribution. As mentioned earlier, unemployment serves as a proxy of economic activity. The estimated effect will only be indicative about whether mortality is procyclical ($\vartheta m_{rt}/\vartheta U_{rt} < 0$), countercyclical ($\vartheta m_{rt}/\vartheta U_{rt} > 0$) or unrelated to transitory changes in local economic conditions without making any causal claims. The signs and magnitudes of $\hat{\beta}_1$ and $\hat{\beta}_2$ will also determine the shape of this relationship.

Apart from linearity, we also relax the symmetry assumption by conditioning mortality on increasing and declining unemployment rates. Following Mocan and Bali (2010) mortality is defined as an asymmetric function of unemployment:

$$m_t = b_0 + b_1 U_t^+ + b_2 U_t^- + e_t \qquad (2)$$

where $U_t^+ = \begin{cases} U_t, & U_t \geq U_{t-1} \\ 0, & U_t < U_{t-1} \end{cases}$ and $U_t^- = \begin{cases} U_t, & U_t < U_{t-1} \\ 0, & U_t \geq U_{t-1} \end{cases}$.

This implies that:

$E(m_t) = b_0 + b_1 U_t^+$ for $U_t - U_{t-1} \geq 0$

$E(m_t) = b_0 + b_2 U_t^-$ for $U_t - U_{t-1} < 0$.

In our context, the empirical model exploring asymmetries is specified as follows:

$$m_{rt} = \alpha + b_1 U_{rt}^+ + b_2 U_{rt}^- + \gamma^k X_{rt}^k + \mu_r + \theta_t + \varphi T_{rt} + \zeta^\tau N_t^\tau + \delta t + u_{rt} \qquad (3)$$

A rejection of the null hypothesis H_0: $b_1 = b_2$ would indicate that unemployment affects mortality asymmetrically, depending on the trajectory it is moving into: downwards or upwards. Neftçi (1984) demonstrated that splitting the sample into two sub-periods, recessionary and non-recessionary, and comparing estimates from separate regressions could lead to biased results and of lower precision due to the smaller sample. Because unemployment increased substantially during the crisis, its relationship with mortality might not have remained stable over time. To test this hypothesis, we interacted both unemployment variables with a time trend, i.e. $(t \times U_{rt}^+)$ and $(t \times U_{rt}^-)$ and included them into equation (3). This will enable us to investigate the relationship between mortality and economic conditions as a function of time, i.e. whether the asymmetric effect of unemployment becomes stronger or weaker over time.

3. Data and descriptive statistics

The Hellenic Statistical Authority (EL.STAT) provided data under a special licence agreement. These are administrative data regarding the exact number of deaths by region, gender, age, cause and month for the period between January 1999 and December 2013. They are collected and processed through an electronic registration system of the Ministry of Interior that is automatically updated every time a vital event occurs. This minimizes the risk of a reporting or measurement error. Regions follow the NUTS-II taxonomy (13 regions), age is reported in 16 categories (≤14, 15-19, 20-24… 80-85, >85) and the 56 underlying causes of death follow the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10). We focus our analysis on the most frequent causes of death in Greece and the main causes discussed in the area of economic fluctuations and mortality internationally (eleven causes in total, see Table 1). Regional data on quarterly unemployment and population size are available from the EL.STAT. Using the quarterly Labour Force Survey (LFS, 1999q1-2013q4) we extracted a series of demographic and other characteristics in order to control for the composition of regional population. These are weighted shares of: females, those aged 0-19, 45-54, 55-64, 65-74 and over 75 years old, non-Greeks or EU citizens, those living in rural areas, those uninsured, those working in their family business, those having finished only secondary schooling and those working in construction. We also use the LFS to calculate regional population at a quarterly frequency. However, we also use regional population figures published by EL.STAT. Merging all data together resulted in a balanced panel of 13 regions observed for 60 quarters.

Figure 1 displays the evolution of overall mortality and unemployment over the total period of investigation. It indicates a possible asymmetric behaviour of unemployment with a slow drop for about a decade followed by a sudden jump in 2008 from a national average of 7.8% to 27.5% in 2013 (EL.STAT. 2015). Unemployment and mortality move together over time; they both have a downward trend before the crisis, which reverses suddenly after 2008q3. However, after 2012, and when unemployment reaches its highest values, the two variables seem to follow different directions. Unemployment continues to increase while mortality starts falling. This latter observation may indicate a non-linear relationship between the two variables.

[**Insert Figure 1 here**]

Table 1 displays some key descriptive statistics. Demographic characteristics have evolved slowly over time. However, unemployment increased from a pre-crisis average of 10.5% to 16.8% during the crisis, escalating to more than 30% in some regions. Moreover, it became much more volatile; the standard deviation is 2.9 and 7.2 for the periods before and during the crisis, respectively.

Statistics on mortality rates are displayed in the lower panel of Table 1. Overall mortality increased significantly during the crisis. The mean difference, obtained as a marginal effect from a Poisson regression of total mortality on a crisis indicator is statistically significant at the 1% level. The increase is higher for females and for those over 75 years old. Death rates are significantly lower for those below 44 years old and for those in the 65-74 years old age band. Looking at specific death causes, death rates associated with vehicle accidents and circulatory system diseases are observed during the crisis. At the same time, increased mortality rates are observed for all the other causes considered here, except for those related to mental health, which have remained unchanged.

[Insert Table 1 here]

4. Results

4.1 Baseline model

Table 2 displays Poisson parameter estimates obtained using variants of equation (1). In column 1, total mortality is regressed on regional, year and quarter fixed effects. The result suggests that a 1 percentage point increase in regional unemployment is associated with a 0.3% increase in overall mortality. This result is significant at the 1% level. Controlling for characteristics of the local population and unobservable time-varying confounders (columns 2-3) reduces the magnitude of the relationship and returns more precisely estimated coefficients. Based on column 3, a 1 percentage point increase in unemployment is accompanied by a 0.14% increase in overall mortality, i.e. 0.36 more deaths per 100,000 inhabitants. This result is statistically significant at the 5% level. In column 4, we estimate the model without controlling for year fixed effects. However, in order to estimate the relationship net of common macro trends, a linear time trend is included. This is done to see whether the result is affected, since in later estimations we will control for variables indicating the recession and austerity periods that are highly collinear with year dummies (Ruhm, 2016). The point estimate is similar and significant at the 1% level. It drops to 0.11% when a quadratic time trend is included in column 5 but it remains statistically significant at the 5% level. The estimated coefficient of the linear time trend (column 4) is -0.009 and significant at the 1%. In the quadratic version (column 5), the time trend coefficient is -0.013 and the coefficient of the squared time trend is 0.0001; both of them significant at the 1%. This indicates a slower decline in overall mortality during more recent years, as shown in a preliminary analysis (Laliotis et al., 2016). As a robustness check, we also estimated the model excluding Attica, which is the largest and most densely populated region, from the estimation sample. However, the coefficient and standard error were identical. The results are also robust when the analysis uses the population size reported by EL.STAT in their quarterly publications. For the remaining part of the analysis, mortality rates will be calculated using the LFS-based population.

