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A REGIONAL INVESTIGATION OF THE IMPACT OF UNEMPLOYMENT AND HOUSEHOLD INCOME ON HEALTH

How Do Regional Differences and Crises Affect Mortality across Europe?

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Abstract. This thesis investigates the direct impact unemployment and household income have on mortality on a regional level across nine European countries between 2000 and 2010. We observe a significantly negative relationship between unemployment and all-cause mortality as well as a number of cause-specific mortality categories. Increases in household income are associated with rising all-cause mortality and higher death rates due to cardiovascular diseases. We attribute these findings to what can be described as the cost of wealth. After segmenting our sample into quintiles based on household income, we find that this relationship is strongest in poorer regions across Europe. Furthermore, we investigate whether health in crisis regions is disproportionately affected by changes in unemployment or household income in comparison to non-crisis regions. We do so by incorporating two established and two new definitions relative to an internal benchmark of a regional crisis in our model. In contrast to our expectations, we find that the impact of unemployment and household income on mortality does not differ between non-crisis and crisis regions. Overall, it is important to take into account that economic development, associated with lower unemployment and higher household income, might have a deteriorating impact on health.

Keywords: unemployment, household income, mortality, crisis, health

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1 Introduction

The economic crisis in Europe casts its shadow on the entire continent, with hardly foreseeable consequences. What is certain is the damage already dealt: with unemployment at historic heights and declining growth rates, an entire generation feels the impact of past structural mistakes and current policy measures. Any effect of the crisis on our economy can impossibly be isolated. Sluggish growth in combination with substantial public debt may require an equally substantial structural adjustment, the consequences of which may stretch to any part of the public sector and beyond. Investments in education, public administration, and social benefits are under scrutiny. Which effect does cutting them have on our generation?

In light of the crisis, in this thesis, we focus on the relationship between economic change and health. To approximate the link, we analyse the effect of unemployment and household income on both all-cause and cause-specific mortality rates. Incorporating the latest data, we perform a cross-country, regional analysis and find that increases in unemployment are associated with decreases in mortality; increases in household income are associated with increases in mortality. While the results do not differ for national versus regional analyses, performing our study on a regional level increases the significance of our results. A "crisis effect" does not seem to be present; the impact differs between regions in different income brackets across, but not within countries.

Most notably, we find that an increase in unemployment by one per cent is associated with a decrease in all-cause mortality by -0.0152 per cent. More unemployment may lead to lower death rates due to a healthier lifestyle (e.g. more walking outside and less stress) and less work-related traffic accidents. A one per cent increase in household income is associated with an increase in all-cause mortality by 0.1145 per cent. Furthermore, the positive linkage between household income and all-cause mortality may be due to what can be described as the "cost of wealth". Higher household income may lead to higher discretionary expenses on unhealthy products such as alcohol and richer food that decrease health. We further split up mortality into cause-specific mortality groups and find that mortality due to cardiovascular diseases is significantly affected, while mortality due to cancer is not. This might be due to long-term diseases such as cancer being less affected by unemployment and household income than those potentially more closely tied to stress levels and lifestyle habits such as cardiovascular diseases. Increases in household income are associated with decreases in suicides in the Portugal, Ireland, Spain, and Greece (PISG) countries. Increases in unemployment are accompanied by falling death rates due to external causes and traffic accidents.

After conducting an analysis on all-cause and cause-specific mortality, we proceed to a more detailed analysis of the determinants of the link between unemployment, household income, and mortality. This way, we shed light on which regions in Europe are affected in particular. We differentiate between long- and short-term unemployment, analyse whether a "crisis effect", a disproportional impact during crises, exists and perform a quintile analysis across income brackets. Long-term unemployment has a more significant impact on (cause-specific) mortality rates than short-term unemployment. Little difference exists between the effect of unemployment and household income on (cause-specific) mortality rates between crisis and non-crisis regions, disproving our hypothesis of a "crisis effect". Income-related differences in mortality rates seem to be driven by cross-country rather than within-country regional

differences. Increasing discretionary income in poorer income regions may lead to increased expenses on harmful lifestyle habits whereas this happens less in higher income regions across countries. Potentially, increased education or the already higher absolute level of expenditures on higher lifestyle habits in regions with higher income could be a reason for this. Increased discretionary income in relatively poorer countries may lead to higher expenses on harmful lifestyle habits, whereas this happens less in higher income countries.

The data we incorporate is for the time period from 2000 to 2010. This enables us to look at two periods of economic hardship and provides a substantial amount of data. Our analysis extends to nine European countries, encompassing 187 sub-national regions. The countries included in our analysis are Germany, Austria, Belgium, the Netherlands, Sweden, Ireland, Portugal, Spain, and Greece. This enables us to look at both cross-country differences as well as structural differences between Northern and Southern Europe. The selection further encompasses all those European countries most heavily struck by the economic crisis (with the exception of Italy due to lacking data).

We employ a fixed effects model using time dummies to control for general linear time trends. In a second step, we also control for region-specific linear time trends and include a lagged dependent variable (which will not be employed in more detailed specifications). We incorporate and compare four different definitions of crisis: An output recession, mass unemployment, as well as a deviation in regional unemployment by more than one standard deviation from either the national or the regional mean unemployment. To analyse whether households in regions with lower incomes are disproportionately affected, we divide the regions in our sample into quintiles based on household income both *across* as well as *within* countries. We interact these quintiles with unemployment and household income to estimate a potential impact of unemployment and household income within the quintiles.

Our motivation for this research is twofold. Being part of a generation that in some European countries is considered "lost" - and studying together with fellow students from all over Europe - is certainly one of the main reasons for our curiosity about the effect the crisis has in particular. Moreover, our genuine interest in health economics and policy, combined with the ambiguity of and debate around this particular topic, sparked our interest. Policy makers aiming to decrease unemployment and increase income need to bear in mind that more prosperity might be associated with deteriorated health. These effects are mostly driven by long-term unemployment and occur in relatively poorer income groups across Europe. Policy makers should hence be particularly aware of negative health effects when working to improve unemployment or household income in these regions or via long-term unemployment.

In economic research, the relationship between economic change and health has been subject to an on-going debate and came to light more publicly during the current crisis due to the many announced budget cuts and health system reforms. Many fear that these cuts may severely impact people's health: "In an effort to finance public debt, ordinary people are paying the ultimate price: losing access to care" (Kentikelenis et al., 2011, p. 1458). However, the relationship is less clear-cut as one could assume: "[H]ealth *improves* when the economy temporarily deteriorates" (Ruhm, 2000, p. 617). How exactly economic downturns influence people's health is not clear-cut: not only the economic channels that influence health, but also the health aspects of people actually influenced by the economic situation are

debated. The effect may differ across countries and has, to our knowledge, not been compared on a sub-national level across countries. The economic indicators most frequently used include unemployment, Gross Domestic Product (GDP) per capita, and household income. Common health variables include morbidity, infection, mortality rates, and in a few cases, self-reported health or mental health. For some analyses, this debate boils down to the availability of data, which in many cases are not comparable across country borders and hence can be a threat to the external validity of the estimations conducted.

Our hypotheses tie closely to this debate: we investigate the direction of the influence of unemployment and household income on both all-cause and cause-specific mortality. Our aim is to also analyse regional differences and understand the impact a crisis may have on the relationship. It may further be the case that regions within different household income brackets are impacted differently than others.

This thesis extends the research frontier in four dimensions: In terms of geographic fragmentation, it is the first cross-country regional analysis of the impact of unemployment and household income on mortality. We also introduce two new relative definitions of crisis that specifically take regional characteristics and their relation to a national context into account. Moreover, we split up cause-specific mortality rates due to external effects, separating suicide and homicide rates as well as deaths due to traffic accidents from the aforementioned group and analyse two rather than one economic indicator. Lastly, we include the most recent data available.

The internal validity of this study may be limited by omitted variable and reverse causality biases; the former we account for methodologically as far as possible whereas to examine the presence of the latter, micro-level data would be necessary. The external validity of our analysis may be limited for countries that are structurally very different from Western European countries. The detailed geographic fragmentation we employ limits data availability to a certain extent. Furthermore, our results are not fully stable across crisis definitions, which proves the additional value inherent in introducing them, but limits comparability. Lack of availability of control variables on a regional level is one of the main challenges of this thesis; we further would have liked to also analyse morbidity instead of mortality only. Lastly, performing this study in a few years and including lagged regressors might provide interesting insights on long-term effects.

Future research could look into a geographic extension of the study by including a third country group or performing the analysis on a set of completely different countries; moreover, employing the crisis definitions introduced in this thesis or other definitions of crisis relative to a regional/country benchmark in other studies has the potential to provide valuable information about regional versus national crisis effects. An interesting extension of our study would be to include more control variables and/or morbidity as well as health expenditures. Performing a similar study on the same regional data in the future might provide insights on long-term effects.

This thesis is structured as follows: *Section 2* introduces the literature and our hypotheses. *Section 3* gives an overview over our dataset and the variables we employ. *Section 4* outlines our estimation strategy. *Section 5* presents our results; in *Section 6*, we interpret and discuss our results, outline the limitations of our work and critically reflect about our methods, depict potential policy implications and point towards opportunities for future research. *Section 7* concludes.

2 Literature Review and Hypotheses

In this section, we give an overview over developments in the literature on how economic change can influence public health. First, we outline the most important broad analyses towards economic crises and health. Second, we split our analysis up by geography and look at Europe in general and Northern and Southern Europe in particular, differentiating by health insurances systems. Third, we categorise the literature by parameters used to describe the relationship between health and economic change. At the end of this section, we outline the hypotheses that are the result of our literature research and guide our work.

2.1 Public Health and Economic Change

The link between economic trends and changes in public health is well-established: the World Health Organization (WHO) has, at various occasions, underlined the importance of this connection (WHO, 2009a,b). The Organization for Economic Cooperation and Development (OECD) seconds this (Morgan and Astolfi, 2013; Scherer and Devaux, 2010). While the effect's existence is almost unquestioned, its direction, extent, and the channels through which it works are a matter of frequent debate. The latter point is reflected in *Common Parameterisations*. While it seems intuitive to assume that negative economic trends reduce public health, there also exists a substantial body of evidence towards the opposite: hypotheses that more free time and reduced income could lead to healthier habits (for example, walking rather than taking the car, eating healthier) have recently gotten support from evidence by Ruhm (2000, 2005). The author finds that total mortality and some causes of death exhibit economic pro-cyclicality and, in a second study, observes that obesity and smoking increase during economic upturns. Moreover, decreased economic activity could reduce the number of traffic accidents and work-related injuries. However, using the same dataset, Economou et al. (2008) do not find evidence for a positive effect of economic downturns on health, but to the contrary observe a negative one. In general, the relationship between income and health is a complicated relationship. It is widely accepted that poverty is associated with a greater risk of premature mortality and higher morbidity (Marmot, 2002). However, at low levels of Gross National Product (GNP), higher income corresponds to a large decrease in mortality, whereas the effect levels off at higher levels of income comparing *across* countries. Additionally, *within* rich countries, it has been documented that higher income leads to lower mortality, though effects are smaller when accounting for education. Income may be important for health due to lower incomes being linked to material deprivation, less control over one's life and the future reducing optimism, and less opportunity for social participation (leading to more stress) (Marmot, 2002). Still, the link between wealth and health is not always positive. It has been documented extensively *inter alia* by the WHO and James (2008) that diseases such as obesity and diabetes are far more prevalent in higher-income countries than in lower- or middle-income countries. Then again, for rich countries, prior research finds evidence that poor health due to obesity, diabetes and sedentariness is higher among the poor (Levine, 2011).

Hence, the way in which economic change (mostly via unemployment and income) relates to health may not be as clearcut as it seems at first sight. As the majority of the literature on the topic finds a negative impact of economic downturns on health, the following section will focus more on a perspective in which there is a counter-cyclical perspective on the relationship between the state of the

economy mortality; we do however also include pro-cyclical examples as well to provide a somewhat more balanced view. Moreover, the literature on the topic is extensive; hence we aim to give diverse examples rather than provide an overview as complete or detailed as possible.

Murphy and Athanasou (1999) analyse sixteen studies of the effect of a change in employment status on mental health - separated in a positive effect of gaining and a negative effect of losing employment - and find many of them to support the existence of a relationship. Catalano (2009) puts this into the context of the current economic crisis and finds strong correlation between job loss and clinical and subclinical depression, anxiety, substance abuse, and antisocial behaviour. Workers with historical illness records may affect their health-related behaviour in two ways when competing for scarce jobs during economic downturns: Those whose absenteeism is due to risk-taking behaviour (e.g. alcohol abuse) may try harder to control themselves; those with chronic illnesses may work in spite of their illness, further decreasing their health. One potential limitation identified in particular with regards to mental health is a potential selection bias: Those with unstable mental health might be the first to lose their jobs. Another interesting study by Roelfs et al. (2011) provides fairly recent evidence across a variety of countries and time periods in a meta-analysis that unemployment is indeed associated with an increased mortality risk for those employees that are in the early or middle stages of their career, but that the effect is reversed in their late-career.

Further literature focuses on the impact of crises on nutrition and food consumption in the context of health. In crises, food prices tend to rise and household incomes to decline. Brinkmann et al. (2010) assess the impact of changes in diet frequency and diversity on nutritional status and health globally. They find a negative relationship between food prices and health for various countries and that households decrease the quality of their food intake first, then the quantity. Cutler et al. (2002) examine the impact of economic downturns on mortality for various time frames in Mexico and find a significant impact of lower household incomes and, to a lesser extent, an increased burden on the medical sector. Furthermore, according to the authors, this effect is more pronounced for the very young and the elderly. Contrary to Catalano (2009)'s hypothesis, they do not find evidence for reduced health due to economic crises forcing less healthy people to work. Walberg et al. (1998) analyse the effect of the 1990-94 economic crisis in Russia and conclude that not mere impoverishment, but an interaction of various socioeconomic factors lead to substantially increased rates of mortality, alcohol playing a major role. They further find effects for men and women to be highly correlated. The former is an important finding also in the context of our work: while finding an effect of economic determinants on public health is what we strive for, policy recommendations will always have to take a more holistic perspective. Garfield and Santana (1997) assess the impact of the US embargo on Cuba at the end of the 1980s and the beginning of the 1990s, finding declining nutritional status and increases in violent deaths as well as infectious disease prevalence. However, they find a significant impact on mortality only for men, contrary to Walberg et al. (1998). Lastly, Paxson and Schady (2005) find a significant impact of public (and potentially, private) health expenditure on infant mortality in Peru during the late 1980s, leading to an estimated 17,000 more children dead than without a crisis.

2.2 Crises and Public Health in Europe

The current economic crisis has had a particularly strong impact on Europe. Affected member states of the Eurozone have no possibility to devalue their currency and face increasing interest rates on their public (and private) debt as well as declining exports, increasing unemployment rates, and decreasing economic activity in general. Alexander et al. (2011) quantify the cost of economic crises in terms of human lives and find that crises increase infant mortality in the OECD European region. Economou et al. (2008) find similar results for unemployment rates on mortality across countries within the European Union (EU). One has to acknowledge stronger existing socioeconomic protection mechanisms which can significantly cushion absolute effects (Karanikolos et al., 2013). Stuckler et al. (2010) find that increased social spending reduces all-cause mortality. The authors further show that a reduction in employment rates and other economic data (GDP per capita, hours worked, and others) can affect cause-specific mortality rates in Europe.

The financial crisis of 2008 has led to what is now known as the European economic crisis that still casts its shadow over economically weak countries in Europe, mostly in the south. The following subsections briefly outline the research that has been done so far specifically on countries in Northern and Southern Europe.

2.2.1 Northern Europe

We divide the literature discussion about the relationship between health effects and the state of the economy, as measured in business cycles or changes in unemployment, according to the countries' respective insurance system. Although there are differences between the basic models of health insurance, this categorisation is widely accepted in the literature.

Bismarckian. In the Bismarckian system, welfare programmes are often related to the earnings and are administered by the employer (Bambra and Eikemo, 2009). The role of the family is important and the redistributive impact is minimal; the role of the market in this basic health model is marginal. Countries such as Austria, Belgium, Germany, and Switzerland fall into this category. Evidence for the link between health and economic development is somewhat ambiguous. Neumayer (2004) finds evidence in support of Ruhm's original analysis in the sense that after controlling for state-specific effects, aggregate mortality rates are lower in recessions as measured by state unemployment rates (and robustness tests with growth rates of real GDP as key variable provide similar results). However, when not controlling for invariant state-specific effects, the results are reversed and he finds a counter-cyclical pattern between mortality rates and business cycles. This leads the author to suggest that counter-cyclical patterns may be due to Omitted Variable Bias (OVb). Huber et al. (2011) find somewhat contradicting results when investigating the health effects of transitions from welfare to employment and assignment to welfare-to-work programmes. They find that entering employment has a positive effect on health mainly via an increase in mental health due to more self-esteem, a higher sense of purpose and belonging, more social recognition, better self-perception and higher life satisfaction. This again suggests a positive relationship between employment and health. An interesting study by Gordo (2006) adds to the literature by separating the effect that short- and long-term unemployment have on health. The author finds evidence that in Germany, short-term unemployment negatively impacts

health satisfaction only for men, whereas it does not negatively impact health satisfaction for women. Long-term unemployment however has a negative relationship with health for both men and women. Another study that addresses the reverse causality issue between health and unemployment focuses on the short-run effect of involuntary job loss in the event of plant closure in Austria (Kuhn et al., 2009). The authors argue that this prevents reverse causality problems, since job displacements due to plant closure are unlikely to be caused by pre-existing differences in health status. Their findings indicate that although overall medical expenditures do not increase substantially due to job loss, prescriptions on mental health problems (for men) such as anti-depressants increase significantly. Furthermore, sickness benefits strongly increase in case of job loss indicating that unemployment is a costly public expenditure that might also be driven by mental health problems.