[Insert Table 2 here]

4.2 Non-linear specifications

Table 3 presents results from estimating variants of equation (1) where we relax the linearity assumption. The unemployment squared coefficient is negative and significant. The results suggest that overall mortality is countercyclical and increases by 0.30% (0.78 more deaths per 100,000 population) for every percentage point rise in regional unemployment. However, the relationship changes for high levels of unemployment, i.e. for more than 23%, that were first observed in late 2012. Some basic specification tests indicate that the unemployment coefficients are statistically different from each other and jointly significant supporting the adoption of a non-linear specification. As a robustness check, we estimated the non-linear specification of column 1 replacing the general time trend with a set of year fixed effects and the results were similar. The coefficients (standard errors) of unemployment and unemployment squared were 0.0062 (0.003) and -0.0002 (0.0001), respectively. The marginal effect of unemployment was 0.0021 (0.0008).

[Insert Table 3 here]

In columns 2-4 we separately control for period effects as explained earlier. In column 5 all three period indicators are included. The results suggest that mortality increased after 2008 and exhibited an additional increase after 2012. The estimated unemployment marginal effect drops to 0.002 and it is significant at the 1% level. Moreover, controlling for crisis and austerity periods indicates that the countercyclical link between overall mortality and unemployment changed sign earlier in time, when unemployment increased to 17% during 2011. The period coefficients are similar when including single period indicators (columns 2-4) or all of them together (column 5). They indicate the mortality effect of recessionary sub-periods beyond that associated to higher unemployment rates (Ruhm, 2016). Moreover, the results look similar when period indicators are replaced with year fixed effects. Ideally, our models should control for healthcare indicators by region and quarter. However, such data were not available. Moreover, given the centralized nature of the Greek healthcare system these indicators would not display a great degree of variation across regions. Controlling for period fixed effects should adequately absorb the impact of crisis and austerity. Unobservable time-varying confounders should pick up any residual variation.

In Table 4 we use the model specified in column 5of Table 3 to report results by gender, age and cause of death. Non-linearity is supported for both genders although the marginal effect of unemployment is higher for females. Females are also hit harder when considering the second austerity period (post-2012q1) although male mortality increased earlier, after 2008q3. Unemployment does not seem to affect mortality rates of those in the two first age categories. In fact, the coefficients of period indicators are mostly negative for those below 44 years old. We find evidence of procyclical mortality behaviour for those 45-64 years old, however, their death rate level deteriorated after 2012. Procyclical mortality for this group became countercyclical when unemployment escalated to more than 22%, rejecting the linearity assumption and confirming the findings of Bonamore et al. (2015) favouring a U-shaped mortality-unemployment relationship. However, the picture is completely reversed when looking at older age groups. Those over 65 years old face a countercyclical mortality plus deteriorating impacts of both the recessionary and the austerity agenda periods. But as unemployment reaches higher values, the relationship between unemployment and mortality becomes negative. This finding supports our hypothesis that psychological responses of the elderly to the crisis is different to those of working age groups. Pensioners have limited scope of compensating their income loss during a crisis as they are out of the labour market and therefore show signs of adoption to the deteriorating economic conditions. The response of the healthcare services might also be able to respond better to the needs of the population, following a short period characterized by a series of cuts, reforms and restructuring.

[Insert Table 4 here]

Not all cause-specific mortality rates are systematically affected by unemployment. The estimated effect for suicides is positive but not significant. However, there is evidence of a weak and positive relationship for high levels of unemployment; the coefficient of the squared term is significant at the 10% level. Homicide mortality decreases after 2010 although it does not vary with unemployment. Vehicle accidents mortality also decreased after 2010 and unemployment squared is negative and significant. The unemployment effect on circulatory system mortality is not different from zero, although the two unemployment terms are significant at the 5% and the linearity assumption is rejected. In addition, recession and the post-2012 austerity period exerted a deteriorating effect the level on this mortality rate.

Nervous and respiratory system mortalities have declined after 2012. Cancer mortality level is lower after 2010q1 although it is not systematically related to transitory unemployment fluctuations. Linearity is also rejected for digestive system mortality and the relationship with unemployment is countercyclical. Mortality due to adverse events during medical treatment does not seem to vary with unemployment. The squared term of the unemployment rate has a positive coefficient, however, it is not significant.

Apart from the mean, we evaluate the marginal mortality effect of unemployment, $\vartheta m_{rt}/\vartheta U_{rt}$, across the unemployment distribution. Figure 2 displays the results for overall, gender and age specific death rates. We plot the estimated marginal effects across the unemployment distribution with their 95% confidence intervals and their respective mean effects for overall mortality (Table 3, column 5) and for gender, age and cause-specific death rates (Table 4). It is graphically confirmed that the overall result is driven by the elderly as recently suggested (Stevens et al., 2015). Death rates for those under 44 years old are not affected by economic fluctuations. Procyclical mortality for those in the 45-64 age group becomes countercyclical and significant as the crisis deepens. As unemployment rises, job market opportunities might become even scarcer for individuals in this age group, relative to younger ones, who at the same time become more dependent on healthcare services because of their age.

[Insert Figure 2 here]

Figure 3 graphs the relationship by cause. Suicide mortality becomes more countercyclical as unemployment increases but the relationship is not estimated very precisely. However, the marginal effect of unemployment is positive and its 95% confidence interval consistently lies above zero for unemployment rates higher than 20%. The marginal effect of unemployment on mortality associated with vehicle accidents decreases with unemployment and becomes procyclical when unemployment rises over 25%. The countercyclical relationship for mortality related to the circulatory system diseases becomes procyclical when unemployment is higher than 16%. However, the horizontal line specified at zero always falls within the estimated confidence interval. The estimated marginal effect for cancer and nervous system mortality rates oscillates around zero across the unemployment distribution. Digestive and respiratory system mortality rates are procyclical for low levels of unemployment but the relationship turns into a procyclical for both of them as the crisis deepens. Finally, there is a tendency for mortality associated to adverse events during medical treatment to become countercyclical but not in a statistically significant way.

[Insert Figure 3 here]

4.3 Asymmetric specifications

The uncovered non-linear effect could be the result of an asymmetric relationship between the two variables. When unemployment escalates to higher levels, its impact on mortality may be different from when it trends downwards. We estimate variants of equation (3) to address this issue and present the results in Table 5. All models control for fixed effects and demographics. For overall mortality, the estimated coefficient of U_{rt}^{-} is significant at the 5% and indicates that mortality decreased by 0.12% for every percentage point decrease in unemployment. The estimated coefficient of U_{rt}^{+} is also positive but weaker in terms of magnitude and statistical significance. It suggests that a one percentage point increase in unemployment is accompanied by an increase in mortality by 0.09%. The two coefficients are jointly significant, but not statistically different from each other. Hence, the symmetry assumption cannot be rejected in this case. All models control the usual set of indicators regarding the crisis and the austerity periods. However, their estimated coefficients are similar to those reported in Table 4 and are not displayed here (they available upon request). Moreover, unemployment coefficients look similar when models control for year fixed effects instead of period indicators.

The same model is estimated using gender, age and cause-specific mortality rates. Asymmetry is rejected for both genders, however the coefficients of unemployment and period indicators are larger for females. No asymmetries are uncovered regarding the first three age categories. The relationship is procyclical for those aged between 25-64 years old and significant only for the 45-64 year old ones. As shown in Table 4, the economic crisis seems to have had a protective effect for these age groups (the only exception is the positive and significant coefficient of the post-2012q1 indicator for the 45-64 year olds). Death rates for those over 65 years old increase when unemployment trends upwards. Moreover, in line with Figure 3, their overall death rates tend to become procyclical as unemployment rises, especially for those older than 75 years old. However, the hypothesis of asymmetry cannot be supported for any of the age-specific mortality rates.

[Insert Table 5 here]

Suicides are asymmetric and systematically related to unemployment fluctuations. The results suggest that suicides increase by 1.7% and decrease by 2.1% for every percentage point rise and fall of the unemployment, respectively. These results resemble those of Wu and Cheng (2010) who presented evidence of asymmetric suicide cycles using US time series data. No asymmetry or systematic relationship with unemployment is uncovered for vehicular accidents and circulatory system mortality. Cancer mortality is asymmetric and decreases as unemployment falls. Death rates from nervous system diseases, digestive system diseases, mental health and medical malpractice also appear to be symmetric. An alternative method to test for asymmetries has been adopted by Wu and Cheng (2010) who apply Hodrick-Prescott (HP) filters to detrend unemployment and mortality US time series. We also run regressions using HP detrended series and the results (available from the authors upon request) led to similar conclusions. Moreover, using panel data with fixed effects ensures that the relationship of interest is estimated using deviations from long-term trends.

Results in Table 5 do not provide strong evidence in favour of asymmetries. However, the relationship between mortality and unemployment increases or decreases might not be stable over time. For example, it seems in Figure 2 that mortality declines while unemployment still rises towards the end of the period. Similarly, mortality starts increasing when unemployment trends downwards before the outburst of the economic crisis in late 2008. Therefore, in order to control for a potentially changing relationship over time, we included two interactions, $(t \times U_{rt}^{+})$ and $(t \times U_{rt}^{-})$, into equation (3). Table 6 reports the results. The finding that total mortality increases with U_{rt}^{+} and decreases with U_{rt}^{-} is confirmed. Moreover, it seems that that both unemployment effects weaken over time; the interaction terms are negative and significant. They are also statistically different, at the 10% level, from each other indicating that the differential unemployment effect on mortality has slightly decreased over time. In addition, specifying the unemployment variables as functions of time leads to a rejection of the linearity assumption. These findings are driven from male and over 75-year-old mortality. There is also evidence of an asymmetric mortality response for the 25-44 year olds; they are not affected when unemployment declines and the relationship becomes procyclical when unemployment increases. Consistent with previous estimates, results in Table 6 suggest that mortality is symmetric and always procyclical for those in the 45-64 year old group. This is the only age group that becomes worse off by the crisis and the deteriorating labour market. Suicides respond asymmetrically to unemployment fluctuations and the relationship remains stable over time. As in Wu and Cheng (2010), suicides increase when unemployment rises but the negative effect is stronger when unemployment declines. Asymmetries are also uncovered regarding death rates associated with vehicle accidents and diseases of the circulatory system.

[Insert Table 6 here]

5. Conclusions

Using regional panel data for 1999-2013 we examine the mortality-unemployment relationship in the context of the Greek economic crisis. We show that total mortality is countercyclical and present evidence for a non-linear and asymmetric behaviour. These results are driven predominantly by those above 65 years of age.

Our finding is in contrast with the majority of the economic literature in the last two decades (Ruhm 2000; Ruhm 2007; Gonzalez and Quast 2011; Tapia-Granados 2005). It is in agreement though with a few recent studies suggesting that the procyclical mortality effects may be changing. Using data from the US and investigating a period similar to the one of our analysis, Gordon and Sommers (2016) found that during 1993-2012, unemployment rates demonstrate a weak and inconsistent effect on mortality. Their findings are similar to a recent study by Ruhm (2016) who found that mortality shifted from strongly procyclical to being weakly or unrelated to unemployment between 1976-2010. Contrary to that latter study though that found that national crises have a protective effect on total mortality (Ruhm 2016), we provide robust evidence of a deteriorating level effect due to the crisis.

Our findings suggest that different economic crises, and even different phases within a crisis period, contain their own idiosyncratic elements in terms of individual behaviours, social norms and institutional functioning (Ruhm 2016). In the Greek case, the countercyclical total mortality and the deteriorating crisis effects are driven by those aged above 65. This suggests that the possible mechanism explaining the overall relationship cannot be related to the labour market. It is likely to reflect a deterioration of the health services, as these are the main users of the health care system. This has significant policy implications highlighting the greater vulnerability of those in the elderly age groups during turbulent times. At the same time we provide evidence that procyclical mortality for those aged 45-64 years old becomes countercyclical as the crisis deepens. As argued in earlier studies, the Greek health system and the labour market faced significant structural problems long before the crisis hit yet little had been done largely due to lack of political will and inertia (Mossialos et al., 2005; Davaki and Mossialos 2005; Economou 2010). Yet, and in response to the crisis a number of policy reforms were introduced during a short time period, even if they had been on the table for decades (Economou, 2015).