Scandinavian. The Scandinavian welfare regimes generally offer the highest social protection to their citizens. The state intervenes more than in the other welfare regimes and is generous on social transfers and income protection (Bambra and Eikemo, 2009). Via governmental redistribution, the state promotes social equality of the highest standards. Most evidence with regard to the topic at hand is rendered on Sweden, although results are not completely consistent. Micro-level data by Gerdtham and Johannesson (2003) render evidence that although unemployment significantly increases the risk of mortality, it only does so via suicides and "other diseases", but not via for example cardiovascular diseases, contrasting other analyses. Gerdtham and Johannesson (2005) extend the evidence on a counter-cyclical relationship between business cycles and mortality risk, however cause-specific results are somewhat different in this research as mortality due to cardiovascular diseases, cancer, and suicide are significantly impacted. Åhs and Westerling (2006) conduct another study on Sweden, finding a significant impact of unemployment on suicides and that the mortality risk among those without employment, the retired or those on temporary disability pension was higher mostly due to suicides. Svensson (2007) finds contradictory evidence: The effect of business cycles is insignificant on myocardial infarction rates in Sweden. Nonetheless, the author finds a significant counter-cyclical effect on average for those people between 20 and 49 (prime working age). Certain authors also focus more detailedly on specific health risks due to unemployment: Bjarnason and Sigurdardottir (2003) find evidence across six Northern countries that leaving unemployment leads to less distress, a psychological factor that could have an impact on mortality. Reine et al. (2004), too, focus on psychological health and determine that long-term unemployment and poor psychological health are linked especially for younger people. More recent evidence also points in the direction of unemployment increasing mortality risk as Lundin et al. (2010) demonstrate in their study. However, Böckerman and Ilmakunnas (2009) provide micro-level data evidence from Finland that unemployment does not necessarily decrease health as they find that becoming unemployed does not have an impact on self-assessed health. Hence, although most Scandinavian evidence points towards a counter-cyclical relationship between business cycles and health (usually proxied by mortality risk), there are some that contradict this stance.

After reviewing the literature for the Northern part of Europe with a focus on Bismarckian and Scandinavian countries due to the countries selected in this research, in the following section we investigate the literature for Southern European countries in more detail.

2.2.2 Southern Europe

The Southern European countries have been struck harder by recent economic hardships. This could result in a pronounced impact of changes in unemployment and wealth on health particularly in the Southern countries. Furthermore, some suggest that relative inequalities in health due to socioeconomic status (such as unemployment) should be larger in these countries (Kunst et al., 1998). Not only do these countries differ in their economic climate, but also in their insurance systems. Bambra and Eikemo (2009) describes the insurance systems in Southern Europe as "rudimentary", characterised by a fragmented system of welfare provisions, ranging from meagre to generous welfare contributions. Furthermore, reliance on family income to compensate for partial coverage is also a prominent feature of these insurance systems.

Greece. According to Fahy (2012), Greece has one of the lowest levels of health system expenditures compared to other EU countries. These expenditures fell by 23.7 per cent between 2010 and 2011 (Kondilis et al., 2013). Policy measures taken by the Greek government, many of these on recommendation of the Troika consisting of EU, International Monetary Fund (IMF), and European Central Bank (ECB), include cuts in minimum wages (reducing households' disposable income), cuts on health spending and wages in the public/health sector, job reductions (150,000 between 2011 and 2015), reduced public spending on pharmaceuticals, and other measures (Karanikolos et al., 2013). Kentikelenis et al. (2011) analyse the impact of the economic downturn in Greece on health, combining socioeconomic data obtained from Eurostat, the European Commission (EC)'s Directorate-General responsible for statistical information and methods, with a survey on health and living conditions. They find significant supply constraints (long waiting times, travel distance to care, etc.) to be the reason for an overall decline in health care coverage. They further link this to a decrease in public health they find in early indicators (survey and statistical data were obtained for the years 2007 and 2009), such as public versus private hospital admissions or self-reported health, as well as suicides and HIV infections. Karanikolos et al. (2013) also report rising mortality rates, reduced access to care, and an increase in the prevalence of mental diseases. Economou et al. (2011) report a 36 per cent increase in the number of people who attempted suicide between 2009 and 2011; they further link this to individual economic distress and find a significantly higher proportion of increasingly distressed people having attempted suicide. Lastly, Kondilis et al. (2013) find increases in homicide and suicide rates in Greece between 2007 and 2009, while the utilisation of public primary care and inpatient services rose by 21.9 per cent and 6.2 per cent, respectively. Kentikelenis and Papnicoas (2011) stress the importance of this imbalance of increasing demand versus reduced supply. They further point out that its "administrative weakness" (Kentikelenis and Papnicoas, 2011, p. 5) constrains the Greek public health system further and argue that vulnerable groups of the society need special protection.

Portugal. According to Augusto (2012, p. 400) Portugal's 2012 national health budget was the toughest in decades with a significant potential to harm people's health. In an exploratory work, Barbosa (2012) studies regional discrepancies of demand and supply for health care within Portugal. His results point towards a disproportionate allocation of public funds towards health care in socioeconomically advantaged regions. Having to save €670 million as stipulated in the agreement between troika and Portuguese government, the state cuts spending on drugs and health workforce and increases user charges (Karanikolos et al., 2013). According to Santana (2000), historically, access to

health and long-term care has been unequal in Portugal. Hence, the measures taken lately may most likely adversely affect the poor, and disproportionately so (Augusto, 2012).

Spain. After the conservative People’s Party won not only the national, but also many regional elections in 2011, health budgets in Spain are under revision and cuts may affect people’s health (Garcia Rada, 2011). According to Karanikolos et al. (2013), the number of hospital beds has been substantially decreased and co-payments for drugs introduced for pensioners. A royal decree (bypassing parliament) was issued in April, 2012, moving health insurance from universal to employment based, effectively subjecting millions of illegal immigrants to emergency care only. Gili et al. (2012) examine the impact of the European economic crisis on the mental health of the population in Spain. Using a randomised sample of outpatient consultations, they find one third of the risk of the overall population developing mental health issues or abusing alcohol to be associated to household unemployment and mortgage repayment difficulties - indicators of economic crises - and conclude that the recession has substantially elevated these risks. Hence, previous evidence of mortality rates increasing pro-cyclically (meaning that mortality rates decrease in an economic expansion when unemployment decreases) rendered in particular by Granados (2005) with respect to the period 1980-1997 might be different in more contemporaneous periods.

The effect of economic crises on public health has been analysed in sufficient breadth and depth to argue in favour of the existence of a negative impact of crises on health in general. In the light of the recent economic crisis, Southern Europe seems to be particularly affected. Evidence from the reviewed literature points towards a negative effect via different channels; furthermore, these channels may differ not only according to the research method used, but also the countries analysed. Most authors focus on one particular country of interest; the few cross-national studies that exist employ national data, which are much more rapidly and easily available. However, we show below that it is of utmost importance not only to look at national, but also at regional comparisons, as people living in some regions within one country may fare much better than others, be it due to the composition of the population or the economic strength of one particular region. Moreover, to identify potential national effects as well as to derive appropriate policy advice, it is of interest how comparably poor regions fare in different national settings.

2.3 Common Parameterisations

Historically and recently, various parameters in both the economics and health domains have served to analyse a potential link between economic development and public health. This subsection gives a brief overview over those frequently applied.

On the economic side, GDP growth and changes therein, severity of recession (Alexander et al., 2011), deviation from the GDP trend, industry capacity utilisation, industry confidence indicators, notification rate of job loss (Gerdttham and Johannesson, 2003) unemployment (Economou et al., 2008) and employment rates, changes in working status, household and/or personal income, and public expenditure on health (total or as per cent of GDP; overall or per capita) have been used in analyses.

In the health domain, mental health (Gili et al., 2012), (infant) mortality rates (Economou et al., 2008; Karanikolos et al., 2013), hospital bed density and/or number, cause-specific mortality, in particular of cardiovascular or hypertensive diseases, suicide (Karanikolos et al., 2013) or homicide, (Economou et al., 2008) infectious disease prevalence (in particular HIV/AIDS (Karanikolos et al., 2013)), length of hospitalisation, medical technological change (for instance proxied by in-patient care admissions), employment levels in the health sector, self-perceived health, substance abuse (drug, alcohol, tobacco consumption (Economou et al., 2008)), nutrition, diabetes prevalence (as consequence of poor food consumption habits), and obesity were included in impact assessments.

Some authors consider education, government social spending, population density/urbanisation (Economou et al., 2008), and poverty rates to have an indirect effect. Furthermore, a number of other socioeconomic factors such as immigrant status and marital conditions have frequently been examined (Gerdtham and Johannesson, 2003). This list is by no means exhaustive, but shows how extensive researchers have made use of available data for different countries to find out via which channels economic crises can affect public health.

2.4 Common Methods

To embed our research in a methodological context, we provide a short overview over the methods applied to analyse the link between economic development and public health. They include descriptive and correlation analyses (Portela and Thomas, 2013) as well as more advanced identification strategies: Statistical estimation strategies employed range from Ordinary Least Squares (OLS) via Fixed Effects (FE) (Economou et al., 2008) and multivariate logistic regression models (Gili et al., 2012) to the development of indices capturing health inequality in countries in order to make outcomes comparable across borders - without having the same data available for all countries (Mackenbach et al., 2008) as well as quantile regression models (Alexander et al., 2011). However, as most analyses compare countries or populations with somewhat similar characteristics, the most commonly applied model is the FE model. In the following, we briefly outline an FE model, as well as a multivariate logistic regression model as examples of how the association between health and economic change is being analysed.

Economou et al. (2008) employ a FE model, controlling for time-invariant characteristics within countries. They use lifestyle risk factors, urbanisation, and medical intervention indicators as control variables and find that adverse economic conditions do have a significant negative impact on health. The dependent variable is age-standardised mortality rates; the primary independent variable is the unemployment rate. Economou et al. control for education, population density, as well as lifestyle factors such as cigarette and alcohol consumption, as well as obesity. They then analyse the effect of unemployment on seven different age-standardised causes of mortality (ischaemic heart diseases, cancer, malignant neoplasms, motor vehicle accidents, homicide and purposeful injury, suicide and self-inflicted injury, as well as infant mortality) and hypothesise that some of these should be affected by economic crises, whereas others may not.

Gili et al. (2012) examine the effect of the European economic crisis on people's mental health by comparing the results of a survey, conducted in 2006 and 2010 in Spain. Using a multivariate logistic

regression model, they find that in 2010, the proportion of patients diagnosed with mood, anxiety, somatoform, and alcohol disorders increased significantly, while diagnoses of eating disorders remained constant (and insignificant). The dependent variable is the probability of having one of the above-mentioned disorders. They further include a year-dummy to estimate the changes in the probability of psychiatric morbidity between 2006 and 2010 and control for various socioeconomic variables such as age, gender, marital status, education, and whether patients live in an urban environment. In a second step, they evaluate the determinants of the (increased) probability of diagnosis and find that about one third of the risk can be attributed to the combined risks of mortgage payment difficulties and household unemployment.

2.5 Hypotheses

Below, we state our hypotheses. They follow our reasoning from a more general perspective on Europe as a whole and variation between countries towards a more detailed analysis on a regional level.

- (1) Unemployment and household income impact mortality across Europe.
- (2) Unemployment and household income affect some causes of death more than others (e.g. circulatory versus chronic).
- (3) The impact differs when looking at a regional or a country-specific level.
- (4) The impact differs between regions depending on whether they are in a state of crisis or not.
- (5) The impact differs between regions for different income brackets across countries - poor regions are disproportionately affected by the crisis in terms of health.

Hypotheses 1 and *2* are our point of departure: The ambiguity of results reflected in the literature as well as the substantial theoretical and interpretative differences between among others Economou et al. (2008), Kentikelenis et al. (2011) on the one and Ruhm (2000) on the other side sparked our interest in the matter. *Hypothesis 3* reflects the fact that in the economic research above, the discussion on the economic research above is based on different regional and national studies, rendering ambiguous results. *Hypothesis 4* reflects our interest in the current economic crisis and its potential disproportionate effect on the relationship between unemployment, household income, and mortality. Only limited research on this exists (see for example (Stuckler et al., 2009)). Analysing *Hypothesis 5*, we hope to further the understanding on which regions within Europe are more affected by the above.

Summary. This section gives an overview over the relevant literature and categorises it, as well as common parameterisations and methods employed. The effect of crises on public health is a matter of frequent discussion in both the economic and the health domain. Its strength and direction are debated. In the context of existing research and the conflicting views therein, we further introduce our hypotheses. The next section introduces our data.

3 Data and Parameters

In this section, we outline our data sources and choice of parameters as well as the underlying reasoning. Standardised data on public health and economic indicators are available from WHO, OECD, as well as Eurostat. We then explore the compiled dataset to give an overview over the data gathered.

3.1 Data Sources

The core of this work is the *Regional Statistics Database* of Eurostat. It enables us to analyse data of sufficient geographic fragmentation and provides data on various regional levels according to the Nomenclature of Territorial Units for Statistics (NUTS) classification (Eurostat, 2013). Most data are provided on a national as well as two sub-national levels; data for more detailed fragmentations exist, but unfortunately not for all indicators we use. However, our results are of great value already on a NUTS 2 basis. The NUTS standard harmonises statistical geographical areas within the EU by population size. For example, in Spain, NUTS 1 corresponds to three groups of autonomous communities (Comunidades Autónomas) and NUTS 2 to the autonomous communities themselves.

The countries from which we obtain our regional data are Belgium, Germany, Netherlands, Austria, Sweden, Portugal, Ireland, Greece and Spain. The former five countries correspond to a group of economically stronger countries characterised by an insurance system that is either Scandinavian or Bismarckian. Our original intention was to also include Denmark and Finland in our analysis; however, do to a lack of data on a regional basis we decided not to do so. Furthermore, we decided not to include Norway either, considering its oil driven economy and relative insensitivity to the recent economic hardships. Portugal, Greece and Spain are characterised by a Southern European insurance system and form a group of economically weaker countries. Although Ireland does not have a similar insurance system (namely Anglo-Saxon), in comparison to the Mediterranean countries included in our sample, we felt it would be inappropriate to exclude a country that was also severely impacted by the poor economic climate over the last years. Unfortunately, we can not include the complete set of Portugal, Italy, Ireland, Spain, and Greece (PIISG) countries in this research due to the lack of regional data for Italy. However, we believe that the countries chosen in this thesis renders a set of countries corresponding to two groups: one set of economically stronger countries characterised by Scandinavian or Bismarckian insurance systems and one set of weaker countries mainly characterised by Southern European insurance systems. Although there are regional data available on some Central and Eastern European countries, though certainly not all, we feel that both their insurance systems, the economic state of these countries, as well as their history as part of the former Soviet Union make them too different to be included in our sample.

Our data covers a time period of eleven years, from 2000 to 2010. However, 2010 is dropped when introducing a one-year time lag. This period covers sufficient economic change and provides us with many crisis data, a fact we illustrate in *Section* .

3.2 Choice of Parameters

As depicted in *Common Parameterisations*, there has been a great variety throughout the literature with respect to the choice of both health and economic, as well as a wide range of control variables.

Economic variables. From an economic perspective, both variables related to employment statistics and variables related to output (e.g. GDP, capacity utilisation) and income can be justified. Results, however, can differ depending on the key explanatory variable, since the strength of the association between unemployment and GDP varies significantly over time and across countries (due to for instance diverging fiscal responses across countries). This implies that both indicators need not necessarily be highly correlated, even though decreases in GDP generally are connected to increases in unemployment (Stuckler et al., 2009). On the one hand, (un)employment arguably relates more strongly to changes in health than other indicators and could have a stronger impact on more vulnerable members of society than output indicators that look more at a region’s aggregate productivity (averaged if per capita) (Stuckler et al., 2009). On the other hand, using unemployment entails certain drawback as well: Gerdtham and Johannesson (2005) point out that unemployment does not account for changes in the labour force, nor does it reflect government-sponsored labour market policy programs. Moreover, reverse causality could appear between unemployment and health. However, the argument that unemployment may relate more directly to health and possibly may illustrate better the impact of economic downturns on public health leads us make the unemployment rate the principal economic variable of interest. To ensure completeness, we also explore the impact of household income as a measure of the state of the economy. Moreover, we will take both short- and long-term unemployment into account. Short-term unemployment is here defined as less than twelve months of unemployment; long-term as twelve months or more.

Health variables. Two variables appear to be of particular importance when investigating the relationship between public health and the state of the economy: mortality and morbidity rates. Since morbidity rates are generally not available on NUTS 2 basis and regional exploration forms a key part of this thesis, the principal health variables are mortality rates. More specifically, we use both the crude mortality rate (per 100,000 inhabitants) and the crude infant mortality rate to measure the general effect of economic downturns on public health. Furthermore, we analyse whether some causes of death exhibit significant changes during times of crisis. Here, we use a methodology close to that of Gerdtham and Johannesson (2003), who categorise causes of death into five groups reflecting a duality between mortality due to diseases and due to external causes. We employ a similar duality, segmenting death by external causes somewhat further. We expect the effect of unemployment (or other indicators of poor economic times) to impact health differently across diseases. It can safely be assumed that, in the short run, in Western societies, unemployment has a stronger link to cardiovascular diseases (due to its relationship to lifestyle factors such as nutrition and alcohol/tobacco consumption) than to cancer. Therefore, both mortality rates due to cardiovascular diseases (International Statistical Classification of Diseases and Related Health Problems (ICD) I00-99) and cancer (ICD C00-D48) serve as separate groups, effectively creating a control group in the form of people deceased due to cancer. We further include death due to nutritional diseases (ICD E00-99, including for example diabetes) as well as mental and behavioural diseases (ICD F00-99). With regard to death due to external causes, Gerdtham and Johannesson (2003) differentiate between suicide (ICD X60-84, Y870) and deaths due to other external

causes (accidents, motor vehicle accidents, and homicides). In this thesis, we further segment the latter group to differentiate between traffic accidents (ICD V01-99, Y85), homicides (X85-Y09, Y871), and other external causes (ICD V01-Y89 subtracting traffic accidents, homicides), because among others Ruhm (2000) suggests that due to a lower economic activity, traffic accidents could decrease in sluggish economic times. The relationship between business cycles, crises, and crime is slightly ambiguous. On the one hand, research shows that high unemployment rates are correlated with more psychological and behavioural disorders possibly leading to more violence and homicides (Lester, 2001). On the other hand, a number of authors among which Ruhm (2000) finds pro-cyclical evidence on murders since increases in unemployment, and thus a deteriorating economy, reduce homicides. To investigate this, we define a separate indicator for death due to homicide. Furthermore, we define a residual group, incorporating diseases potentially related to unemployment.

Control variables. Lastly, we control for a number of factors to ensure robustness. Following the majority of literature on this topic, we include an education variable in the form of the proportion of people between 20 and 64 with upper secondary or tertiary educational attainment as there may exist an inverse relationship between education and mortality risk. Furthermore, since population density tends to be positively correlated to mortality levels (possibly as a result of higher rates of psychological illness or easier transfer of infectious diseases in densely populated areas), we also control for the degree of urbanisation.¹ Moreover, we use year-dummies to control for year-fixed effects and control for region-specific time trends to exclude any regional trend impacting mortality rates over time. We provide an overview in *Table 1* below.