Our study offers important methodological insights regarding the nature of the relationship between unemployment and mortality. We find robust evidence that the relationship is both asymmetric and non-linear, and is driven by those over 65 years old. The sharp and sudden deterioration in the prevailing economic conditions, coupled with the implementation of a fiscal consolidation policy agenda, seem to have temporarily disrupted the downward mortality trend in Greece during the crisis period. However as the crisis continues with persistently high unemployment levels, mortality seems to get back on its declining trajectory hence resulting in a sign change of the estimated relationship. We also show that reductions in unemployment reduce mortality more relative to increases when unemployment rises. These findings regarding the kind of the relationship are crucial and would not have been observed without relaxing the assumptions of linearity and symmetry. On this basis, we argue that related studies should consider for such effects, particularly in the context of wider economic crises. Although claims for the mechanisms that underline asymmetries and non-linearities are hard to establish, our findings suggest that these are likely to be age related. Indeed, both asymmetries and non-linearities are mainly driven by those above 65 years old, hence the interpretation cannot be related to labour force status and psychological responses to job loss as previous studies had argued (Bonamore et al., 2015; Wu and Cheng, 2010). Our results confirm our hypothesis that different age groups will respond differently to worsening economic conditions.

The lack of regional data on indicators such as health expenditure does not allow us to test further health system related factors. Future research on this area could shed more light on the impact of crises on population health.

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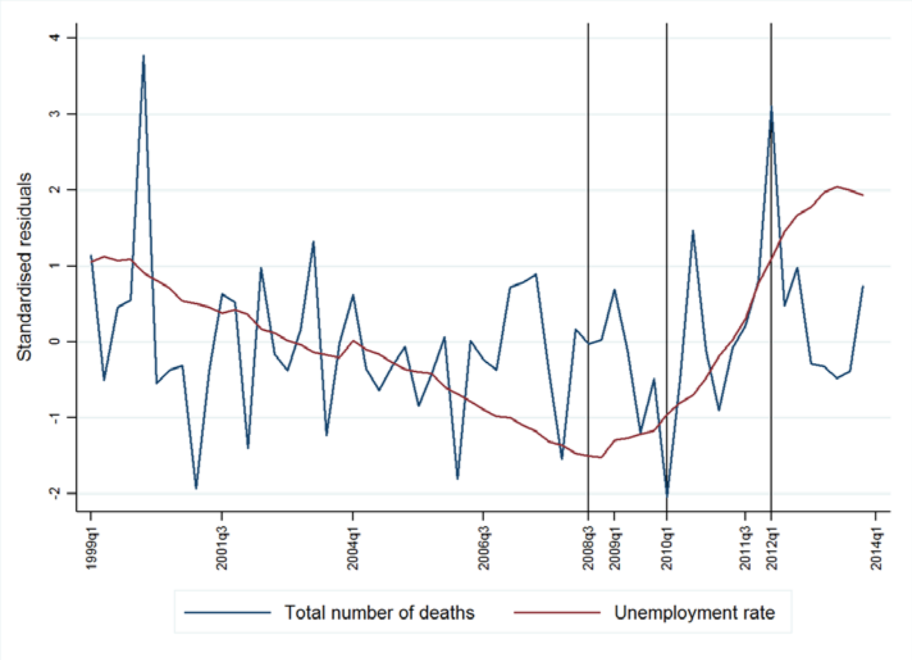
Tables and Figures

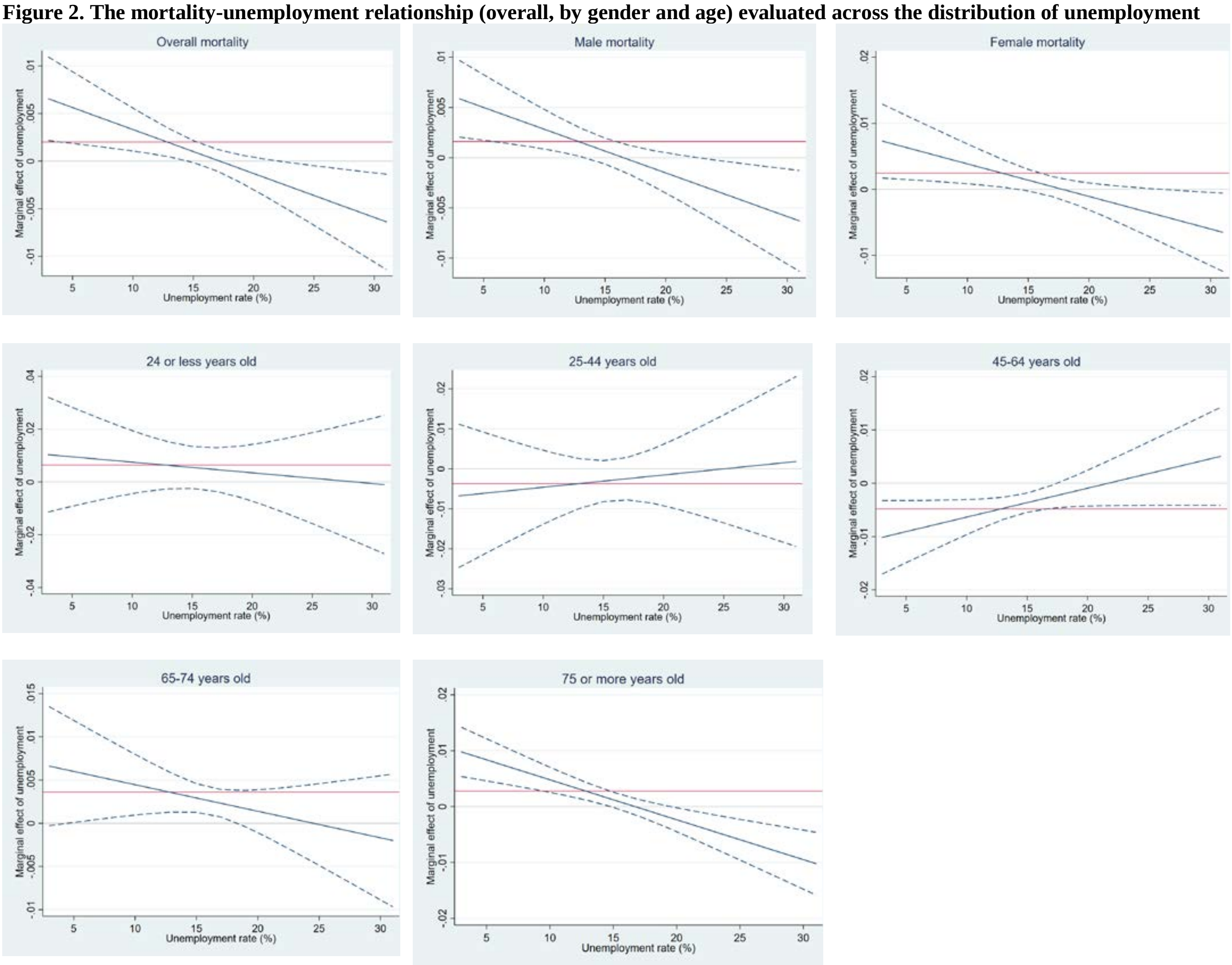
Figure 1. Deaths and unemployment in Greece



Source: Hellenic Statistical Authority (EL.STAT).