Table 1 Variable Overview

Variable	Variable Label
unemployment	Unemployment percentage compared to labour population
household income	Primary household income in purchasing power standard
educ	Education
degurb	Degree of urbanisation
all-cause	Crude mortality rate all-cause
cardio	Crude mortality rate due to cardiovascular diseases
cancer	Crude mortality rate due to malignant neoplasms (cancer)
nutrition	Crude mortality rate due to nutritional diseases
mental	Crude mortality rate due to mental diseases
otherext	Crude mortality rate due to other external causes (excluding traffic, homicide, suicide)
residual	Crude mortality rate residual group (excl mental diseases)
traffic	Crude mortality rate due to traffic accidents
homicides	Crude mortality rate due to homicides
suicides	Crude mortality rate due to suicides

3.3 Data Exploration

After explaining the choice of parameters considered in this thesis, in the following section we explore the data to make the reader comfortable with the variables used throughout the analysis. The following

¹See also Economou et al. (2008, p. 372), who suggest that "highly urbanised areas are expected to exhibit a higher incidence of mental and psychosomatic diseases, due to the rapid rhythms in the way of living and the increased stress".

table provides a description of the variables used throughout the analysis with their corresponding descriptions. Mortality rates are always given per 100,000 inhabitants.

We further provide summary statistics for the key variables in *Table 2*. The number of observations for each variable varies between 1199 and 1387 observations. Most variables vary greatly between their 5th and 95th percentile, rendering confidence that there exists enough variation between regions to obtain meaningful results: the percentage difference in unemployment between the 5th and 95th percentile is roughly 15 per cent. The all-cause mortality rates also exhibit sufficient variation, where the maximum all-cause mortality rate per 100,000 inhabitants is roughly threefold of the minimum all-cause mortality rate in the dataset.

Table 2 Summary Statistics of Key Variables

Variable	mean	min	p5	p50	p95	max	N
unemployment	.082	.012	.029	.071	.178	.304	1387
household income	17397.9	8225.1	10881.7	17576.3	23364.8	28605.6	1209
educ	66.1	12.8	30.5	71.7	86.8	96.7	1343
degurb	.485	.0287	.129	.472	1.000	1.000	1199
all-cause	966.0	507.6	695.4	976.9	1185.4	1449.7	1242
cardio	388.1	136.1	228.3	384.25	550.3	648	1242
cancer	241.8	109.1	183.3	244.7	288.9	344.9	1242
nutrition	30.6	5.0	10.7	28.5	60.8	103.7	1242
mental	22.1	.2	1.0	19.5	53.7	90.1	1237
otherext	20.8	3.0	11.0	19.4	37.2	47.7	1216
residual	240.4	112.8	161.7	233.7	345.7	487.8	1237
traffic	10.0	1.4	3.7	8.7	19.8	41.8	1241
homicides	.9	.1	.3	.8	2.0	6.1	1216
suicides	11.3	1.0	3.1	11.3	20.8	29.3	1241

The fact that there is substantial variation in a variable does not necessarily mean that there are differences in the respective variable across countries or regions. Although a substantial variation in unemployment rates between countries struck more intensely by the crisis and those not may seem intuitive, it is nevertheless important to check whether this is indeed the case. A similar reasoning applies to whether there exists variation across regions. It can easily be observed, however, that there is substantial variation across countries from *Figure 1* and *2*. Furthermore, taking Spain as an example, there is substantial variation in unemployment rates even within a country struck intensely by the crisis with huge differences between for example for Comunidad de Madrid and Andalucía. *Appendix A.2* provides an overview over the unemployment and household income data by country.

To check whether the variables used throughout this thesis exhibit a relationship before modelling, it is important to check their corresponding correlations. As can be inferred from *Table 3*, where cross-correlations and their corresponding p-values for their significance are shown, most variables display a significant correlation. Furthermore, some basic checks render evidence that the variables have been encoded correctly. Unemployment and household income are negatively correlated with a coefficient of -0.393 , since higher unemployment leads to lower household income. Furthermore, the fact that both mortality rates due to cardiovascular diseases and deaths due to malignant neoplasms (cancer)

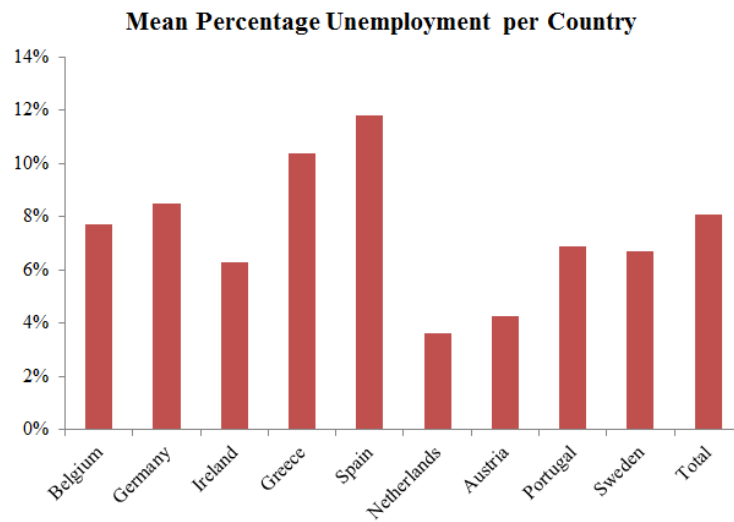


Figure 1 Mean Percentage Unemployment per Country

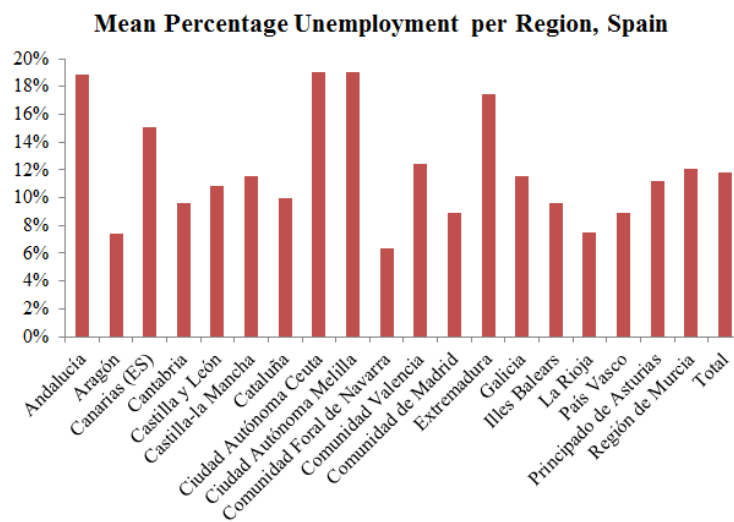


Figure 2 Mean Percentage Unemployment per Region, Spain

are highly correlated with all-cause mortality rates naturally follows from these two causes of death being the main causes of mortality.

Table 3 Cross-correlation Table[†]

Variables	unemployment	income	all-cause	infant	cardio	cancer	nutrit	mental	residual	otherext	suicides	homicides
unemployment	1.000											
income	-0.393 (0.000)	1.000										
all-cause	0.174 (0.000)	-0.194 (0.000)	1.000									
infant	-0.013 (0.643)	0.145 (0.000)	-0.169 (0.000)	1.000								
cardio	0.161 (0.000)	-0.081 (0.006)	0.829 (0.000)	-0.169 (0.000)	1.000							
cancer	0.034 (0.231)	0.102 (0.001)	0.798 (0.000)	0.004 (0.887)	0.589 (0.000)	1.000						
nutrition	-0.069 (0.016)	-0.129 (0.000)	0.233 (0.000)	0.018 (0.537)	0.006 (0.834)	0.172 (0.000)	1.000					
mental	-0.194 (0.000)	0.331 (0.000)	-0.082 (0.004)	0.227 (0.000)	-0.341 (0.000)	0.178 (0.000)	0.303 (0.000)	1.000				
residual	0.211 (0.000)	-0.399 (0.000)	0.491 (0.000)	-0.076 (0.009)	0.006 (0.837)	0.303 (0.000)	0.170 (0.000)	0.070 (0.013)	1.000			
otherext	-0.109 (0.000)	-0.066 (0.024)	0.438 (0.000)	-0.134 (0.000)	0.290 (0.000)	0.281 (0.000)	0.351 (0.000)	0.068 (0.017)	0.145 (0.000)	1.000		
suicides	-0.288 (0.000)	0.302 (0.000)	0.217 (0.000)	0.097 (0.001)	0.104 (0.000)	0.280 (0.000)	0.500 (0.000)	0.450 (0.000)	-0.065 (0.022)	0.626 (0.000)	1.000	
homicides	0.083 (0.004)	-0.201 (0.000)	-0.046 (0.109)	-0.044 (0.138)	-0.155 (0.000)	-0.210 (0.000)	-0.039 (0.170)	-0.094 (0.001)	0.228 (0.000)	0.194 (0.000)	-0.033 (0.252)	1.000

[†]The correlations of the variables depicted here are in logarithms. *unemployment* is the logarithm of percentage unemployment. *income* is the logarithm of primary household income. The cause-specific mortality rates are defined as given in *Table 1*. *p*-values are given between parentheses.

In this section, we present our data source and analyse the parameters commonly used in the literature to examine the link between public health and economic change. We give a first insight into the structure of our dataset and identify the economic, health, and control variables most promising for our analysis. The next section gives an overview over methods commonly employed, introduces our crisis definitions, and outlines our estimation strategy.

4 Estimation Strategy

In our choice of an estimation strategy to identify the link between economic crises and public health, we build on methods successfully applied in the literature reviewed in *Section 2* at the beginning of this thesis, adapt them to the needs of a regional analysis, and develop them further. This section first gives an insight into various crisis definitions. We then outline our estimation strategy and our reasoning behind it.

4.1 Crisis Definition

Throughout the literature, economic crises have been defined differently. Simply defining a crisis variable reflecting a fixed period of time that commonly is referred to as a crisis might ignore possible regional diversity. Therefore, we define crisis (or arguably business cycle downturns) in terms of both economic variables of interest: change in GDP and unemployment rate. Starting from the textbook example, we identify a more advanced method used in the literature specific to our analysis; we then continue and develop it further to best fit our specific research interests, in particular regionality. Hence, we define crisis as follows:

GDP. First, we create a dummy relating to the general interpretation of an output recession (two successive quarters of output contraction). For every region, years with negative output growth are marked as recession dummies, approximating crisis years.

Unemployment. Furthermore, similarly to Stuckler et al. (2009), we identify specific periods of mass job loss. These periods may disproportionately affect the health of society above and beyond the normal effect of unemployment on health-related factors. As an example, the overall stress levels in society could be impacted due to job insecurity in poor economic times, leading to more stress-related mortality. Stuckler et al. (2009) defines these periods as those in which the absolute percentage of unemployment rises by more than 3 per cent, corresponding to a change of about two standard deviations. As the 95th percentile of the absolute change in the percentage of unemployed between years corresponds to the aforementioned 3 per cent as well, we believe that it is justified to define a crisis variable based upon the 3 per cent cutoff.

Regional Unemployment. Third and last, we account for the fact that our dataset systematically differs from others in the literature. The regional fragmentation of our data, as well as the time period we choose for our analysis are specific to Europe during two crises.

Hence, we define a regional crisis in two different ways relative to a benchmark. First, we define a regional crisis as a state in which the rate of change of regional unemployment is higher than one standard deviation away from the mean of the rate of change of the *national* unemployment rate. This way, we identify crises during which regions deviate substantially from the nations they are part of. Doing so, we compare regional unemployment trends to the national context they are to be considered in. Second, we define a regional crisis as a state in which the rate of change of regional unemployment is higher than one standard deviation away from the mean of the rate of change of its own *regional* unemployment rate. Hereby, we define a region to experience a crisis when its rate of change in regional

unemployment is substantially different from what can be considered a "normal" state, either compared to the country or to the region itself.

4.2 Model

The panel dataset at hand with data from 2000 to 2010 across a substantial number of European regions (according to NUTS classification) can be used under certain assumptions to obtain consistent estimators in the presence of a possible OVB. We follow the notation by Wooldridge (2002) to define our model. Let y and $\mathbf{x} = (x_1, x_2, \dots, x_k)$ be observable random variables and let c be an unobservable random variable. If c is uncorrelated with each x_j , then c is just a variable that has an impact on y without being related to the explanatory variables of interest. If, however, c is correlated with our observable explanatory variables, meaning that $Cov(x_j, c) \neq 0$ for some j , then putting c in the error term could severely bias our results and will lead to an inconsistent estimation of β . We address this latent variable problem by using a fixed effects model, where unobserved heterogeneity c is accounted for by time-demeaning the variables. To be more specific, the linear unobserved effects model for T periods can be written as follows:

$$y_{it} = \mathbf{x}_{it}\beta + c_i + u_{it}, \quad t = 1, 2, \dots, T \quad (1)$$

where c_i is allowed to be correlated with $\mathbf{x}_{it}$.²

The within transformation can be done by averaging (1) over $t = 1, 2, \dots, T$ to obtain the cross-section equation and subsequently subtracting this from (1). Hence, we first obtain the cross section equation:

$$\bar{y}_i = \bar{\mathbf{x}}_i\beta + c_i + \bar{u}_i \quad (2)$$

where $\bar{y}_i = T^{-1} \sum_{t=1}^T y_{it}$, $\bar{\mathbf{x}}_i = T^{-1} \sum_{t=1}^T \mathbf{x}_{it}$, and $\bar{u}_i = T^{-1} \sum_{t=1}^T u_{it}$

By subtracting (2) from (1), we obtain the FE transformed equation for each t :

$$y_{it} - \bar{y}_i = (\mathbf{x}_{it} - \bar{\mathbf{x}}_i)\beta + u_{it} - \bar{u}_i$$

which can be rewritten as

$$\check{\mathbf{y}}_{it} = \check{\mathbf{x}}_{it}\beta + \check{\mathbf{u}}_{it}, \quad t = 1, 2, \dots, T \quad (3)$$

where $\check{\mathbf{y}}_{it} \equiv y_{it} - \bar{y}_i$, $\check{\mathbf{x}}_{it} \equiv \mathbf{x}_{it} - \bar{\mathbf{x}}_i$, and $\check{\mathbf{u}}_{it} \equiv u_{it} - \bar{u}_i$

Time demeaning the data by subtracting the cross section equation from the original equation has resulted in the removal of the unobserved effect c_i , effectively removing OVB arising from correlation

²The most commonly used specification throughout this paper also includes region-specific time trends, rendering a slightly different notation. Equation (1) can then be written down as $y_{it} = \mathbf{x}_{it}\beta + c_i + \mathbf{w}_{it} + u_{it}$, $t = 1, 2, \dots, T$ where $\mathbf{w}_{it}$ are the region-specific time trends. The cross-sectional equation (2) then becomes: $\bar{y}_i = \bar{\mathbf{x}}_i\beta + c_i + \bar{\mathbf{w}}_i + \bar{u}_i$ and after the within-transformation, the model as put forward by equation (3) is written down as: $\check{\mathbf{y}}_{it} = \check{\mathbf{x}}_{it}\beta + \check{\mathbf{w}}_{it} + \check{\mathbf{u}}_{it}$, $t = 1, 2, \dots, T$

between the observable explanatory variables and the time-invariant error. One drawback of this model is that the vector of explanatory variables cannot contain any time-constant variables. However, as we are only interested in those variables that exhibit time variation, we are not primarily interested in modeling factors that remain constant over time. Thus, we estimate our fixed effects model by (3) and later elaborate on its key variables.

To make sure the model’s underlying assumptions are upheld, we check for both heteroskedasticity and serial correlation.³ Following Greene (2000, p. 598), testing for heteroskedasticity of our model, rejects the null hypothesis of homoskedasticity for all mortality rate categories, indicating the presence of possible heteroskedasticity which could bias our estimates if not accounted for. Therefore, we need to adjust our standard errors to make sure that our estimators are robust and consistent in the presence of heteroskedasticity. Testing for serial correlation following Drukker (2003), our results indicate that the null hypothesis of serial correlation can be rejected for the specifications on almost all category-specific mortality rates.⁴ Consequently, we need to account for both heteroskedasticity and serial correlations in our model. To ensure that standard errors are robust to heteroskedastic and serially correlated disturbances, we follow Drukker (2003) and adjust the variance estimators by clustering at panel data level (NUTS 2 regions), providing a clustered sandwich estimator. Clustering has been used throughout the literature (e.g. Stuckler et al. (2009)) to render heteroskedasticity and autocorrelation consistent estimators.

Thus, the model specified by (3) with clustered standard errors will serve to investigate our hypotheses. To further the readers’ understanding of the upcoming results section, we once more stipulate the key variables: the dependent variables consist out of the logarithm of (cause-specific) mortality rates per 100,000 inhabitants. The first specification in order of columns displays all-cause crude mortality rates as the dependent variable, the second specification uses infant mortality rates as its dependent variable, whereas the specifications hereafter are cause-specific mortality rates such as deaths due to cardiovascular diseases.

For each of these specifications, the two key variables of interest are the logarithm of unemployment percentages (of those aged 15 years and over) and the logarithm of household income. We use logarithms due to a number of reasons: First, logarithms have been used commonly throughout the literature (among others by Neumayer (2004); Ruhm (2000)). Second, and more important, without using logarithms it would not be possible to compare the effect of unemployment relative to the effect of household income serving as a proxy for wealth. Transforming the variables makes it easier to compare which variable has the strongest effect. Due to a lack of complete regional data, we only include two control variables that have been used throughout the literature: education and degree of urbanisation. However, the fixed effects model already accounts for any omitted variable being constant over time. Moreover, we include time dummies to control for general linear time trends and in the specification most used in the paper we also control for region-specific time trend to cancel out any linear trends within regions. Further extensions are explained in their corresponding results table in the next section.

³*Appendix A.3* provides the underlying assumptions of a fixed-effects model in more detail and describes the tests used to check for heteroskedasticity and serial correlation

⁴Only with deaths due to homicides and suicides as the dependent variable we do not detect serial correlation.

5 Results

In this section, we outline the results of our analysis. We first provide the general results of our analysis of the impact of unemployment and household income on mortality. We then extend our study by the crisis indicators introduced above as well as the income quintile analysis, breaking the latter down into a cross-country and a within-country analysis.

5.1 Unemployment, Household Income, and Mortality

Table 4, consisting out of three panels, is ordered by increasing degree of robustness to check the reliability of our results. The first panel controls for education, degree of urbanisation, as well as year- and region-fixed effects. The second panel adds region-specific time trends. Lacking more control variables, we consider this to be an important robustness check. However, by using region-specific trends we control for omitted variables that change linearly over time within regions, making the specification significantly more robust. The third panel adds a lagged dependent variable to remove any still existing trend in the cause-specific mortality rates due to previous years. *Table 4* serves to test *Hypothesis 1* and *2* that unemployment and household income impact mortality across Europe *and* that unemployment and household income affect mortality due to certain causes more than others.

We make a number of interesting observations across the three specifications in *Table 4*. The impact of unemployment and household income on all-cause mortality rates renders the most consistent results. Higher unemployment is associated with a decrease in all-cause mortality rates, whereas an increase in household income is associated with an increase in all-cause mortality rates. Note that these results do not contradict each other: since higher unemployment is likely to lead to lower household income, it follows that these two variables are inversely related. The results are similar to evidence rendered by Ruhm (2000, 2005): they support the theory that unemployment has a positive impact on health due to more free time, reducing stress, and that lower household income leads to healthier habits (for example, walking rather than taking the car, eating healthier). In light of this pro-cyclical evidence, where economic upturns lead to higher mortality, it seems appropriate to check whether these theories hold when observing cause-specific mortality rates. Infant mortality does not seem to be related to business cycles in any specification.⁵

As expected, we do find significant results (in specifications A and B) for cardiovascular diseases, whereas cancer is not impacted by neither unemployment nor household income.⁶ Previous work (for example by Gerdtham and Johannesson (2003), Gerdtham and Ruhm (2006)) has shown that malignant neoplasms are less sensitive to changes in economic factors. It has been argued that unlike mortality due to cardiovascular diseases, mortality due to cancer is less related to macroeconomic conditions. Mortality arising from cancer may be less affected by short-term changes in medical care or lifestyle habits. Considering that we also look at the short-term impact of economic change via

⁵Considering the advanced economic development within the EU, this is not surprising.

⁶As the effect of household income on mortality may differ for low and high incomes, we perform our analysis also for household income, squared. The quadratic and level variables are, however, almost perfectly correlated (0.9903), which causes one of the two to drop out of our analysis due to collinearity and leads us to not further consider a quadratic variable in this research.

unemployment and household income, our results support this line of reasoning. Household income does not significantly impact cardiovascular diseases when incorporating a lagged dependent variable. However, specifications A and B render some evidence that increases in household income are followed by higher morality rates due to cardiovascular diseases. Higher income could indicate unhealthier dietary habits facilitated by higher discretionary income, which could have a negative impact on health.

Table 4 Unemployment and Household Income on Mortality Rates[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Panel A: basic specification											
Log Percentage Unemployment	-0.0384*** (0.0071)	-0.0418 (0.0708)	-0.0453*** (0.0099)	-0.0060 (0.0098)	-0.0716 (0.0462)	-0.3560*** (0.0885)	-0.0679*** (0.0152)	-0.0969** (0.0380)	-0.0971** (0.0438)	-0.0766 (0.0921)	0.0644 (0.0544)
Log Household Income	0.2124*** (0.0497)	0.1120 (0.3775)	0.3178*** (0.0745)	0.0670 (0.0548)	0.8946** (0.3460)	0.1471 (0.4673)	0.2110** (0.0959)	0.1988 (0.2634)	-0.0731 (0.2146)	0.0697 (0.5412)	0.0845 (0.3365)
Education	-0.0015 (0.0013)	0.0091 (0.0081)	-0.0001 (0.0011)	-0.0008 (0.0022)	-0.0196*** (0.0052)	-0.0495*** (0.0108)	-0.0050** (0.0021)	0.0068 (0.0072)	-0.0184*** (0.0046)	0.0013 (0.0095)	0.0035 (0.0053)
Degree of urbanisation	0.0095 (0.0327)	-0.6354** (0.2585)	0.0323 (0.0506)	0.0503 (0.0402)	0.0780 (0.2366)	0.8193** (0.3646)	-0.1933*** (0.0598)	0.1037 (0.1659)	-0.0519 (0.1223)	-0.4502 (0.3378)	-0.1455 (0.1844)
Observations	948	913	948	948	948	948	948	933	947	933	947
Number of regions	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.3627	0.1770	0.6804	0.1226	0.1602	0.4038	0.3758	0.1230	0.6549	0.0756	0.0977
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: basic specification including region-specific time trends											
Log Percentage Unemployment	-0.0152*** (0.0050)	-0.0314 (0.0566)	-0.0106 (0.0095)	-0.0014 (0.0059)	-0.0679 (0.0452)	0.0649 (0.0546)	-0.0197* (0.0116)	-0.1309*** (0.0349)	-0.1459*** (0.0458)	-0.1259 (0.1232)	0.0038 (0.0606)
Log Household Income	0.1145*** (0.0415)	0.2628 (0.4326)	0.1460** (0.0578)	0.0268 (0.0454)	0.1619 (0.2475)	0.5122 (0.5505)	0.0705 (0.0983)	0.3464 (0.2438)	0.0239 (0.2711)	0.4600 (0.8020)	-0.0074 (0.5346)
Observations	948	913	948	948	948	948	948	933	947	933	947
Number of regions	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.7478	0.3619	0.8295	0.5481	0.4444	0.6933	0.7046	0.5514	0.7005	0.1187	0.2049
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel C: basic specification including region-specific time trends and lagged dependent variables											
Log Percentage Unemployment	-0.0166** (0.0067)	-0.0198 (0.0684)	-0.0025 (0.0096)	-0.0018 (0.0070)	-0.0841** (0.0371)	0.0692 (0.0467)	-0.0179 (0.0135)	-0.1423*** (0.0416)	-0.1542*** (0.0532)	-0.2329 (0.1469)	-0.0071 (0.0582)
Log Household Income	0.0986*** (0.0361)	0.2286 (0.4794)	0.0765 (0.0569)	0.0144 (0.0517)	0.0450 (0.2792)	0.6859 (0.5829)	0.0695 (0.0788)	0.2463 (0.2595)	0.2662 (0.3349)	0.3849 (0.8847)	-0.2058 (0.4667)
Observations	869	858	869	869	869	869	869	845	868	845	867
Number of region	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.7423	0.3512	0.8124	0.5152	0.4638	0.6970	0.6904	0.5522	0.6980	0.1866	0.2302
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged Dependent Variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. The independent variables of interest are the logarithms of unemployment and household income in the first two rows of each panel. All specifications include controls for education and degree of urbanisation. The panels are displayed in order of robustness: Panel A includes year-fixed and regional-fixed effects. Panel B adds region-specific time trends and panel C adds a lagged dependent variable. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

Furthermore, our results indicate that unemployment also has a negative impact on mortality rates belonging both to the residual group and to other external causes. Another interesting observation can be made when looking at deaths due to traffic accidents: as indicated by Ruhm (2005), decreased economic activity as approximated by higher unemployment could reduce the number of traffic acci-

dents and work-related injuries. Our pan-European regional investigation indicates a similar result, as the effect of unemployment on traffic accidents is negatively significant across all three specifications.

Since testing for joint significance of the region-specific trend dummies indicates that there is a need to account for regional time trends, we are most interested in the results given by panels B and C. The negatively significant impact of unemployment on deaths due to mental diseases in panel A can safely be neglected: the two more robust specifications not only find this effect to be positive, but also insignificant. Panels B and C provide similar results in six out of eleven specifications and the lagged dependent variable is insignificant. Furthermore, the explanatory power of the model does not increase substantially after incorporating lagged dependent variables. To facilitate comparison, we proceed with one uniform specification for cause-specific mortality rates. Trading off the inclusion of insignificant variables in one part with potentially increased explanatory power in the other, we drop the lagged dependent variable in further specifications. With the exception of suicides and homicides, the explanatory power of our model across cause-specific mortality rates is quite high.

Most significant results found in *Table 4* appear to be somewhat driven by the economically weaker countries in our sample. The logarithms of household income significantly affect all-cause mortality rates for the PISG countries, whereas it does not affect mortality rates in the Northern-continental European countries. Furthermore, the relationship between unemployment and mortality due to cardiovascular diseases appears to be opposite between the two segments. The weaker European countries seem to drive overall results in this case. A similar inference can be made with regard to deaths due to traffic accidents. A last observation to be made is that although increases in household income are joined by decreases in suicides in the PISG countries, the same relationship is insignificant in non-crisis countries. One potential explanation is that psychological stress levels in crisis countries are higher, possibly leading to suicides derived from income-related stress. Considering that overall levels of income are higher in the non-crisis countries, the effect of income on suicides might be less straightforward here. This result strengthens our belief that there are indeed differences in the relationship between health and economic change when separating regions according to whether they are impacted by crises or not. However, as we are more interested in defining crisis on a regional level than on a national level, we investigate regional crises further in the following sections. To ensure completeness, *Appendix A.4* provides the same analysis as *Table 4* on a country-basis, separating what we label non-crisis and crisis countries. However, before doing so we first investigate whether there is a difference between the impact of long- and short-term unemployment on health.

Having investigated the impact of unemployment and household income on various cause-specific mortality rates, we fail to reject Hypothesis 1 and 2. Higher unemployment is associated with a decrease in all-cause mortality rates, whereas an increase in household income is associated with an increase in all-cause mortality rates, supporting Hypothesis 1. Furthermore, an increase in mortality due to cardiovascular diseases is associated with an increase (decrease) in household income (unemployment);⁷ mortality due to cancer does not seem to be affected as expected. Furthermore, increases in unemployment are also associated with increases in mortality due to other external causes and traffic accidents.

⁷The increase in mortality due to cardiovascular diseases associated with a decrease in unemployment is only significant in the specification without regional-specific time trends. The direction however is the same and the size of the coefficients similar across specifications.

Increases in household income are associated with decreases in suicides in the PISG countries. Considering the differential impact of both unemployment and household income on various cause-specific mortality rates, we may safely assume that Hypothesis 2 can not be rejected either.

Regional versus national effects. With *Hypothesis 3*, we want to test whether results differ when looking at a regional compared to a national level. *Table 5* depicts panel B for regional as well as national data. We observe that the direction and size of most coefficients is fairly similar. All-cause mortality rates as well as mortality rates due to cardiovascular diseases and cancer render coefficients for unemployment and household income similar in size and direction. However, the regional analysis provides more significant coefficients on unemployment and household income (possibly due to more observations). Although unemployment has a significantly negative impact on deaths due to traffic accidents both on a country and a regional level, the size of the coefficient is half on a regional level. Furthermore, we also test whether the difference in coefficients is significantly different on a country versus a regional level using Welch’s T-test: considering that the difference in coefficients between the regional and national analysis is significant for 6 out of 11 specifications for unemployment and 8 out of 11 specifications for household income, we believe that *Hypothesis 3* can not be rejected.⁸ This strengthens our belief in the validity of performing our research on a regional level. For completeness, *Appendix A.5* provides the cross-country analysis performed for all three panels. Surprisingly, when doing a regional analysis per country as shown in *Appendix A.7*, we hardly find any significant results, possibly due to a reduced number of observations for some countries.

Long- and Short-term Unemployment Prior research indicates that health may be impacted differently by short- and long-term unemployment (Gordo, 2006). From *Table 6*, we observe that long-term employment has a more significant impact on (cause-specific) mortality rates than short-term unemployment. Increases in long-term unemployment appear to be followed by decreases in all-cause mortality rates, whereas short-term unemployment boosts do not significantly affect all-cause mortality rates. A similar inference can be made for the cause-specific mortality rates related to residual diseases, other external causes, and traffic accidents that all exhibit a negative relationship with long-term unemployment, but not with short-term unemployment.⁹ Furthermore, it appears that long-term unemployment increases mortality rates due to mental diseases, whereas short-term unemployment does not - its coefficient even points to the opposite direction. This result is in line with evidence provided by Reine et al. (2004) that especially long-term unemployment is linked to poor mental health.

Long-term unemployment has a more significant impact on (cause-specific) mortality rates than short-term unemployment.

⁸Appendix A.6 provides a more detailed explanation of Welch’s T-test and displays the difference in coefficients and their corresponding significance.

⁹Deaths due to homicides and long-term unemployment also depict a negative relationship, but this is only borderline significant.

Table 5 Regional versus National Analysis[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Panel B-1: Region-specific specification including region-specific time trends											
Log Percentage Unemployment	-0.0152*** (0.0050)	-0.0314 (0.0566)	-0.0106 (0.0095)	-0.0014 (0.0059)	-0.0679 (0.0452)	0.0649 (0.0546)	-0.0197* (0.0116)	-0.1309*** (0.0349)	-0.1459*** (0.0458)	-0.1259 (0.1232)	0.0038 (0.0606)
Log Household Income	0.1145*** (0.0415)	0.2628 (0.4326)	0.1460** (0.0578)	0.0268 (0.0454)	0.1619 (0.2475)	0.5122 (0.5505)	0.0705 (0.0983)	0.3464 (0.2438)	0.0239 (0.2711)	0.4600 (0.8020)	-0.0074 (0.5346)
Observations	948	913	948	948	948	948	948	933	947	933	947
Number of region	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.7478	0.3619	0.8295	0.5481	0.4444	0.6933	0.7046	0.5514	0.7005	0.1187	0.2049
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel B-2: Country-specific specification including country-specific time trends											
Log Percentage Unemployment	-0.0181 (0.0179)	-0.1059 (0.1225)	-0.0135 (0.0503)	-0.0075 (0.0122)	-0.0380 (0.1778)	0.1496 (0.1900)	-0.0331 (0.0411)	-0.1392** (0.0437)	-0.2799*** (0.0207)	-0.1210 (0.0846)	-0.0905 (0.0592)
Log Household Income	0.1283* (0.0614)	-0.6208 (0.7324)	0.1857 (0.2367)	0.0258 (0.0948)	-0.0523 (0.4995)	2.3929* (1.2296)	-0.0629 (0.3717)	0.2020 (0.3594)	-0.6727 (0.4677)	0.5123 (1.1897)	-0.5421 (0.6747)
Observations	74	77	74	74	74	74	74	74	74	74	74
Number of region	9	9	9	9	9	9	9	9	9	9	9
Adjusted R-squared	0.8800	0.7753	0.9183	0.7823	0.6293	0.6566	0.6228	0.7087	0.9245	0.4572	0.3716
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. The independent variables of interest are the logarithms of unemployment and household income in the first two rows of each panel. All specifications include controls for education, degree of urbanisation and year-fixed effects. Panel B-1 accounts for regional-fixed effects and region-specific time trends, whereas panel B-2 accounts for country-fixed effects and country-specific time trends. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

Table 6 Long- and Short-term Unemployment[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Log Percentage Long-Term Unemployment	-0.0080* (0.0046)	-0.0442 (0.0371)	-0.0025 (0.0067)	0.0039 (0.0044)	-0.0554 (0.0371)	0.0989** (0.0397)	-0.0188** (0.0086)	-0.0701*** (0.0226)	-0.0859*** (0.0310)	-0.1576* (0.0925)	-0.0229 (0.0348)
Log Percentage Short-Term Unemployment	-0.0071 (0.0068)	-0.0234 (0.0631)	-0.0120 (0.0089)	-0.0029 (0.0086)	-0.0064 (0.0582)	-0.0858 (0.0619)	0.0078 (0.0179)	0.0044 (0.0350)	-0.0754 (0.0607)	0.0712 (0.1089)	0.0641 (0.1004)
Log Household Income	0.1048** (0.0427)	0.1333 (0.4886)	0.1095 (0.0759)	0.0419 (0.0454)	0.0903 (0.2382)	0.9669 (0.6369)	0.0873 (0.1087)	0.5469** (0.2387)	-0.3574 (0.3468)	-0.1441 (0.8465)	0.0106 (0.6774)
Observations	845	820	845	845	845	845	845	838	844	838	845
Number of region	100	100	100	100	100	100	100	100	100	100	100
Adjusted R-squared	0.7622	0.3681	0.8408	0.5807	0.3848	0.7187	0.7279	0.5797	0.7628	0.1449	0.1973
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. The independent variables of interest are the logarithms of long- and short-term unemployment and household income in the first three rows. All specifications include controls for education and degree of urbanisation. Furthermore, year-fixed effects, regional-fixed effects, and region-specific time trends are accounted for. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

5.2 Crises

In this subsection, we investigate whether our findings are different in regions that can be defined as experiencing a crisis. Doing so, we aim to answer *Hypothesis 4* that the impact of unemployment and household income on mortality rates differs between regions depending on whether they are in a state of crisis or not. To analyse this, we use four crisis variables corresponding to the following definitions:

- (1) Recession: a recession is usually defined as an output contraction of two quarters or more in a row. As we work with annual data, we define a recession as a year in which the region experiences negative GDP growth, assuming that this normally incorporates at least two quarters of output contractions in a row. Even if this was not the case, a year in which there is an output contraction is a strong sign of economic crisis.
- (2) Massunemployment: we define a region to experience mass unemployment if the absolute percentage change in unemployment growth is higher than or equal to 3 per cent.
- (3) Crisisdefinition1: we define a variable that indicates a regional crisis if the region's absolute percentage change in unemployment is larger than the ten year average change in national unemployment plus one standard deviation.
- (4) Crisisdefinition2: we define a variable that indicates a regional crisis if the region's absolute percentage change in unemployment is larger than the ten year average change in the region's own unemployment plus one standard deviation.

The second crisis definition is the most restrictive: it renders the least amount of regions defined to experience a crisis. Furthermore, the regions that display mass unemployment are concentrated in the PISG countries, whereas the regions that experience crisis according to the other three definitions are spread across Europe. It appears that regions experiencing a crisis defined as being in a recession are only slightly overrepresented in PISG countries. Since we create the newly added crisis definitions 1 and 2 relative to its own internal (national or regional) benchmark, it is not surprising that regions experiencing a crisis according to these definitions are more spread out across throughout Europe. *Figure 3* displays the number of crisis regions¹⁰ per crisis definition across the entire time period. In this subsection, we are most interested in the interactions between unemployment and household income with the crisis variables. Therefore, the control variables education and degree of urbanisation and their interactions with the crisis variables are not shown in *Table 7*, although they are controlled for. The table displays four panels constructed in order of the crisis definitions mentioned above.

Panel A shows that the impact of unemployment on all-cause mortality rates is smaller in crisis regions compared to non-crisis regions. To illustrate, the (borderline significant) coefficient of unemployment of -0.0156 on crude death rates becomes less negative when adding the coefficient on the interaction term of 0.0070. A similar inference can be made for deaths due to nutritional diseases and the residual group, where the coefficient on the latter even turns slightly positive instead of negative

¹⁰Defined as a region experiencing a crisis during a given year. This not necessarily implies that the same region experiences a crisis in any other year.