Notes: Population weighted residuals for unemployment rate and total death count are obtained from weighted regressions on time trends, regional and time fixed effects. They are collapsed by quarter and standardized to zero means and unit standard deviations. Vertical lines indicate the beginning of the economic crisis (2008q3) and the fiscal consolidation (2010q1, 2012q1) periods.

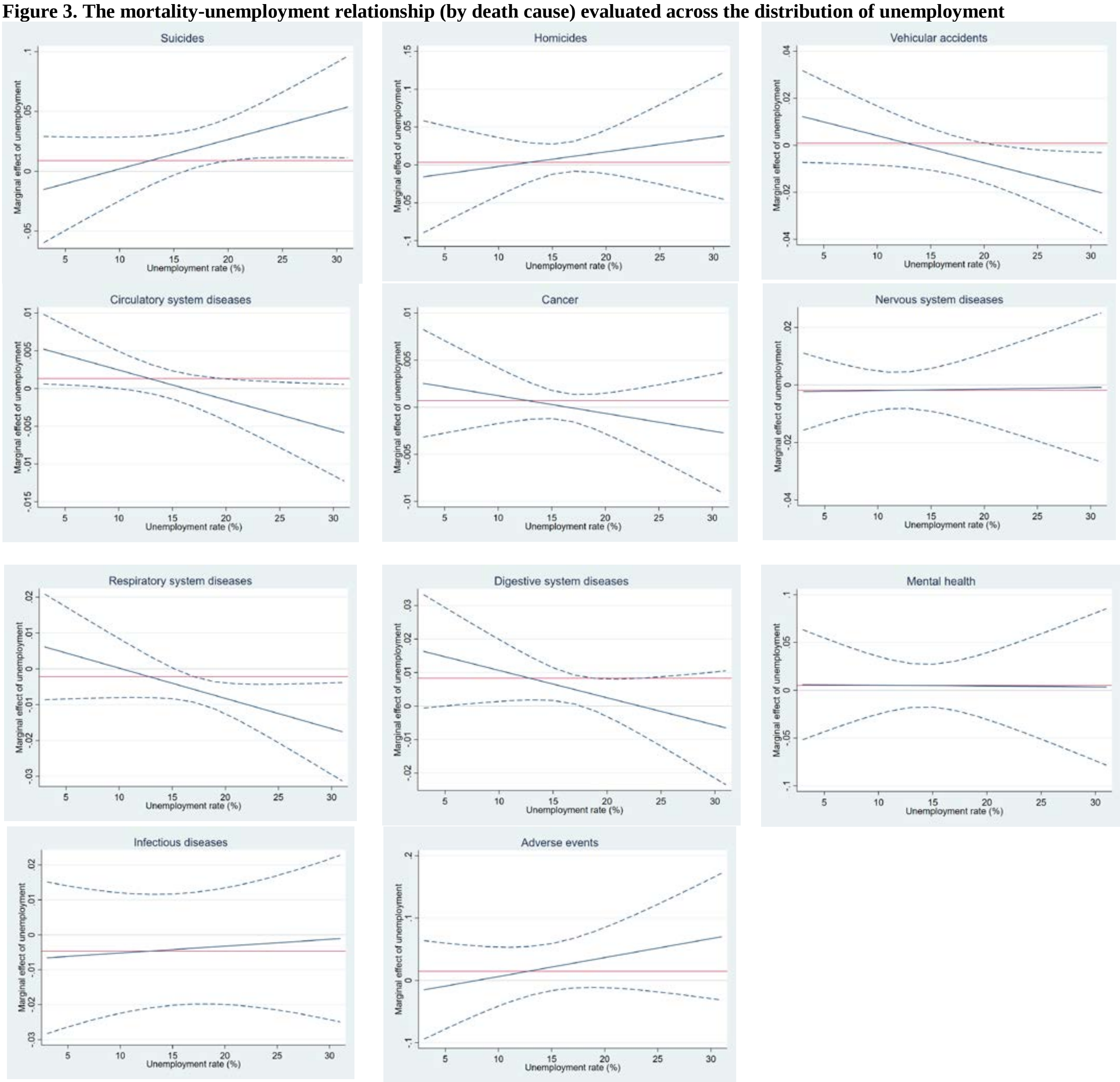
Figure 2. The mortality-unemployment relationship (overall, by gender and age) evaluated across the distribution of unemployment



Source: Hellenic Statistical Authority (EL.STAT), Labour Force Survey (LFS).

Notes: Based on models of Tables 3 (column 5) and 4. Dashed lines indicate the 95% CIs (based on standard errors obtained via the delta method) for the estimated unemployment effect. Horizontal lines indicate the mean unemployment effect. Horizontal pale lines are specified at 0 of the vertical axis.

Figure 3. The mortality-unemployment relationship (by death cause) evaluated across the distribution of unemployment



Source: Hellenic Statistical Authority (EL.STAT), Labour Force Survey (LFS).

Notes: Based on models of Table 4. Dashed lines indicate the 95% CIs (based on standard errors obtained via the delta method) for the estimated unemployment effect. Horizontal lines indicate the mean unemployment effect. Horizontal pale lines are specified at 0 of the vertical axis.

Table 1. Descriptive statistics

	Before crisis: 1999q1-2008q2				During crisis: 2008q3-2013q4				Mean
Demographics	Mean	Std.Dev	Min.	Max.	Mean	Std.Dev	Min.	Max.	difference
Unemployment rate	10.50	2.94	3.20	21.90	16.81	7.22	2.90	32.60	6.03[a]
% female	50.67	0.63	48.95	51.93	50.91	0.54	48.78	51.95	0.24
% ≤19 years old	21.77	1.71	18.53	25.88	20.46	1.44	18.15	24.32	-1.31[a]
% 45-54 years old	12.76	0.63	11.60	14.23	13.57	0.60	12.39	14.86	0.80[a]
% 55-64 years old	11.27	0.76	9.54	12.65	11.94	0.64	10.55	13.29	0.67[a]
% 65-74 years old	10.17	1.45	7.64	13.34	10.23	1.10	7.62	11.89	-0.96[a]
% ≥75 years old	8.11	1.64	4.94	11.79	10.42	1.59	6.82	13.00	2.25[a]
% non-Greeks/EU	2.73	1.62	0.1	7.89	4.66	2.11	1.25	9.94	1.84[a]
% in rural areas	36.77	14.17	0.65	65.54	35.74	14.33	0.47	63.85	-0.99[a]
% uninsured	3.80	0.99	1.17	6.93	4.68	1.55	1.30	10.27	0.86[a]
% in family business	9.83	3.86	2.26	21.06	7.14	2.47	1.34	12.88	-2.82[a]
% high-school	21.36	3.12	14.81	29.59	23.93	2.30	18.61	29.89	2.53[a]
% in constructions	3.42	0.73	1.86	5.59	2.76	1.03	1.07	5.44	-0.68[a]
Death rates (ICD codes)*									
Overall	260.69	40.75	176.86	427.10	265.30	37.46	173.34	386.48	4.60[a]
Males	137.33	21.22	96.17	225.23	138.79	19.08	93.41	198.20	1.45[c]
Females	123.35	20.63	76.14	201.87	126.51	19.43	75.39	188.28	3.15[a]
≤24 years old	3.44	1.14	0.49	8.30	2.43	0.86	0.00	5.85	-1.07[a]
25-44 years old	6.90	1.45	2.48	12.40	6.02	1.32	2.01	10.28	-0.89[a]
45-64 years old	28.53	4.04	18.30	49.33	28.86	3.37	19.26	36.87	0.33
65-74 years old	49.73	10.27	21.98	92.08	38.20	6.40	23.93	61.69	-12.00[a]
≥75 years old	172.08	36.73	110.64	312.93	189.78	33.30	112.39	299.20	17.48[a]
Suicides (54)	0.96	0.54	0.00	3.63	1.09	0.56	0.00	2.91	0.13[c]
Homicides (55)	0.24	0.26	0.00	1.99	0.29	0.26	0.00	1.48	0.05
Vehicles (47)	4.52	1.71	0.51	18.16	3.28	1.34	0.35	11.34	-1.30[a]
Circulatory (25-30)	128.84	24.77	78.22	231.45	116.16	21.79	68.44	178.73	-12.87[a]
Cancer (08-14,16-17)	59.88	7.44	41.24	80.51	63.37	7.80	39.90	80.54	3.46[a]
Nervous (22)	2.97	1.07	0.31	7.58	3.74	1.28	1.01	8.01	0.76[a]
Respiratory (31-32)	19.52	5.94	7.82	41.99	25.06	6.34	10.95	50.50	5.38[a]
Digestive (33-34)	5.85	1.41	1.49	11.81	6.40	1.50	2.97	11.36	0.54[a]
Mental (21)	0.31	0.31	0.00	2.02	0.30	0.28	0.00	1.42	-0.01
Infectious (01-07)	1.90	1.17	0.00	7.13	3.09	1.82	0.00	9.88	1.13[a]
Adverse events (49)	0.16	0.21	0.00	1.04	0.23	0.27	0.00	1.48	0.65[b]
Observations		494				286			

Source: Hellenic Statistical Authority (EL.STAT) and Labour Force Survey (LFS).

Notes: Death rates are calculates as number of deaths per 100,000 population. [a],[b] and [c] indicate whether mean differences (average marginal effects obtained by Poisson regressions of each variable on a post-2008q3 indicator) are statistically significant at the 1%, 5% and 10% level, respectively. [*] International Classification System of Diseases and Related Health Problems (version 10.0) codes in parentheses.

Table 2. Overall mortality and regional unemployment

	(1)	(2)	(3)	(4)	(5)

Unemployment rate	.0034[a] (.0009)	.0020[a] (.0006)	.0014[a] (.0005)	.0020[a] (.0004)	.0010[b] (.0005)
Regional fixed effects	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	-	-
Demographics	-	Yes	Yes	Yes	Yes
Regional time trends	-	-	Yes	Yes	Yes
Linear time trend	-	-	-	Yes	Yes
Quadratic time trend	-	-	-	-	Yes

Source: Hellenic Statistical Authority (EL.STAT), Labour Force Survey (LFS).

Notes: Poisson parameter estimates. Sample size is 780 region-quarter observations. Death rate (death count per 100,000 population) is the dependent variable. Demographics include regional shares of: females, aged ≤19, 45-54, 55-64, 65-74 and ≥75 years old, non-Greeks/EU citizens, living in rural areas, uninsured, working in their family business, secondary education graduates and construction workers. Robust standard errors clustered by region in parentheses. [a] p<.01, [b] p<.05, [c] p<.1.

Table 3. Overall mortality and regional unemployment: Non-linearities and recessionary indicators

	(1)	(2)	(3)	(4)	(5)
U_{rt}	.0067[a] (.0016)	.0054[a] (.0016)	.0066[a] (.0025)	.0095[a] (.0020)	.0079[a] (.0027)
U_{rt}^2	-.0001[a] (.0000)	-.0001[b] (.0000)	-.0001[c] (.0000)	-.0003[a] (.0001)	-.0002[a] (.0001)
Post-2008q3 indicator	-	.0208[b] (.0094)	-	-	.0199[a] (.0008)
Post-2010q1 indicator	-	-	.0016 (.0141)	-	.0047 (.0129)
Post-2012q1 indicator	-	-	-	.0577[a] (.0135)	.0582[a] (.0122)
U_{rt} marginal effect	.0030[a] (.0006)	.0028[a] (.0006)	.0029[a] (.0008)	.0023[a] (.0006)	.0020[a] (.0008)
Turning point	23.02%	26.41%	23.14%	16.94%	17.18%
$U_{rt} = U_{rt}^2$ [1]	17.80[a]	10.87[a]	6.80[a]	23.63[a]	8.46[a]
$U_{rt} = U_{rt}^2 = 0$ [1]	22.83[a]	19.02[a]	13.40[a]	24.07[a]	8.60[b]
Period indicators[1]	-	-	-	-	51.47[a]
Regional fixed effects	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes
Regional time trends	Yes	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes	Yes

Source: Hellenic Statistical Authority (EL.STAT), Labour Force Survey (LFS).