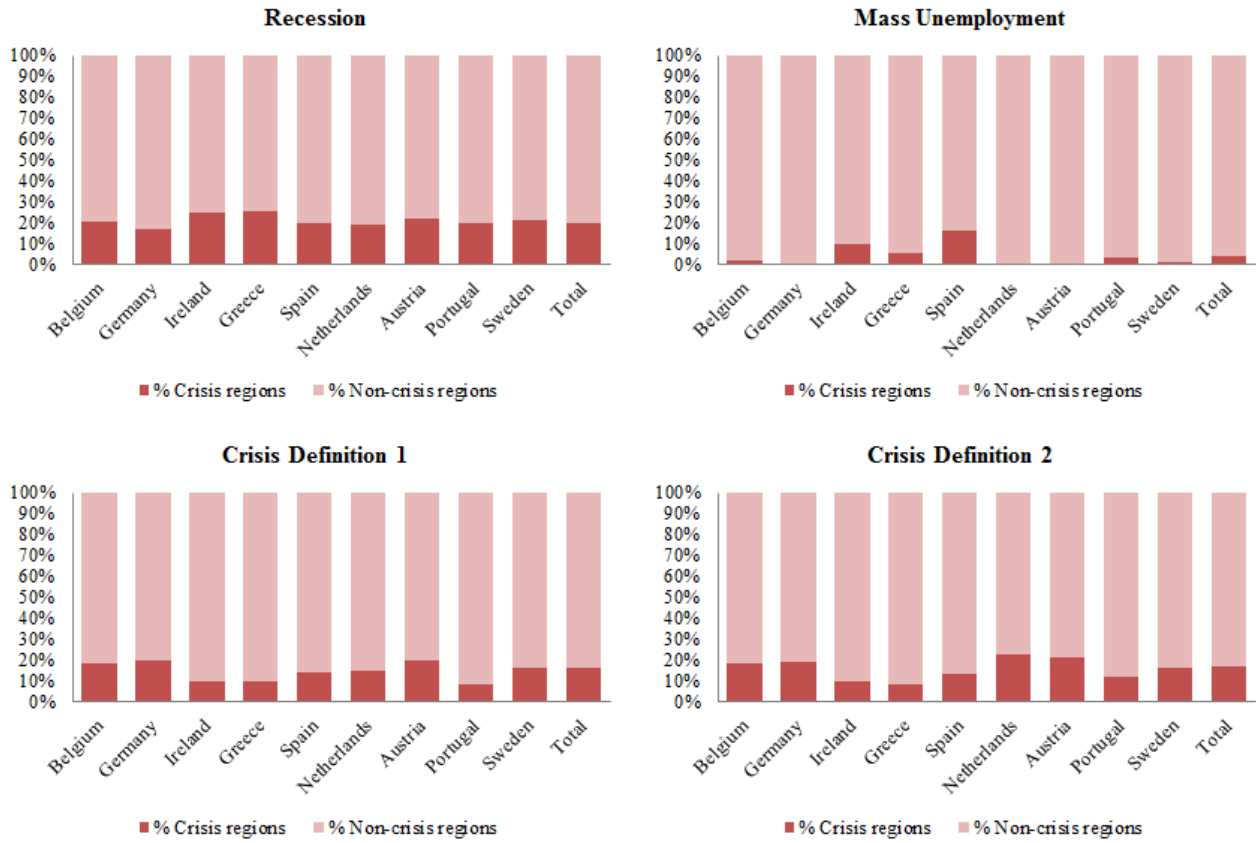


Figure 3 Number of Crisis Regions as Percentage of Total by Crisis Definition

in the crisis regions compared to non-crisis regions. Performing Wald tests indicates that the hypothesis that the added coefficients of *the logarithm of percentage unemployment* and *the interaction term between the logarithm percentage unemployment and recession* on all-cause mortality are jointly zero, cannot be rejected. The same inference can be made when testing the joint significance of these coefficients on either mortality due to nutritional diseases or residual diseases. Thus, to be more specific, it appears that unemployment does not impact (i) all-cause mortality, (ii) mortality due to nutritional diseases and (iii) mortality due to residual diseases *in crisis regions* (suffering a recession). It further appears that when household income increases during crises, more people die of nutritional diseases and diseases in the residual group.

Panel B, in which we use mass unemployment to define regions experiencing a crisis, renders different evidence. It appears that mortality rates in both regions experiencing a crisis and those not experiencing a crisis are significantly negatively impacted by unemployment and significantly positively impacted by household income. The interaction terms are, however, not significant, meaning that there are no substantial differences with regard to all-cause mortality rates between non-crisis and crisis regions. A questionable effect can be found for deaths due to traffic accidents in crisis regions, where the interaction of mass unemployment with unemployment and household income are both borderline negatively significant, while generally these two are inversely related.

In panel C, we define a region to experience a crisis relative to an average change in national unemployment (and hence analyse regions that have higher unemployment than the country average plus one standard deviation). Considering that virtually all interaction terms are insignificant, it seems that there are no substantial differences between unemployment and household income in relation to (cause-specific) mortality rates between non-crisis and crisis regions. The interaction terms only indicate that when unemployment rises in a crisis region, this decreases deaths due to traffic accidents even more than in a non-crisis region. However, the coefficient is only borderline significant.

In panel D, we define a region to experience a crisis relative to its own change in regional unemployment (and hence analyse regions when they experience higher than their own average unemployment over the past decade). Again, in light of virtually all interaction terms being not significant, it seems that there are no substantial differences between unemployment and household income in relation to (cause-specific) mortality rates between non-crisis and crisis regions. There are only a few (borderline) significant interaction terms, which indicate that a crisis compared to a non-crisis region experiences a decrease in deaths due to cardiovascular diseases when unemployment increases. However, keep in mind that the coefficient of -0.011 is only borderline significant. Furthermore, similar to the previous crisis definition, the results indicate that when unemployment rises in a crisis region, this decreases deaths due to traffic accidents even more than in a non-crisis region. Lastly, higher unemployment and higher household income seem to be related to higher deaths due to suicides in crisis regions. Again, this finding is only borderline significant.

Overall, it seems that there is little difference between the effect of unemployment and household income on (cause-specific) mortality rates between crisis and non-crisis regions. Health in crisis regions does not seem to be affected more or less by economic activity than in regions not experiencing a crisis. Furthermore, the significant results inferred from the previous tables must be interpreted with caution as they are not stable across the different crisis definition panels. For completeness, *Appendix A.8* provides the regression results of all crisis definitions, but with unemployment separated in long- and short-term unemployment.

There exists little difference between the effect of unemployment and household income on (cause-specific) mortality rates between crisis and non-crisis regions. Consequently, we reject Hypothesis 4 that the impact differs between non-crisis and crisis regions.

5.3 Income Distribution

Furthermore, we are interested in how the association differs across different income levels. In this section, we test *Hypothesis 5* that the impact of unemployment and household income on mortality differs between regions for different income brackets across countries. We separately analyse the regional effects across and within countries to understand whether there exists a difference in the role income levels play for regional differences in mortality. This also gives us the opportunity to better distinguish between regional effects relating to income differences across all countries and within the countries themselves.

Table 7 Unemployment and Household Income on Mortality Rates during Crises[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) othertext	(9) traffic	(10) homicides	(11) suicides
Panel A: Recession											
Log Percentage Unemployment	-0.0156** (0.0063)	-0.0316 (0.0606)	0.0011 (0.0095)	-0.0003 (0.0073)	-0.1287** (0.0524)	0.0491 (0.0488)	-0.0273** (0.0138)	-0.1331*** (0.0422)	-0.1391** (0.0546)	-0.1081 (0.1412)	-0.0142 (0.0751)
Log Household Income	0.0851** (0.0330)	0.5122 (0.4708)	0.0877* (0.0505)	-0.0095 (0.0481)	0.2869 (0.2965)	0.9716* (0.5576)	0.1040 (0.0797)	0.2016 (0.2639)	0.2104 (0.3465)	1.0340 (0.8603)	-0.0082 (0.5684)
Recession	-0.1235 (0.1153)	0.6656 (1.1189)	0.3485 (0.2190)	-0.0559 (0.1623)	-3.6964*** (1.0028)	-1.3218 (1.3523)	-0.5534** (0.2351)	0.1183 (0.5665)	0.2396 (0.8235)	0.0340 (3.5536)	0.1708 (1.1057)
Interaction Log Perc Unemployment and Recession	0.0070* (0.0040)	0.0416 (0.0385)	-0.0073 (0.0083)	0.0014 (0.0057)	0.1044*** (0.0356)	0.0589 (0.0421)	0.0304*** (0.0086)	-0.0297 (0.0201)	0.0154 (0.0321)	-0.1358 (0.1019)	0.0150 (0.0329)
Interaction Log household income and Recession	0.0137 (0.0133)	-0.0399 (0.1264)	-0.0425 (0.0257)	0.0049 (0.0182)	0.4357*** (0.1145)	0.1562 (0.1569)	0.0657** (0.0265)	-0.0205 (0.0655)	-0.0393 (0.0953)	-0.0432 (0.4064)	0.0030 (0.1271)
Observations	890	869	890	890	890	890	890	877	889	877	889
Number of region	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.7394	0.3559	0.8206	0.5056	0.3855	0.7153	0.7190	0.5673	0.6977	0.1395	0.2266
Panel B: Mass Unemployment											
Log Percentage Unemployment	-0.0133** (0.0064)	-0.0183 (0.0575)	0.0024 (0.0100)	0.0021 (0.0074)	-0.0989* (0.0527)	0.0526 (0.0507)	-0.0211 (0.0132)	-0.1432*** (0.0429)	-0.1272** (0.0510)	-0.2061 (0.1406)	-0.0281 (0.0563)
Log Household Income	0.0892** (0.0356)	0.1708 (0.4531)	0.0776 (0.0545)	0.0080 (0.0484)	0.5574* (0.3062)	0.7367 (0.5356)	0.1115 (0.0813)	0.1793 (0.2694)	-0.1078 (0.3865)	0.4193 (0.8254)	-0.0045 (0.3544)
Massunemployment	0.3123 (0.2972)	-5.5622 (3.5046)	0.3379 (0.4936)	-0.7231** (0.3528)	0.7971 (1.2705)	-4.6480 (3.2316)	1.0287* (0.5637)	0.5944 (1.9460)	4.2269* (2.1483)	-6.2270 (5.9876)	0.8142 (3.1683)
Interaction Log Perc Unemployment and Massunemployment	-0.0138 (0.0168)	0.2409 (0.1838)	-0.0263 (0.0342)	0.0041 (0.0178)	-0.0244 (0.0730)	0.0131 (0.1279)	0.0122 (0.0277)	0.0154 (0.0929)	-0.3191* (0.1611)	0.6257 (0.4917)	-0.1556 (0.2356)
Interaction Log household income and Massunemployment	-0.0383 (0.0347)	0.6430 (0.4146)	-0.0485 (0.0584)	0.0793* (0.0407)	-0.0833 (0.1459)	0.5229 (0.3594)	-0.1114* (0.0647)	-0.0857 (0.2111)	-0.4546* (0.2366)	0.7496 (0.6686)	-0.0754 (0.3725)
Observations	892	870	892	892	892	892	892	879	891	879	891
Number of region	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.7384	0.3446	0.8234	0.5207	0.3662	0.7257	0.7181	0.5664	0.7212	0.1451	0.2903
Panel C: Crisisdefinition1											
Log Percentage Unemployment	-0.0171*** (0.0064)	-0.0050 (0.0597)	-0.0036 (0.0097)	0.0027 (0.0072)	-0.1004* (0.0557)	0.0842 (0.0543)	-0.0271** (0.0133)	-0.1621*** (0.0445)	-0.1509** (0.0582)	-0.1934 (0.1433)	-0.0332 (0.0643)
Log Household Income	0.0737** (0.0324)	0.2623 (0.4489)	0.0552 (0.0504)	0.0148 (0.0467)	0.5592* (0.3032)	0.9128 (0.5596)	0.0676 (0.0727)	0.0963 (0.2708)	-0.1306 (0.4147)	0.4753 (0.7915)	0.0955 (0.4138)
crisisregion definition 1	-0.0286 (0.0904)	-0.3609 (1.3992)	0.1775 (0.1803)	-0.0328 (0.1837)	-0.1448 (0.8138)	1.0694 (1.4880)	-0.4387 (0.2759)	-0.5726 (0.8086)	0.7800 (0.9541)	-0.6445 (2.4493)	-0.3753 (0.6306)
Interaction Log Perc Unemployment and Crisisregion1	-0.0033 (0.0036)	-0.0211 (0.0468)	-0.0113 (0.0080)	-0.0015 (0.0071)	0.0050 (0.0253)	-0.0620 (0.0419)	0.0024 (0.0094)	0.0026 (0.0246)	-0.0727* (0.0413)	-0.0873 (0.1150)	0.0199 (0.0276)
Interaction Log household income and Crisisregion1	0.0033 (0.0106)	0.0338 (0.1617)	-0.0227 (0.0207)	0.0037 (0.0206)	0.0300 (0.0925)	-0.1160 (0.1648)	0.0492 (0.0306)	0.0646 (0.0905)	-0.1030 (0.1174)	0.0481 (0.2843)	0.0736 (0.0695)
Observations	892	870	892	892	892	892	892	879	891	879	891
Number of region	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.7367	0.3453	0.8207	0.5158	0.3645	0.7282	0.7192	0.5652	0.7130	0.1443	0.2636
Panel D: Crisisdefinition2											
Log Percentage Unemployment	-0.0169** (0.0065)	-0.0013 (0.0637)	-0.0049 (0.0100)	0.0034 (0.0077)	-0.1098* (0.0572)	0.0998* (0.0564)	-0.0264** (0.0131)	-0.1548*** (0.0444)	-0.1172** (0.0522)	-0.1768 (0.1444)	-0.0486 (0.0659)
Log Household Income	0.0740** (0.0323)	0.2826 (0.4568)	0.0584 (0.0521)	0.0156 (0.0465)	0.5102* (0.2972)	0.9408 (0.5787)	0.0725 (0.0728)	0.1213 (0.2663)	-0.0567 (0.3969)	0.5337 (0.7747)	0.0076 (0.4318)
crisisregion definition 2	-0.0252 (0.0799)	-0.3098 (1.3689)	0.2472 (0.1560)	-0.1353 (0.1661)	-1.2162 (0.8107)	0.1434 (1.2453)	-0.1759 (0.2531)	-0.1093 (0.7567)	0.6628 (0.8193)	-0.8512 (2.3846)	-0.6815 (0.5788)
Interaction Log Perc Unemployment and Crisisregion2	-0.0021 (0.0030)	-0.0015 (0.0367)	-0.0110* (0.0064)	0.0013 (0.0060)	0.0157 (0.0219)	-0.0359 (0.0345)	-0.0012 (0.0081)	0.0242 (0.0222)	-0.0817** (0.0397)	-0.0497 (0.1101)	0.0421* (0.0248)
Interaction Log household income and Crisisregion2	0.0038 (0.0093)	0.0303 (0.1544)	-0.0281 (0.0182)	0.0150 (0.0184)	0.1483 (0.0912)	-0.0113 (0.1380)	0.0207 (0.0282)	0.0159 (0.0843)	-0.1037 (0.0992)	0.0798 (0.2795)	0.1096* (0.0656)
Observations	892	870	892	892	892	892	892	879	891	879	891
Number of region	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.7369	0.3445	0.8198	0.5160	0.3659	0.7287	0.7168	0.5652	0.7173	0.1438	0.2571
Controls and Interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. Each panel has a different crisis definition and should be read as follows: The first two rows indicate the impact of unemployment and household income on (cause-specific) mortality rates for non-crisis regions. The third row is a dummy measuring the impact of when a region is in a state of crisis on (cause-specific) mortality rates. The interaction terms in the fourth and fifth row specify the additional impact unemployment and household income have on (cause-specific) mortality rates when a region experiences a crisis. Considering that most interaction terms are insignificant across panels, unemployment and household income do not appear to impact (cause-specific) mortality rates differently between non-crisis and crisis regions. All specifications include controls for education and degree of urbanisation (and interactions of controls with the crisis dummy). Furthermore, year-fixed effects, regional-fixed effects, and region-specific time trends are accounted for. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

5.3.1 Cross-country Analysis

We investigate this by segmenting our data into five quintiles based on household income and interacting these with unemployment and household income. We first create dummies for the respective quintiles and hereafter interact them with all independent variables. The base case scenario is represented by the yearly bottom 20 per cent of household income across countries. Although we also interacted the variables education and degree of urbanisation with the household income quintiles, they are not shown in *Table 8* below as they are not the key variables of interest. As expected, regions within the bottom quintile are mostly found in the PISG countries, whereas regions in the top quintile mostly belong to stronger economic countries. To illustrate this, *Figure 4* provides the percentage of regions belonging to each quintile as a percentage of the total amount of regions across years.

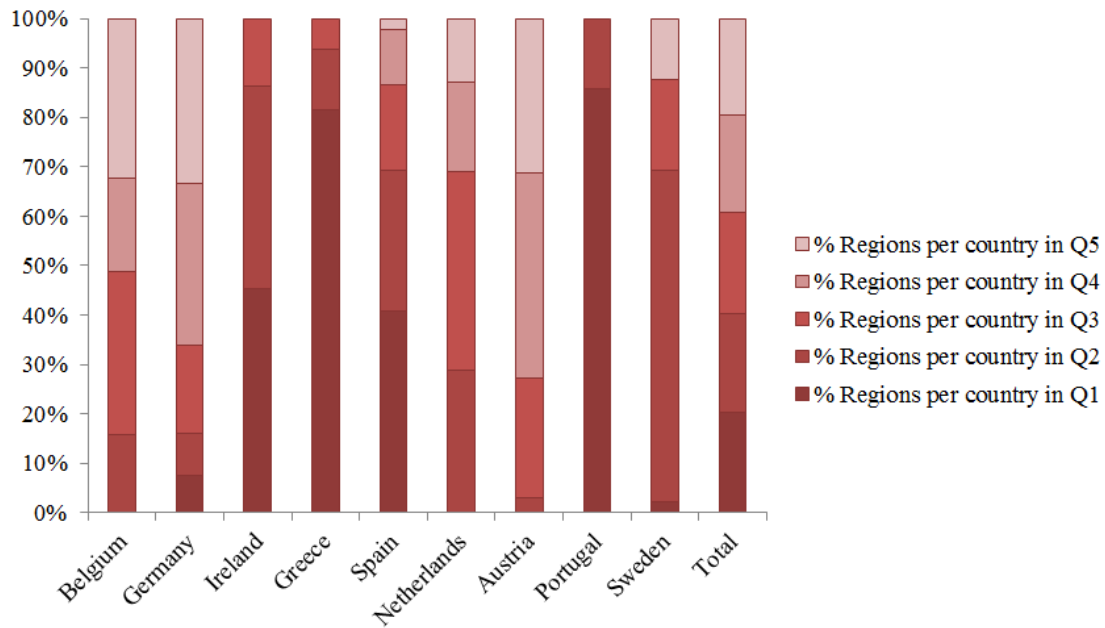


Figure 4 Regional Income Quintile Distribution

To make the results across the income distribution somewhat more easily interpretable, below, we explain the most important outcomes, starting with the first regression where all-cause mortality is the dependent variable. It is important to keep in mind that the base case for these results is formed by regions that fall in the bottom 20 per cent of regions according to yearly household income. Thus, the coefficients in the top two rows on percentage unemployment and household income, with regard to the cause-specific mortality rates, apply to regions that fall in the bottom 20 per cent of household income. To understand how our two key economic variables impact (cause-specific) mortality rates in other income brackets, we need also look at the coefficients of the interaction terms between the respective quintiles and either unemployment or household income. As such, we can see how unemployment or household income impacts (cause-specific) mortality within different income brackets.

When looking only at the household income dummies in *Table 8*, quintile 2 - quintile 5 household income, for all-cause mortality rates and residual diseases, we observe that the mortality rates appear

to be higher in the middle-to-higher income brackets. More specifically, compared to the poorest regions in quintile 1, all-cause mortality rates are 1.3060%, 1.114% and 1.6901% higher in the top three quintiles (41-60 - 61-80 - 81-100). *Ceteris paribus*, regions in the top 20 per cent of household income have 1.6901% higher mortality rates in comparison with the bottom 20 per cent. A similar trend can be found for mortality due to residual diseases in which the higher quintiles also exhibit somewhat higher mortality rates. The coefficient of -0.0217 on Log Percentage Unemployment implies that in the regions forming the yearly bottom 20 per cent of household income, a 1% increase in the percentage of unemployment leads to a decrease in all-cause mortality rates of -0.0217%. An increase of 1% in household income leads to an increase in mortality rates of 0.1582%. Recall that these results apply only to the base case, the bottom 20% of household income. To see whether regions in different wealth brackets are also more sensitive to change in unemployment and household income, we need to look at the interaction terms. The coefficients on the interaction terms between the logarithm of household income and the top three household income quintiles are significantly negative. We illustrate what this implies for all-cause mortality rates first before elaborating on the cause-specific mortality rates such as cardiovascular diseases. As mentioned before, a 1% increase in the percentage of unemployment leads to a decrease in all-cause mortality rates of -0.0217%. Since all interaction terms between the quintile dummies (representing the income groups) and unemployment are insignificant for all-cause mortality rates (first column), this effect does not differ across income groups. However, when looking at the interaction between the income quintiles and the logarithm of household income, we do see differences across income groups. Although mortality rates in the poorest regions increase by 0.1582% for every percentage increase in unemployment, mortality rates in the richer regions respond significantly less to household income. More specifically, a 1% increase in household income in the regions pertaining to the highest income bracket leads to a decrease in mortality rates of -0.0154% (0.1582% - 0.1736%). Performing Wald tests indicates that the hypothesis that the added coefficients of *the logarithm of household income* and *the interaction term between the logarithm of household income and quintile 3, 4, or 5* on all-cause mortality are jointly zero, cannot be rejected. Thus, in relatively richer regions, all-cause mortality rates do not increase with increases in household income. As we argued above that mortality rates might increase due to higher household income as a result of unhealthier habits (e.g. consumption of more alcohol, eating "richer" food), it would seem that this result holds mostly true for the poorer regions of our sample. Although this might seem counterintuitive, it falls in line with obesity and/or diabetes research, where among a set of rich countries evidence has been rendered that the poorest regions in those regions exhibit the highest degree of poor health as measured by obesity and/or diabetes.

When looking at the interaction terms of unemployment and the quintile dummies for cause-specific mortality rates, it seems that mortality rates due to cardiovascular diseases decrease by -0.055% for every percentage increase in unemployment in the bottom household income quintile. The interaction terms (varying between 0.0457% and 0.0532%) for all other quintiles cancel out the impact of unemployment on mortality rates due to cardiovascular diseases, implying that in all other quintiles, unemployment does not impact deaths due to cardiovascular diseases.¹¹ A similar reasoning can be applied to mortality due to cancer and mental diseases with the exception that interaction term on

¹¹Performing Wald tests indicates that the hypothesis that the added coefficients of *the logarithm of percentage unemployment* and *the interaction term between the logarithm of percentage unemployment and quintile 2, 3, 4, or 5* on mortality due to cardiovascular diseases are jointly zero, cannot be rejected.

quintile 2 turns insignificant.¹² Lastly, it appears that although increases in household income significantly increase deaths in the bottom two quintiles due to diseases in the residual group (0.2429% for every 1% increase in unemployment), we observe that this positive impact reverses in the top three quintiles after taking into account the interaction term. Performing Wald tests renders evidence that it cannot be rejected that the impact of household income and its interaction term with quintile 3 on mortality due to residual diseases is jointly zero, meaning that household income does not impact mortality due to residual disease in quintile 3. As the Wald tests for household income and the interaction terms with quintile 4 or 5 reject that the coefficients are jointly zero, it follows that increases in household income are associated with decreases in mortality rates due to diseases in the residual group in quintile 4 and 5. We would attribute this to a similar reasoning as provided for the top 3 quintiles of all-cause mortality. For completeness, *Appendix A.9* provides the regression results across income distribution and countries with unemployment separated in long- and short-term unemployment.

In *Table 8*, we construct the income distribution quintiles *across* countries on a yearly basis. We also investigate the relationship that unemployment and household income have with health *within* the countries across the income distribution. In the following, we construct quintiles based on household income *within* a country on a yearly basis and interact these with our key variables of interest. More specifically, quintile 1 consists out of the poorest regions for the respective year within a country, whereas quintile 5 comprises the richest regions within a country.

5.3.2 Within-country Analysis

From *Table 9*, we observe that the household income dummies themselves are not significant on average: cause-specific mortality rates are not significantly different between income brackets per country. Only deaths due to cardiovascular diseases appear to be somewhat lower (-1.6699% and -1.1464%) in quintile 2 and quintile 3 (borderline significant) across income brackets. The interaction terms provide more information. Similarly to *Table 8*, the coefficients on "Log Percentage Unemployment" and "Log Household Income" essentially pertain to the bottom 20% of household income per country. The quintile interaction terms (if significant) need to be added to this coefficient in order see the impact of the coefficient for the different quintiles. For example, although a 1% increase in unemployment leads to a decrease in all-cause mortality rates by -0.0231%, this coefficient is significantly smaller for quintile 3. Here, a 1% increase in unemployment leads to a decrease in all-cause mortality rates by -0.0047% (-0.0231% + 0.0184%). As the interaction terms between the household income dummies and unemployment are insignificant for quintile 2, 4 and 5, the coefficient on unemployment in these quintiles seems to be similar to that described for quintile 1 (-0.0231%). With respect to the relationship between the interaction terms and unemployment and the cause-specific mortality rates, only deaths due to cardiovascular diseases render (borderline) significant observations. The negatively significant relationship (-0.0323% for every 1% increase) between unemployment and deaths due to cardiovascular diseases is smaller for quintiles 2 and 3. Here, the interaction terms render positive coefficients of 0.0229 and 0.0313, partially cancelling out the negative coefficient of -0.0323 observed in the base case.

¹²Performing Wald tests indicates that the hypothesis that the added coefficients of *the logarithm of percentage unemployment* and *the interaction term between the logarithm of percentage unemployment and quintile 2, 3, 4, or 5* on mortality due to cancer are jointly zero, cannot be rejected. Further Wald tests indicate that the hypothesis that the joint effect of *the logarithm of percentage unemployment* and *the interaction term between the logarithm of percentage unemployment and quintile 3, 4 (at 5% level), or 5* on mortality due to mental diseases is zero, cannot be rejected.

Table 8 Quintile Analysis - Income across Countries[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Log Percentage Unemployment (Q1)	-0.0217** (0.0095)	-0.0723 (0.1302)	-0.0550*** (0.0170)	-0.0324** (0.0137)	0.0090 (0.0684)	0.3012*** (0.1114)	0.0172 (0.0226)	-0.1911** (0.0867)	-0.2264** (0.1043)	-0.1934 (0.2027)	-0.1135 (0.1332)
Log Household Income (Q1)	0.1582*** (0.0487)	0.0969 (0.7817)	0.1010 (0.0795)	0.0516 (0.0534)	0.2980 (0.4002)	1.8155** (0.8332)	0.2429* (0.1271)	0.6997* (0.3933)	0.3145 (0.3974)	-0.2027 (0.9903)	-0.9226 (0.7422)
Quintile 2 household income	-0.1106 (0.5853)	-1.6962 (7.2923)	-0.6022 (0.7728)	0.9819 (0.6892)	-2.9087 (5.4310)	9.7567 (6.4348)	0.0773 (1.5053)	3.7433 (4.5748)	8.4281 (5.6616)	-8.4299 (10.0098)	-6.9996 (7.9355)
Quintile 3 household income	1.3060** (0.5894)	2.1862 (8.1718)	-0.0711 (0.9806)	1.1015 (0.6964)	-1.2514 (4.0650)	8.3824 (8.4645)	3.4151** (1.3873)	8.8474* (5.1452)	4.7907 (4.8420)	-9.5527 (13.2508)	-0.9286 (7.0487)
Quintile 4 household income	1.1114* (0.5685)	-0.7028 (7.9128)	0.0239 (0.9622)	0.5875 (0.6876)	1.9028 (5.0176)	8.0267 (7.2144)	4.0676*** (1.4509)	2.6368 (4.7680)	2.8316 (5.0070)	-4.1223 (11.8516)	-8.6107 (7.0060)
Quintile 5 household income	1.6901*** (0.6210)	0.3507 (8.5780)	-0.1350 (1.0737)	1.6907 (1.0313)	5.4283 (5.8095)	3.4891 (8.4291)	5.5005*** (1.6364)	3.3974 (5.3293)	4.8409 (5.3266)	6.5659 (13.8026)	-8.3153 (6.9883)
Interaction Q2 with log perc unemployment	0.0106 (0.0123)	-0.0128 (0.1445)	0.0532*** (0.0200)	0.0228 (0.0182)	-0.0534 (0.0699)	-0.0110 (0.1353)	-0.0342 (0.0283)	-0.0537 (0.0946)	0.0154 (0.1040)	0.0362 (0.2327)	0.1559 (0.2113)
Interaction Q3 with log perc unemployment	0.0072 (0.0125)	0.0297 (0.1375)	0.0457** (0.0190)	0.0324* (0.0167)	-0.0082 (0.0834)	-0.3380*** (0.1238)	-0.0423 (0.0269)	0.0739 (0.0924)	0.1577 (0.1149)	0.0110 (0.2392)	0.1442 (0.1648)
Interaction Q4 with log perc unemployment	0.0091 (0.0118)	0.1098 (0.1357)	0.0468** (0.0196)	0.0418** (0.0164)	-0.1426 (0.1012)	-0.4150*** (0.1277)	-0.0252 (0.0282)	0.1018 (0.0895)	0.0782 (0.1080)	0.0922 (0.2531)	0.1405 (0.1568)
Interaction Q5 with log perc unemployment	0.0013 (0.0118)	0.0822 (0.1524)	0.0485** (0.0212)	0.0368** (0.0176)	-0.2026* (0.1165)	-0.2917** (0.1413)	-0.0436 (0.0295)	0.1404 (0.0976)	0.0967 (0.1101)	0.1093 (0.2696)	0.1371 (0.1536)
Interaction Q2 with log household income	0.0082 (0.0628)	0.1705 (0.7733)	0.0748 (0.0846)	-0.0996 (0.0732)	0.2998 (0.5654)	-0.9126 (0.6781)	-0.0362 (0.1619)	-0.4345 (0.4926)	-0.8985 (0.6185)	0.8271 (1.0714)	0.7209 (0.8680)
Interaction Q3 with log household income	-0.1428** (0.0622)	-0.2529 (0.8612)	0.0181 (0.1031)	-0.1195 (0.0723)	0.1233 (0.4207)	-0.8506 (0.8697)	-0.3849** (0.1484)	-0.9747* (0.5390)	-0.4608 (0.5221)	0.8042 (1.3797)	0.1374 (0.7646)
Interaction Q4 with log household income	-0.1176* (0.0595)	0.0499 (0.8290)	0.0096 (0.1006)	-0.0543 (0.0716)	-0.2856 (0.5347)	-0.8933 (0.7458)	-0.4412*** (0.1534)	-0.2543 (0.4982)	-0.2496 (0.5401)	0.1854 (1.2478)	0.9664 (0.7671)
Interaction Q5 with log household income	-0.1736*** (0.0638)	-0.1311 (0.8821)	0.0200 (0.1135)	-0.1541 (0.1057)	-0.6054 (0.5935)	-0.3733 (0.8637)	-0.5750*** (0.1688)	-0.3895 (0.5526)	-0.4746 (0.5694)	-0.8390 (1.4568)	0.9841 (0.7695)
Observations	948	913	948	948	948	948	948	933	947	933	947
Number of region	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.7584	0.3554	0.8317	0.5644	0.4544	0.7150	0.7164	0.5691	0.7054	0.1140	0.2463
Controls and Interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. The table should be read as follows: the first two rows indicate the impact of unemployment and household income on (cause-specific) mortality rates, for the bottom quintile (Q1) of household income. Hereafter, quintile dummies for different income brackets *across* countries are given in increasing order of household income, measuring purely how (cause-specific) mortality rates depend on a region's income bracket. The following eight rows depict interaction terms between quintile dummies for income brackets and unemployment (or household income). These interaction terms measure the additional impact unemployment (or household income) has on (cause-specific) mortality rates across income brackets. All specifications include controls for education and degree of urbanisation (and interactions of controls with the crisis dummy). Furthermore, year-fixed effects, regional-fixed effects, and region-specific time trends are accounted for. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

On average, it seems that across household income brackets, the relationship between unemployment and cause-specific mortality rates usually does not differ. Looking at the relationship between household income and mortality rates across categories, we do not observe many significant differences across income brackets either within a country. Only the interaction term (0.1767%) between quintile 2 and the logarithm of household income suggests that increases in household income are followed by increases in mortality due to cardiovascular diseases within this income bracket.¹³ For completeness, *Appendix A.10* provides the regression results across income distribution within countries, but with unemployment separated in long- and short-term unemployment.

Comparing the income group analysis *across* to the income group analysis *within* countries, there are a few things that can be noted. Interestingly, all-cause mortality rates do not differ between income groups when comparing them within a country, but they do differ when comparing them across countries. Recall that when comparing the income groups across countries, this means that richer regions are mostly found in richer countries (Germany, Netherlands, Austria). When comparing the income groups within a country, for instance the richest regions are always selected per country: the top quintile includes the richest 20% of each country. Considering that the household income quintile dummies 3 to 5 themselves are significantly positive for the richer regions across countries, but not within countries, it appears that all-cause mortality rates are higher for the richer regions across countries, which are mostly found in the richer countries.

Also, the finding across countries that the negative relationship between unemployment and cardiovascular diseases (and cancer, see *Table 8*) appears to be driven mostly by poorer regions does not hold true on a within-country basis. Recall that the interaction terms for quintile 3 until 5 with unemployment were significantly positive in the cross-country, but not the within-country analysis. Furthermore, when looking at income groups within a country, the impact of household income on all-cause mortality rates is (borderline) significantly positive. When looking at income groups across countries, this significantly positive relationship decreases in size (or even turns negative) for the richer quintiles 3 to 5.

Income distribution related differences across regions seem to be driven by regional differences across countries rather than within countries. Although richer regions display slightly higher mortality rates overall as can be observed by the income bracket dummies across countries, when looking at the interaction terms it becomes clear that poorer regions across countries in our sample appear to experience harmful health effects more than richer regions when the economy improves. We do not find a similar effect when comparing regions in different income brackets within countries. Thus, we fail to reject Hypothesis 5 when comparing differences in income brackets across countries, but we reject the hypothesis that the impact of unemployment and household income on mortality differs for different income brackets within countries.

¹³The coefficient of the interaction term between quintile 4 and the logarithm of household income on mortality due to mental diseases is only borderline significant.