Notes: Poisson regression parameter estimates. Sample size is 780 region-quarter observations. Death rate (death count per 100,000 population) is the dependent variable. Robust standard errors clustered by region in parentheses. [a] p<.01, [b] p<.05, [c] p<.1. [1] *F*-test χ^2-values.

Table 4. Gender, age, cause-specific mortality and regional unemployment: Non-linearities and recessionary indicators

	Males	Females	≤24 years	25-44 years	45-64 years	65-74 years	≥75 years	Suicides	Homicides
U_{rt}	.0072[a]	.0088[b]	.0116	-.0077	-.0118[a]	.0075[c]	.0119[a]	-.0227	-.0215
	(.0024)	(.0034)	(.0134)	(.0112)	(.0044)	(.0043)	(.0028)	(.0268)	(.0459)
U_{rt}^2	-.0002[a]	-.0002[b]	-.0002	.0002	.0003[c]	-.0002	-.0004[a]	.0012[c]	.0010
	(.0001)	(.0001)	(.0004)	(.0003)	(.0001)	(.0001)	(.0001)	(.0007)	(.0014)
Post-2008q3 indicator	.0241[a]	.0150	.0153	-.0335	.0198	.0252[c]	.0203[b]	.0200	-.0668
	(.0069)	(.0122)	(.0567)	(.0470)	(.0181)	(.0147)	(.0089)	(.0920)	(.1887)
Post-2010q1 indicator	-.0120	.0232	-.0021	-.0215	.0236	-.0361	.0085	.0610	-.4038[a]
	(.0105)	(.0166)	(.0588)	(.0373)	(.0155)	(.0260)	(.0137)	(.1120)	(.1092)
Post-2012q1 indicator	.0392[a]	.0790[a]	-.1655[b]	-.0521	.0429[b]	.0352[b]	.0700[a]	-.1617	.0443
	(.0146)	(.0132)	(.0671)	(.0559)	(.0189)	(.0145)	(.0154)	(.1151)	(.1833)
U_{rt} marginal effect	.0016[b]	.0025[b]	.0064	-.0038	-.0048[a]	.0036[a]	.0028[a]	.0089	.0034
	(.0007)	(.0011)	(.0046)	(.0033)	(.0011)	(.0012)	(.0008)	(.0106)	(.0133)
Turning point	16.51%	17.83%	28.59%	25.05%	21.70%	24.52%	16.70%	9.21%	11.09%
$U_{rt} = U_{rt}^2$[1]	8.99[a]	6.51[b]	0.73	0.47	7.19[a]	3.04[c]	18.60[a]	0.75	0.23
$U_{rt} = U_{rt}^2 = 0$[1]	9.06[b]	6.58[b]	1.96	1.44	19.86[a]	11.97[a]	18.88[a]	8.82[b]	1.47
Period indicators[1]	44.52[a]	44.05[a]	8.42[b]	3.90	11.37[a]	14.44[a]	41.65[a]	3.12	16.49[a]
	Vehicle accidents	Circulatory system	Cancer	Nervous system	Respiratory diseases	Digestive diseases	Mental health	Infectious diseases	Adverse events
U_{rt}	.0157	.0064[b]	.0031	-.0025	.0087	.0188[c]	.0060	-.0072	-.0244
	(.0116)	(.0029)	(.0035)	(.0086)	(.0090)	(.0104)	(.0362)	(.0123)	(.0484)
U_{rt}^2	-.0006[c]	-.0002[b]	-.0001	.0000	-.0004[c]	-.0004	-.0000	.0001	.0015
	(.0003)	(.0001)	(.0001)	(.0000)	(.0002)	(.0003)	(.0012)	(.0003)	(.0015)
Post-2008q3 indicator	.0371	.0289[b]	-.0017	.0440	.0585	-.0212	-.0328	.2814[a]	-.2324
	(.0751)	(.0132)	(.0098)	(.0457)	(.0364)	(.0611)	(.1632)	(.0464)	(.3331)
Post-2010q1 indicator	-.0908[c]	-.0177	-.0389[a]	.0245	-.0546[b]	-.0277	-.0749	-.2311[a]	.3510
	(.0548)	(.0139)	(.0134)	(.0548)	(.0259)	(.0571)	(.1612)	(.0662)	(.3287)
Post-2012q1 indicator	-.0324	.0636[b]	.0137[c]	.2594[a]	.1275[a]	.0623	.0135	.0224	-.0274
	(.1042)	(.0252)	(.0078)	(.0916)	(.0365)	(.0522)	(.2186)	(.0937)	(.2867)
U_{rt} marginal effect	.0008	.0013	.0007	-.0018	-.0022	.0083[b]	.0050	-.0047	.0147
	(.0052)	(.0010)	(.0010)	(.0032)	(.0030)	(.0033)	(.0118)	(.0083)	(.0202)
Turning point	13.54	16.19%	16.48%	46.75%	10.24%	23.03%	72.40%	36.68%	8.00%
$U_{rt} = U_{rt}^2$[1]	1.87	4.94[b]	0.76	0.08	0.96	3.23[c]	0.03	0.33	0.27
$U_{rt} = U_{rt}^2 = 0$[1]	5.45[c]	4.94[c]	0.77	0.35	14.69[a]	6.93[b]	0.18	0.36	2.23
Period indicators[1]	3.55	9.21[b]	9.37[b]	9.36[b]	47.53[a]	2.35	0.33	87.66[a]	2.27

Source: Hellenic Statistical Authority (EL.STAT), Labour Force Survey (LFS).

Notes: Poisson regression parameter estimates. Sample size is 780 region-quarter observations. Death rate (death count per 100,000 population) is the dependent variable. All models are specified as in column 5 of Table 3. Robust standard errors clustered by region in parentheses. [a] $p<.01$, [b] $p<.05$, [c] $p<.1$.
[1] *F*-test *p*-values.