Table 9 Quintile Analysis - Income within Countries[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Log Percentage Unemployment (Q1)	-0.0231*** (0.0086)	0.0736 (0.1015)	-0.0323** (0.0154)	-0.0060 (0.0126)	-0.0228 (0.0726)	0.1388 (0.1100)	-0.0327 (0.0201)	-0.1649*** (0.0513)	-0.1576 (0.0994)	-0.0925 (0.1838)	0.0817 (0.0894)
Log Household Income (Q1)	0.0842* (0.0451)	0.3488 (0.5971)	0.0355 (0.0826)	0.0564 (0.0719)	0.2306 (0.5175)	1.3377 (0.8731)	0.0337 (0.1223)	0.0420 (0.2948)	0.3754 (0.3680)	0.4631 (1.0293)	0.3482 (0.4558)
Quintile 2 household income	-0.4871 (0.3483)	-7.5242 (4.9402)	-1.6699** (0.6912)	0.6081 (0.6086)	-0.1123 (3.8602)	8.7256 (7.6344)	-0.5008 (0.8363)	-2.6529 (2.8397)	3.9062 (2.9636)	2.0208 (7.7245)	2.2964 (4.3146)
Quintile 3 household income	-0.5478 (0.3989)	-3.7004 (4.4647)	-1.1464* (0.6616)	-0.1166 (0.5469)	-1.1799 (4.3419)	6.5013 (7.0047)	-0.5255 (1.1762)	-3.2163 (2.1737)	5.0214 (3.7085)	-5.4205 (9.5492)	3.5652 (6.7174)
Quintile 4 household income	-0.1135 (0.4928)	4.6212 (5.4938)	-0.9726 (0.7994)	0.8022 (0.6742)	0.6890 (5.4918)	10.3261 (7.0212)	-0.4006 (1.4648)	-5.5206 (3.5421)	4.2161 (2.9433)	11.6906 (10.3700)	3.9416 (3.1441)
Quintile 5 household income	-0.0805 (0.5726)	-1.3599 (6.1873)	-0.6366 (0.9671)	0.6419 (0.9660)	7.6369 (5.2857)	-6.0998 (7.9178)	-0.2651 (1.4044)	-2.2202 (3.9166)	0.3838 (3.8004)	5.7977 (12.1097)	0.9124 (4.4213)
Interaction Q2 with log perc unemployment	0.0083 (0.0065)	-0.0958 (0.0955)	0.0229* (0.0132)	0.0065 (0.0112)	0.0647 (0.0807)	-0.0993 (0.1350)	0.0058 (0.0174)	-0.0040 (0.0548)	0.0062 (0.0931)	-0.1069 (0.1865)	-0.0612 (0.0719)
Interaction Q3 with log perc unemployment	0.0184** (0.0087)	-0.0471 (0.1051)	0.0313** (0.0138)	0.0030 (0.0127)	-0.0139 (0.0969)	-0.1018 (0.1219)	0.0335 (0.0235)	0.0420 (0.0662)	0.0894 (0.1253)	0.0999 (0.2342)	-0.0657 (0.1003)
Interaction Q4 with log perc unemployment	0.0077 (0.0089)	-0.1648 (0.1048)	0.0132 (0.0168)	0.0037 (0.0133)	0.0077 (0.1207)	-0.1684 (0.1290)	0.0187 (0.0249)	0.0762 (0.0712)	-0.0196 (0.1037)	-0.0165 (0.1960)	-0.0501 (0.0824)
Interaction Q5 with log perc unemployment	-0.0004 (0.0100)	-0.0875 (0.1405)	0.0330 (0.0200)	0.0069 (0.0166)	-0.2343* (0.1188)	0.1108 (0.1498)	-0.0140 (0.0249)	0.0298 (0.0830)	-0.0075 (0.1012)	-0.1930 (0.2099)	-0.1505 (0.1032)
Interaction Q2 with log household income	0.0476 (0.0387)	0.7486 (0.5645)	0.1767** (0.0776)	-0.0698 (0.0669)	0.0480 (0.4504)	-0.9828 (0.8568)	0.0423 (0.0905)	0.3167 (0.2993)	-0.3734 (0.3227)	-0.1158 (0.8876)	-0.2840 (0.4754)
Interaction Q3 with log household income	0.0564 (0.0446)	0.3323 (0.5208)	0.1225 (0.0748)	0.0053 (0.0615)	0.0919 (0.5017)	-0.7434 (0.7884)	0.0598 (0.1283)	0.3684 (0.2466)	-0.4943 (0.4343)	0.6559 (1.0808)	-0.4531 (0.7745)
Interaction Q4 with log household income	0.0047 (0.0565)	-0.7281 (0.6393)	0.0981 (0.0940)	-0.1063 (0.0781)	-0.1456 (0.6535)	-1.3282* (0.7920)	0.0537 (0.1666)	0.6444 (0.4140)	-0.3893 (0.3373)	-1.4279 (1.2218)	-0.4684 (0.3581)
Interaction Q5 with log household income	0.0174 (0.0634)	0.1106 (0.6850)	0.0450 (0.1095)	-0.0064 (0.1059)	-0.6364 (0.6213)	0.6537 (0.9723)	0.0290 (0.1562)	0.2148 (0.4285)	-0.2271 (0.3797)	-0.6121 (1.3384)	-0.1834 (0.5393)
Observations	948	913	948	948	948	948	948	933	947	933	947
Number of region	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.7523	0.3707	0.8338	0.5619	0.4671	0.7085	0.7056	0.5506	0.7026	0.1155	0.2020
Controls and Interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. The table should be read as follows: the first two rows indicate the impact of unemployment and household income on (cause-specific) mortality rates, for the bottom quintile (Q1) of household income. Hereafter, quintile dummies for different income brackets *within* countries are given in increasing order of household income, measuring purely how (cause-specific) mortality rates depend on a region's income bracket. The following eight rows depict interaction terms between quintile dummies for income brackets and unemployment (or household income). These interaction terms measure the additional impact unemployment (or household income) has on (cause-specific) mortality rates across income brackets. All specifications include controls for education and degree of urbanisation (and interactions of controls with the crisis dummy). Furthermore, year-fixed effects, regional-fixed effects, and region-specific time trends are accounted for. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

Summary. This section outlines our results. Most notably, increases in unemployment are indeed associated with decreases in all-cause mortality and increases in household income are linked to increases in all-cause mortality. Moreover, in line with existing research, mortality due to cardiovascular diseases is significantly affected by a change in unemployment/household income whereas mortality due to cancer is not. Increases in household income are associated with decreases in suicides in the PISG countries. Furthermore, increases in unemployment are accompanied by falling death rates due to external causes and traffic accidents. After conducting an analysis on all-cause and cause-specific mortality, we proceed to a more detailed analysis of the determinants of the link between unemployment, household income, and mortality: We differentiate between long- and short-term unemployment, analyse whether a "crisis effect", a disproportional impact during crises, exists and perform an income quintile analysis. Long-term unemployment has a more significant impact on (cause-specific) mortality rates than short-term unemployment. Little difference exists between the effect of unemployment and household income on (cause-specific) mortality rates between crisis and non-crisis regions, disproving our hypothesis of a "crisis effect". Income-related differences in mortality rates seem to be driven by cross-country rather than within-country regional differences. In *Appendix A.11*, we further analyse how regions differ according to their industry composition, with inconclusive results.

In the next section, we outline how this work contributes to economic research, critically discuss our approach and methods employed, depict the limitations of our research, and interpret our results. We deduct policy implications from our interpretations and indicate opportunities for future research.

6 Discussion

After having introduced the reader to the topic in the literature review and presented our dataset and methodology, as well as our results, in this section, we discuss and critically reflect about our work. We start by reviewing our point of departure and how we extend the current body of research. We then interpret the results of our analysis and discuss its limitations. The section concludes with policy implications deducted from our results.

6.1 Extending the Research Frontier

Our interest in the matter first sparked when we noticed the conflicting views presented in the literature: while the existence of an effect of unemployment and household income on mortality can be considered well-established, its extent and direction are a matter of frequent debate among researchers. Moreover, few insights exist on whether this effect is actually more pronounced during crises. However, especially in times of crises, society can not *afford* insecurity about this link - hence our motivation to contribute further to this debate. Moreover, we felt that the effect could be different across income brackets, which if true could imply that health policies might have to be targeted differently across specific income groups.

Geographic fragmentation. First, on a geographic level, analyses performed so far include cross-country analyses and regional analyses for single countries. Cross-country analyses compare effects on a national level among a set of countries. Regional analyses do the same between regions, so far for a number of individual countries only. Our thesis contributes to the existing body of research, analysing regional-level data across nine European countries.

Crisis definition. Second, various definitions of crisis exist in the literature, none of which specifically takes into account individual regional characteristics. We hence set out to develop a way to incorporate these, introducing two new definitions of crisis: One comparing regions to their own average unemployment and another comparing them to national average unemployment. We create a relative measure of crisis both in comparison to what can be considered as the normal regional unemployment itself and in comparison to a normal national unemployment.

Variables employed. Third, splitting up mortality rates the way we do is innovative in the sense that typically, the analysis purely focuses on mental health, homicide, and suicide rates or simply includes them into the group of deaths due to external causes. As we are interested in both these *and* traffic accidents, we fragment this group further, enabling us to perform our analysis on a more detailed level. Furthermore, most research only incorporates one economic key variable at a time - such as unemployment - and investigates its impact on health. We believe, however, that investigating the impact of unemployment without accounting for the income in a region may lead to flawed results. Hence, we conjointly employ unemployment and household income, hypothesising that the effects of both variables might run via different channels.

Time horizon. Fourth and last, we include the latest data available. The most recent publications at the time of writing this thesis included data from 2008 (Stuckler et al., 2009). Including two more years not only gives more recent insight but also arguably provides us with more regions experiencing a crisis, as can be seen in *Figure A.3* of *Appendix A.12*: the years 2009 and 2010 add a substantial amount of regions defined as in a state of crisis; this is constant across all crisis definitions, although the distribution across other years varies depending on how crisis is defined. This fact underlines the importance of how the crisis is being defined. We contribute to current research by introducing two new definitions that shed light on regional differences.

6.2 Interpretation of Results

Where appropriate, we briefly outline the expectations we had towards the respective category before starting to interpret our results, after browsing the literature and formulating a first, rough version of our hypotheses. This also serves to later further distinguish certain results.

6.2.1 Unemployment, Household Income, and Mortality

In contrast to our initial expectations - a negative impact of economic downturns on health -, looking at *Hypothesis 1* and *2*, we find evidence in line with Ruhm (2000, 2005) in the sense that all-cause mortality and certain cause-specific mortality rates display economic pro-cyclicality. Unemployment across methods has a negatively significant relationship with all-cause mortality rates, whereas household income exhibits a positively significant relationship. We hypothesise that more unemployment may lead to lower death rates due to a healthier lifestyle (e.g. more walking outside and less stress) and less work-related traffic accidents. The latter argument is supported by the negative relationship between unemployment and deaths due to traffic accidents. Furthermore, the positive linkage between household income and all-cause mortality may be due to what can potentially be described as the "cost of wealth": economic upturns as measured by higher household income may lead to higher discretionary expenses on unhealthy products such as alcohol and "richer" food that decrease health. In the following we will refer to this effect simply as the "cost of wealth". This is backed up by the positively significant relationship between household income and deaths due to cardiovascular diseases. Moreover, the direction of the coefficient measuring the impact between household income and mortality due to nutritional diseases is also positive, though not significant across all specifications.¹⁴

In *Hypothesis 3*, we state our belief that analysing the association between unemployment, household income, and mortality on a regional instead of a national level matters. While the direction and size of this association are fairly similar for this specification, the significance of the results is stronger for our regional analysis. Although this may be due to an increased number of observations, we do conclude that it is important to perform cross-country, regional analyses.

Long- and Short-term Unemployment As not much research exists separating long-term from short-term employment in this field, it is interesting to observe that the impact of unemployment

¹⁴Unemployment generally has a negative relationship with deaths due to nutritional diseases (although not always significant), supporting the "cost of wealth" argument. Here, unemployment could lead to lower household income, leading to less discretionary expenses on unhealthy products.

on cause-specific mortality rates emanates mostly from long-term unemployment as judged by the significance of the coefficients. As illustrated in *Appendix A.13*, on average, long-term unemployment as a percentage of total unemployment is around 40.5% of total unemployment, although long-term as a percentage of total unemployment is somewhat lower in the PISG countries. Also, especially in the PISG countries short-term unemployment (and long-term unemployment) has risen substantially over the last years. Long-term unemployment has a significantly negative impact on all-cause mortality, whereas short-term unemployment does not. We observe the same effect for mortality rates related to residual diseases and traffic accidents, leading us to believe that being unemployed for more than twelve months is more strongly related to health than less than twelve months. A potential reason for this is that when being unemployed for a longer term, people adjust their lifestyle and cut down discretionary expenses on expensive unhealthy products such as alcohol and richer foods. The short-term unemployed might, on average, not adjust their expense pattern substantially. Also, it could be that the long-term unemployed experience less stress by having come to terms with their unemployment, whereas those with short-term unemployment are more stressed due to their recent job loss and insecure future. This might cancel out any positive effects from unemployment on health such as extra free time (to go for a walk) for the short-term unemployed, but not for the long-term unemployed. It is important, however, to keep in mind that this is speculation and even though the coefficients on short-term unemployment are not significant, the size of the coefficients is only somewhat smaller than that of long-term unemployment. One last interesting observation that deserves more attention in the future is that increase in long-term unemployment is associated with increases in mortality due to mental diseases, whereas short-term unemployment is not (and even has a coefficient with the opposite direction). We interpret this finding as supporting evidence by Reine et al. (2004) that especially long-term unemployment is linked to poor mental health.

6.2.2 Crises

While the few analyses in the literature explicitly looking at crises are ambiguous, we did expect crises to have an additional, disproportional impact on people's health and hence, on mortality rates - especially in light of the recent severe economic crisis in Europe. *Hypothesis 4* reflects these expectations.

Considering, however, that we expected unemployment on average to positively impact death rates, which we can not confirm, the disproportional effect we expected to find during crises might also not be present. The impact of unemployment and household income on health does not differ greatly conditional on a region experiencing a crisis or not. Although a few interaction terms are significant per panel, the results are not stable across crisis definitions. The most constant result across crisis definitions is that an increase in unemployment in crisis regions decreases deaths due to traffic accidents even more than in non-crisis regions. This could be due to work-related traffic being disproportionately lower in regions experiencing a crisis. Nonetheless, the general takeaway here is that the way in which unemployment and household income impact mortality rates does not differ greatly between non-crisis and crisis regions.

6.2.3 Income Distribution

The set-up of the regressions allows us to observe not only what the impact of being in a certain income group is on cause-specific mortality, but also whether the impact of our key variables (unemployment and household income) is different between income brackets. Furthermore, looking at income groups both *across* and *within* countries enables us to investigate whether results are different comparing a region's income to income *across* regions in all countries or regions *within* a country. In *Hypothesis 5*, we state our initial expectation that lower income groups are disproportionally affected by an increase in unemployment or a decrease in household income. We expected that groups with less discretionary income might be less able to compensate for job loss or lower income. This could lead to higher stress levels in lower income groups than in higher income groups (being unemployed and not knowing whether one can pay the rent at the end of the month may be different from being unemployed and not being able to go on a holiday). Furthermore, groups with less discretionary income may be obliged to cut back on essential health drivers such as good nutrition, whereas those in higher income groups can compensate a loss in income in different ways. We interpret our findings first *across* countries and then *within* countries and conclude comparing a possible difference between the two.

Recall that in contrast to our expectations, increases in household income are followed by increases in all-cause mortality rates, corresponding to what we describe as the "cost of wealth". This is supported by the coefficients of the dummies on household income groups, where the richer income brackets have somewhat higher all-cause mortality rates (and death rates due to residual diseases). Interestingly, looking at the differences *across* countries between income brackets, we observe that the strength of the relationship between household income and mortality is stronger in the poorer regions. The effect even changes sign when looking at the highest income group. This implies that increases in household income in the lowest income groups are associated with more deaths, whereas this effect is less pronounced in higher income groups. One potential reason for this could be that additional discretionary income in poorer income regions leads to more expenses on harmful lifestyle habits (e.g. purchasing more unhealthy food and possibly alcohol, tobacco or drugs) whereas this happens less in higher income regions across countries. Potentially, increased education or the already higher absolute level of expenditures on higher lifestyle habits in regions with higher income could be a reason for this. When analysing this effect *across* countries as we do in the first specification, most poor regions are found in poor countries and vice versa. It is important to note that the aforementioned interpretation should not only be seen as a comparison between poorer and richer regions, but also as a comparison between poorer countries and richer countries (potentially even Northern and Southern countries with the exception of Ireland). Continuing this hypothesis, additional discretionary income in poorer (or possibly Southern) countries may lead to higher expenses on harmful lifestyle habits (e.g. purchasing more unhealthy food and possibly alcohol, tobacco or drugs), whereas this happens less in higher income (or possibly Northern) countries. This is in line with prior literature, demonstrating that within richer countries, diseases such as obesity and diabetes are found more frequently in lower income groups. A similar reasoning could be applied to the association between increases in unemployment and decreases in deaths due to cardiovascular diseases in lower income regions.¹⁵

¹⁵The finding with respect to all-cause mortality rates is supported by findings on death rates due residual diseases.

Turning to the comparison between income brackets *within* countries, we check whether the aforementioned interpretation relates mostly to poorer regions in general or to poorer regions in comparison to regions within a country. On average, *within* countries, there are few differences between regions. Neither the dummies for the regions by income brackets themselves, nor the interaction terms with unemployment and household income provide straightforward, significant results. Differences in mortality rates between regional income brackets are only present when comparing regions on an absolute income level *across* and *within* countries. When trying to improve wealth in poorer regions, policy-makers should take the finding that increases in household income are associated with increases in mortality rates especially in poorer regions into account.

6.3 Critique and Limitations

As every academic piece of research, this thesis deserves thorough criticism and needs to be considered within its own limitations. Most notably, our results are not always stable nor robust across specifications. One easy "way out" would have been to only include one specification and limit our analysis accordingly; however, one of our core ambitions is to facilitate comparison, which we make possible by including various specifications. Moreover, we look at regional and national averages without supporting micro-level data. While this in no way limits us in terms of general interpretations, it is not possible to deduct individual-level inferences and recommendations from our analysis.

Internal validity. Internal validity is an important issue to address since this is required to make statistical inferences about the population being studied. We address this below.

An important threat to internal validity is OVB. There always is a potential for OVB and if the omitted variable would not only be a determinant of the independent variable, but also be correlated with one or more of our regressors, this could bias our estimators. As mentioned before, a number of variables that we consider to be important relating to lifestyle behaviour (alcohol, tobacco, and drug consumption) and governmental health expenditures per region were not available on a regional level. These variables could impact our dependent variable and also be correlated with our regressors. We do, however, think that controlling for time-invariant effects via a fixed effects model, with the addition of year-fixed effects and region-specific time trends deals with OVB to a large extent. Nevertheless, we cannot be certain that our model is not subject to OVB, however small it may be.

The functional form of our model appears to be correctly specified: for instance, interactions are always interacted with all independent variables and dummies, even though not all interaction terms are always displayed in the table. We further believe that the scaling of the variables has been done correctly.

Measurement error does not seem to be a big issue in our research considering the data have been gathered from Eurostat, which in turn uses national statistics authorities to obtain data. Nevertheless, in the past, there has been some controversy in particular about the statistics gathered by Elstat, the Hellenic Statistical Authority, which has repeatedly been accused of falsifying data (EC, 2010). We consider this to only be a minor issue and do not think it influences our results, especially in light of the improvements made in (Greece in) recent years to increase the credibility of official data.

Sample selection bias could have occurred in the process of excluding a number of countries either due to lack of data (e.g. Italy) or different country settings such as insurance systems (e.g. Central-European countries). However, we think that our country selection prevents having a highly non-randomly unbalanced panel and keeps the countries relatively similar. We hence believe that this does not severely distort our results, especially considering the broad range of countries in the sample.

A more serious issue when investigating the impact of economic on health variables is a possible simultaneous causality bias. For example, even though it is quite likely that unemployment impacts health, it could also be the case that the unhealthy are those that become unemployed first. Previous studies suggest that there may be a truth to both mechanisms (Bartley, 1994; Bartley et al., 2004; Thomas et al., 2005). Prior literature further indicates that stress caused by loss of income and lack of activity due to job loss may have a deteriorating effect on health (Graetz, 1993; Mathers and Schofield, 1998; Morrell et al., 1994). Although these findings are not in line with ours, the direction of the relationship still flows from unemployment to health. Conversely, Thomas et al. (2005) renders evidence in favour of the "healthy worker theory": people with ill health or chronic disabilities are less likely to find employment and that those with poor health are more likely to become unemployed. Thus, reverse causality can be an issue in our research. It can, however, usually only be dealt with on a micro level with more detailed information (Kuhn et al., 2009). Regardless, the idea that unemployment (or other economic variables) affects health is well-established in the literature, leading us to believe that this does not pose major inference challenges.

Overall, it appears that the internal validity of this research is quite solid. Nonetheless, we do not reject the possibility of omitted variable and reverse causality bias.

External validity. This thesis analyses the relationship between two well-established economic measures and a well-established health indicator for a diverse set of countries in Europe. Furthermore, we account for regional and national time-invariant fixed effects depending on the specification in our model. Moreover, we employ year-fixed effects and account for region-specific time trends. Given sufficient data, extending our analysis to similar countries within the EU and the rest of the Western world seems feasible. Moreover, as we discuss in *Subsection 6.5*, performing this analysis for countries at different stages of economic development - and different institutions - has the potential to provide interesting insights about the link between unemployment, household income, and mortality. However, the more structurally different the countries analysed are, the bigger the threat to external validity. As we point out below, the effects might differ for different time horizons. We incorporate data from as early as it was available; however, as time passes, long-term effects might set in which could be a threat to external validity across time.