Table 5. Mortality and unemployment: Results from asymmetric specifications

	Overall	Males	Females	≤24 years	25-44 years	45-64 years	65-74 years	≥75 years	Suicides	Homicides
U_{rt}^{+}	.0009[c]	.0005	.0013	.0058	-.0028	-.0034[a]	.0029[a]	.0009	.0168[c]	.0079
	(.0005)	(.0005)	(.0008)	(.0040)	(.0024)	(.0010)	(.0007)	(.0006)	(.0092)	(.0098)
U_{rt}^{-}	.0012[b]	.0007	.0017[c]	.0067	-.0015	-.0034[a]	.0032[a]	.0012[c]	.0212[b]	.0058
	(.0006)	(.0006)	(.0009)	(.0043)	(.0019)	(.0011)	(.0008)	(.0007)	(.0095)	(.0095)
$U_{rt}^{+}=U_{rt}^{-}$[1]	.38	.20	.49	.49	1.09	.00	.16	.32	3.98[b]	.50
$U_{rt}^{+}=U_{rt}^{-}=0$[1]	4.88[c]	1.43	3.53	2.41	1.56	11.05[a]	20.01[a]	2.94	7.19[b]	.93
	Vehicle accidents	Circul. system	Cancer	Nervous system	Respir. diseases	Digestive diseases	Mental health	Infect. diseases	Adverse events	
U_{rt}^{+}	-.0010	.0004	.0004	-.0014	-.0046[b]	.0059[b]	.0044	-.0042	.0266	
	(.0046)	(.0010)	(.0008)	(.0041)	(.0021)	(.0024)	(.0125)	(.0080)	(.0203)	
U_{rt}^{-}	.0009	.0003	.0015[b]	.0000	-.0050[b]	.0043[c]	.0032	-.0042	.0342[c]	
	(.0047)	(.0012)	(.0007)	(.0049)	(.0022)	(.0025)	(.0158)	(.0079)	(.0200)	
$U_{rt}^{+}=U_{rt}^{-}$[1]	2.26	.00	6.14[b]	.78	.27	2.30	.06	.00	2.01	
$U_{rt}^{+}=U_{rt}^{-}=0$[1]	2.30	.17	8.79[b]	1.14	5.34[c]	7.62[b]	.42	.29	4.58	

Source: Hellenic Statistical Authority (EL.STAT) and Labour Force Survey (LFS).

Notes: Poisson regression parameter estimates. Death rate (death count per 100,000 population) is the dependent variable. All models control for time and region fixed effects, regional time trends and local demographics. Robust standard errors clustered by region in parentheses. [a] p<.01, [b] p<.05, [c] p<.1. F-test χ^2-values.

Table 6. Asymmetric specifications: Unemployment increases and decreases as functions of time

	Overall	Males	Females	≤24 years	25-44 years	45-64 years	65-74 years	≥75 years	Suicides	Homicides
U_{rt}^{+} marginal effect	.0021[a]	.0018[a]	.0024[b]	.0066[c]	-.0024	-.0040[a]	.0037[a]	.0027[a]	.0074	.0137
	(.0007)	(.0007)	(.0009)	(.0038)	(.0027)	(.0012)	(.0010)	(.0007)	(.0111)	(.0113)
$t \times U_{rt}^{+}$	-.0002[a]	-.0002[a]	-.0002[a]	-.0003[b]	-.0000	.0001	-.0002[b]	-.0002[a]	.0011[a]	-.0006
	(.0000)	(.0000)	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)	(.0004)	(.0007)
U_{rt}^{-} marginal effect	.0027[a]	.0024[a]	.0030[a]	.0077[c]	-.0003	-.0040[a]	.0043[a]	.0033[a]	.0124	.0150
	(.0008)	(.0008)	(.0011)	(.0042)	(.0022)	(.0014)	(.0012)	(.0009)	(.0112)	(.0120)
$t \times U_{rt}^{-}$	-.0002[a]	-.0002[a]	-.0002[b]	-.0003[b]	-.0002	.0000	-.0002[b]	-.0003[a]	.0010[a]	-.0009
	(.0000)	(.0001)	(.0001)	(.0001)	(.0002)	(.0000)	(.0001)	(.0001)	(.0003)	(.0009)
$U_{rt}^{+}=U_{rt}^{-}$[1]	4.82[b]	7.55[a]	1.70	.34	4.79[b]	.00	1.15	4.22[b]	3.27[c]	.43
$U_{rt}^{+}=U_{rt}^{-}=0$[1]	14.38[a]	20.38[a]	9.01[b]	6.86[b]	4.80[c]	5.83[c]	10.35[a]	23.45[a]	3.87	1.46
$t \times U_{rt}^{+}=t \times U_{rt}^{-}$[1]	3.71[c]	6.11[b]	.95	.01	2.55	.00	1.37	2.86[c]	.96	.59
	Vehicle accidents	Circul. System	Cancer	Nervous system	Respir. diseases	Digestive diseases	Mental health	Infect. diseases	Adverse events	
U_{rt}^{+} marginal effect	.0002	.0014	.0012	-.0007	-.0006	.0075[a]	.0089	-.0026	-.0030	
	(.0047)	(.0010)	(.0009)	(.0044)	(.0028)	(.0020)	(.0143)	(.0078)	(.0219)	
$t \times U_{rt}^{+}$	-.0003[c]	-.0002[a]	-.0001[a]	-.0001	-.0005[a]	-.0002[b]	-.0005	-.0002	.0027[a]	
	(.0002)	(.0001)	(.0000)	(.0002)	(.0001)	(.0001)	(.0005)	(.0002)	(.0009)	
U_{rt}^{-} marginal effect	.0026	.0018	.0024[a]	.0016	-.0001	.0060[b]	.0080	-.0004	-.0041	
	(.0050)	(.0011)	(.0008)	(.0051)	(.0029)	(.0023)	(.0170)	(.0078)	(.0249)	
$t \times U_{rt}^{-}$	-.0004[b]	-.0002[a]	-.0001[b]	-.0001	-.0005[a]	-.0002	-.0005	-.0003	.0032[a]	
	(.0002)	(.0001)	(.0001)	(.0002)	(.0001)	(.0001)	(.0007)	(.0003)	(.0010)	
$U_{rt}^{+}=U_{rt}^{-}$[1]	3.37[c]	5.00[b]	.86	1.81	1.70	.41	.01	1.12	.88	
$U_{rt}^{+}=U_{rt}^{-}=0$[1]	5.12[c]	8.84[b]	8.71[b]	2.02	6.42[b]	31.85[a]	1.07	1.19	4.64[c]	
$t \times U_{rt}^{+}=t \times U_{rt}^{-}$[1]	2.56	5.93[b]	.06	.75	3.00[c]	.05	.00	.90	2.18	

Source: Hellenic Statistical Authority (EL.STAT) and Labour Force Survey (LFS).

Notes: Poisson regression parameter estimates. Death rate (death count per 100,000 population) is the dependent variable. All models control for time and region fixed effects, regional time trends and local demographics. Robust standard errors clustered by region in parentheses. [a] p<.01, [b] p<.05, [c] p<.1. [1] F-test χ^2-values.