Geographic fragmentation. The geographic fragmentation we look at is at the core of our work. It does, however, come with a few drawbacks, mostly connected to the lack of regional data for some countries. Most notably, after due consideration, we decided to exclude Italy, one of the countries most severely struck by the current crisis - and one of the largest countries in Europe -, from our analysis. The data gaps for Italy were not random, considering that all regions lacked health data for 2004 and 2005 and a number of regions (mostly south and insular Italy) lacked health data for the entire observation period. Weighing a substantially less balanced panel in combination with limited

interpretative value for Italy itself against the intuition of including "crisis countries", we decided to stick to methodological rigidity. While Ireland does not exhibit a significant lack of data, it is a small country that does not have a big effect on our analysis. However, including it did not harm and provides some more general interpretation possibility towards "crisis countries". For us surprisingly, harmonised education and urbanisation data were only partly available for Sweden. We did, however, run the basic specification excluding Sweden without a change in results. Greece lacks household income data until 2005 with similar consequences.

Crisis definition. Our results vary, depending on the definition of crisis we employ. One the one hand, this proves the additional value in developing crisis definitions that take into account regional characteristics as well as a comparison between region and state. On the other hand, it limits the possibility to compare our results between crisis definitions, since the results are not stable or significant across specifications. The fact that results would vary across crisis definition was to be expected, as they are defined differently. However, due to a lack of overall significance and stability relating to crisis regions, these results should only be interpreted cautiously.

Variables employed. Our choice of regional fragmentation limits the availability of data, most notably for control variables but also for some other potentially interesting aspects. In this context, it is important to have in mind that we analyse a set of European countries that generally speaking, do not exhibit big differences. Nevertheless, we would have liked to control for age as well as alcohol, tobacco, and drug consumption. Including age would have given us the opportunity to further analyse who is most affected by the links we observe, adding to the where and how. Alcohol, tobacco, and drug consumption have been demonstrated to be related to health as well (Economou et al., 2008) and would be worthwhile to include in our analysis. Moreover, controlling for health care expenditures per region would have given us a supply measure of health care, potentially enabling us to draw further inferences about structural regional patterns or even regional health policy.

Furthermore, performing our analysis for morbidity in addition to mortality rates would provide us with a more direct short-term measure of the impact of unemployment and household income on health. Morbidity data add significant value since troublesome health conditions possibly influenced by economic activity need not necessarily lead to death. These effects cannot be captured by mortality rates. Unfortunately, none of the above indicators was available on a NUTS 2 level, limiting the scope of our research.

Time horizon. While we do include a lagged dependent variable in our analysis, the lag we employ is one year and it is on the explanatory side of the equation. Hence, we only look at direct short-term effects of unemployment and household income on mortality. Another interesting perspective would be an extended time horizon, including longer time lags between regressors and the dependent variable, looking at long-term effects of crises. Especially in light of the severity of the current crisis, it would be interesting to see whether certain health effects only materialise over a longer time period.

6.4 Policy Implications

The results we observe lead us to a number of implications for regional, national, and European policymaking. However, these are careful suggestions rather than strong recommendations, as further research, is necessary to provide more detailed insight on regional diversity.

After observing what can be described as the "cost of wealth", it is important that policymakers take this effect into account on a regional level. In this research we demonstrate that regions with a higher average household income exhibit higher mortality rates. Furthermore, decreasing unemployment, which usually occurs in economic upturns, increases mortality rates even further. Governments should find ways to ensure that economic development does not come at the cost of reduced health. Examples for this could be educating society better how to prudently deal with (unusually high) discretionary incomes in times of prosperity. Governments could focus even more on stimulating expenditures that foster a healthy lifestyle and reducing discretionary expenses on unhealthy goods such as alcohol, tobacco, drugs and rich foods. Furthermore, considering that more employment is accompanied by higher all-cause mortality rates, one could speculate this might be due to employment-related stress and less free time to engage in healthy activities such as outdoor activities. To prevent this, governments could consider crafting programs that help employees deal with employment-related stress and reward companies that facilitate a better work-life-balance. This way, governments could compensate for the negative health effect of higher employment. Moreover, policymakers should take into account that the increases in household income are followed by increases in all-cause mortality mostly for the poorest regions. As the health in these regions appears to be disproportionately negatively affected in economic upturns, it is important that they focus in particular on preventing the negative health effects of economic growth.

Moreover, we see deaths due to traffic accidents rise in periods of economic growth. Governments should have this in mind when recovering from an economic downturn and take appropriate measures, such as improving traffic infrastructure to increase safety, traffic education, as well as public awareness campaigns.

The effect of crises is not stable across specifications and not statistically significant. The absence of a "crisis effect" could help governments focus on long-term policymaking - including crisis prevention - without focusing too strongly on unlikely disproportional health effects during a crisis.

This goes hand in hand with the implications drawn from comparing long- to short-term unemployment effects: short-term unemployment does not have a strong, nor significant impact on mortality. This gives governments the opportunity to justify not only short-term employment measures but also measures reducing long-term unemployment (including health-compensating policies). More specifically, the negative relationship between long-term unemployment and all-cause mortality rates implies that when policymakers aspire to decrease long-term unemployment, they should take concurrent measures to cancel out any negative health effects. Lastly, policymakers should take into account that only long-term unemployment is linked to poor mental health, whereas short-term unemployment is not. Hence, it is important that when long-term unemployment increases, policymakers should take measures to ensure that this does not deteriorate mental health.

6.5 Future Research

Extending the research on the link between unemployment, household income, and mortality, our thesis creates opportunities for future research in many directions. Moreover, overcoming some of its limitations entails the opportunity to further increase the interpretative value of our results.

Geographic fragmentation. This thesis is, to our best knowledge, the first to perform a cross-country, regional analysis and provides valuable insights about the similarities and differences between national and regional analyses. Extending the methodology to a broader and/or different geographic range in general would be a logical next step. In particular, including a third group of countries that exhibit certain structural similarities - for example, Central and Eastern European countries - would provide a fresh and maybe divergent perspective. Performing our analysis on all EU countries would be an alternative approach to the one we decided for. However, lack of data for some countries would pose the challenge of a potentially severely unbalanced panel, in which the lack of data might not be random. Lastly, conducting this research on countries at different stages of development, for example including developing and emerging economies, could shed light on the influence of institutions and stage of development on health.

Crisis definition. In this work, we introduced two new definitions of economic crisis and compared the results to already existing definitions. A potential extension of this analysis would be to perform previous analyses in the literature with the new crisis definitions where applicable and compare the new to the existing results. The key feature of the two crisis definitions used in this research is that they are defined in a relative manner: The first defines a region to experience a crisis compared to the country's average unemployment (plus one standard deviation) over a decade. The second defines a region to experience a crisis compared to the region's own average unemployment (plus one standard deviation) over a decade. The takeaway here is that these crisis definitions are not absolute cutoffs, but are dependent on either the country or the region itself as a relative benchmark. As it can be expected that different regions have different "normal" rates of unemployment, using relative measures in future research such as the ones employed in this thesis might add value to the existing body of literature.

Variables employed. Adding certain variables to our analysis could increase the possibility to interpret our results in various ways: First, adding morbidity has the potential to provide us with an even more powerful message, especially looking at the short-term impact of unemployment and household income on health. Unfortunately, at the time of writing, these data were not available on a regional level; however, we are confident they exist (potentially for certain countries only) and could be included, even though maybe in the analysis of a smaller set of countries. Second, regional social expenditures, particularly health expenditures, would provide us with a measure of health supply and give us the opportunity to account for measures taken by the government to keep or improve health. Third, within-country, cross-regional migration and/or migration between neighbouring regions could provide us with information about work-related mobility. One of the core political concepts and goals of the EU is to provide its citizens with (almost) unlimited mobility between its member states. Incorporating data about this in our analysis, potentially controlling for it, would create the opportunity to account for the likely fact that workers are inclined to migrate between geographically

close regions to find employment while this might not be the case for longer distances. Fourth and last, incorporating a more qualitative analysis of certain regions of interest according to some selected parameters (e.g. coastal versus land-locked regions, regions close to national borders, regions that exhibit certain economic characteristics) could add some colour to our method. Nevertheless, such a qualitative analysis could only be of limited interpretative value, as it would probably not fit into our statistical model.

Time horizon. Performing our analysis again some years from now and possibly including regressors that were lagged over a number of years would provide valuable additional insights, mainly due to two reasons. First, harmonised data are only available from the year 2000 onwards. Understanding if, how, and why results differ, in five or ten years would be interesting to see. Second, a longer time horizon could provide valuable information about whether the European economy works in some form of cycles, and whether and how these cycles are different on a national versus a regional level. Potentially, an analysis could be performed about whether these cycles become more or less asynchronous over time and how this affects public health.

Summary. We start this section by pointing out in which ways this thesis contributes to the body of research and interpreting our results. We continue with a critical assessment of our approach and methods employed and outline the limitations of our work. We then outline policy implications resulting from our analysis and point towards interesting future research possibilities. The next section concludes our thesis.

7 Conclusion

In this thesis, we set out to investigate unemployment and household income in relation to mortality on a regional level across European countries. In light of the recent economic crisis, we further hypothesised that the impact of our two key variables, unemployment and household income, on health might be different across regions in non-crisis and crisis times. Thereby, we seek to contribute to the ambiguous literature that researches the relationship between economic change and health.

Our basic findings are in line with Ruhm (2000, 2005) in the sense that we observe a negative relationship between unemployment and all-cause mortality. Mortality due to residual causes, other external causes, and traffic accidents also decreases when unemployment increases. The negative relationship between unemployment and mortality rates seems to be driven mostly by long-term unemployment. Furthermore, increases in household income are associated with increases in all-cause mortality. We observe a similar positive relationship between deaths due to cardiovascular diseases and household income. Taking these findings into account, it appears there is a cost of wealth related to economic upturns: higher unemployment and lower household income may lead to a healthier lifestyle due to more free time and less discretionary expenses on unhealthy goods. More free time might reduce stress, which has been shown to deteriorate health via a variety of diseases. Furthermore, less income might decrease expenses on unhealthy consumption of alcohol, tobacco, drugs and rich foods, which could have debilitating effects on health via inter alia cardiovascular diseases or conditions relating to nutrition such as diabetes and obesity. In general, these results are not significantly different between regions experiencing a crisis and those that do not. Interestingly however, when comparing these results across countries, the regions that are poorer in absolute terms (thus mostly found in poorer countries) appear to be most affected by these symptoms.

After contemplating the implications of these results, a number of policy recommendations come to mind: First and foremost, policy makers aspiring to decrease unemployment and increase income need to bear in mind that more prosperity might be associated with deteriorated health. Moreover, these effects are mostly driven by long-term unemployment and occur in relatively poorer income groups across Europe. Policy makers should hence be especially aware of negative health effects when trying to improve unemployment or household income in these regions or via long-term unemployment. Possible education about how to prudently deal with more discretionary expenses and employment-related stress may contribute to preventing an unhealthy lifestyle. Lastly, when the economy picks up, it is important that governments try to prevent accidents due to increases in work-related traffic by educating society more on dangers in traffic and improving conditions that facilitate safe traffic.

To conclude, we call for more research on the relationship between socioeconomic factors and health. Although our results point towards a counter-cyclical relationship between the state of the economy and health conditions on a macro-level across regions, the literature is characterised by high ambiguity. We believe that more research with a regional perspective on both a qualitative and quantitative basis may not only lead to more clarity in this domain, but also has the potential to improve society's health. And as we know from personal experience and as once delicately put in words by the Roman poet Virgil:

"The greatest wealth is health."

A Appendix

A.1 List of Abbreviations

EC European Commission

ECB European Central Bank

EU European Union

GDP Gross Domestic Product

GNP Gross National Product

GVA Gross Value Added

ICD International Statistical Classification of Diseases and Related Health Problems

IMF International Monetary Fund

NACE Nomenclature Générale des Activités Economiques dans l'Union Européene
— Statistical classification of economic activities in the European Community

NUTS Nomenclature des unités territoriales statistiques
— Nomenclature of Territorial Units for Statistics

OECD Organization for Economic Cooperation and Development

OLS Ordinary Least Squares

OVB Omitted Variable Bias

PIISG Portugal, Italy, Ireland, Spain, and Greece

PISG Portugal, Ireland, Spain, and Greece

WHO World Health Organization

A.2 Unemployment and Household Income per Country

This appendix displays unemployment percentages and household income for all regions across the countries in our sample. As can be observed, household income data until 2005 are missing for Greece.



Figure A.1 Unemployment Percentages per Country (%)



Figure A.2 Household Income per Country ('000)

A.3 Model Assumptions, Heteroskedasticity Test, Serial Correlation Test

This appendix specifies the assumptions underlying a fixed-effects model more explicitly following Wooldridge (2002). Furthermore, it describes the tests used to check for heteroskedasticity and serial correlation to ensure completeness.

Applying a fixed effects transformation, which is also known as a within transformation because it exploits time variation within each cross section (which corresponds to NUTS 2 regions), requires a number of assumptions. The first-fixed effects assumption requires strict exogeneity of the independent variables $\mathbf{x}_{it}$ conditional on the unobserved effect c_i :

$$\text{Assumption FE.1} \quad E(u_{it}|\mathbf{x}_i, c_i) = 0, \quad t = 1, 2, \dots, T$$

To ensure that the FE estimator is both asymptotically well behaved and efficient we need to make two more assumptions. Assumption FE.2 ensures that the FE estimator is asymptotically normal (and also demonstrates why time-invariant variables are not allowed in FE analysis unless interacted with time-variant variables):

$$\text{Assumption FE.2} \quad \text{rank}\left(\sum_{t=1}^T E(\ddot{\mathbf{x}}'_{it}\ddot{\mathbf{x}}_{it})\right) = \text{rank}[E(\ddot{\mathbf{X}}'_i\ddot{\mathbf{X}}_i)] = K$$

Lastly, to ensure efficiency of the FE estimator, we require the idiosyncratic errors u_{it} to have a constant variance across t and to be serially uncorrelated, which is reflected in assumption FE.3:

$$\text{Assumption FE.3} \quad E(\mathbf{u}_i\mathbf{u}'_i|\mathbf{x}_i, c_i) = \sigma_u^2\mathbf{I}_T$$

To make sure the model's underlying assumptions are upheld, we need to check for both heteroskedasticity and serial correlation. Following Greene (2000, p. 598), we test for heteroskedasticity of our model, where the null hypothesis assumes homoskedasticity specifying that $\sigma_i^2 = \sigma^2$ for $i = 1, \dots, N_g$, where N_g is the number of NUTS 2 regions. Then let $\hat{\sigma} = T_i^{-1} \sum_{t=1}^{T_i} \hat{e}_{it}^2$ be the estimator of the i th NUTS 2 region's error variance, based upon the T_i residuals $\hat{e}_{it}$ available for the specific NUTS 2 region. Then the modified Wald test statistic (distributed as $\chi^2_i[N_g]$) can be defined as:

$$W = \sum_{i=1}^{N_g} \frac{(\hat{\sigma}_i^2 - \hat{\sigma}^2)^2}{V_i}$$

where the estimated variance of $\hat{\sigma}_i^2$ is defined as:

$$V_i = T_i^{-1}(T_i - 1)^{-1} \sum_{t=1}^{T_i} (\hat{e}_{it}^2 - \hat{\sigma}_i^2)^2$$

The null hypothesis of $\sigma_i^2 = \sigma^2$ for $i = 1, \dots, N_g$ is rejected for all mortality rate categories, indicating the presence of possible heteroskedasticity which could bias our estimates if not accounted for. Therefore, we need to adjust our standard errors to make sure that our estimators are robust and consistent in the presence of heteroskedasticity.

According to Wooldridge (2002), serial correlation in $\{u_{it} : t = 1, \dots, T\}$ can bias the usual FE standard errors and lead to misleading inferences. Hence, it is important to check and account for serial correlation. Following Wooldridge (2002) and Drukker (2003), we use the residuals from a regression in first-differences defined as follows:

$$y_{it} - y_{it-1} = (\mathbf{x}_{it} - \mathbf{x}_{it-1})\beta + u_{it} - u_{it-1}$$

$$\Delta y_{it} = \Delta \mathbf{x}_{it}\beta + \Delta u_{it}$$

After obtaining the residuals $\hat{e}_{it}$ from (A.3) and regressing these on their respective lags ($\hat{e}_{it-1}$), the null hypothesis ($Corr(\Delta u_{it}, \Delta u_{it-1}) = -0.5$) that the coefficient equals -0.5 can be rejected for the specification on almost all category-specific mortality rates where we detect serial correlation.¹⁶

Consequently, as explained before, we cluster our standard errors at NUTS2 level following Drukker (2003) to ensure heteroskedasticity and autocorrelation consistent estimators.

¹⁶Only with deaths due to homicides and suicides as the dependent variable we do not detect serial correlation.

A.4 Non-crisis versus Crisis Countries

This appendix illustrates the relationship between household income and unemployment with respect to (cause-specific) mortality rates. Countries have been segmented according to whether they belong to crisis-struck countries or not. The countries most substantially struck by poor economic times are those corresponding to the commonly known PISG countries.

Table A.1 Unemployment and Household Income on Mortality Rates - Non-crisis versus Crisis Countries[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Panel A: Non-crisis Countries: Austria, Belgium, Germany, Netherlands, Sweden											
Log Percentage Unemployment	0.0028 (0.0054)	0.1104 (0.0749)	0.0373** (0.0146)	-0.0003 (0.0080)	-0.2719*** (0.0936)	-0.0869 (0.0639)	-0.0077 (0.0163)	-0.0467 (0.0347)	0.0249 (0.0581)	-0.1665 (0.1845)	0.0458 (0.0349)
Log Household Income	0.0161 (0.0388)	-0.3200 (0.5517)	0.0695 (0.0746)	-0.0555 (0.0677)	0.1304 (0.4544)	0.5278 (0.3616)	-0.2268** (0.0878)	0.0474 (0.3432)	0.0569 (0.4432)	-0.5154 (1.1249)	0.0141 (0.2732)
Education	0.0003 (0.0006)	0.0048 (0.0095)	-0.0002 (0.0014)	-0.0008 (0.0012)	-0.0067 (0.0104)	0.0063 (0.0079)	0.0027 (0.0019)	0.0022 (0.0060)	-0.0133 (0.0094)	0.0244 (0.0219)	0.0011 (0.0037)
Degree of urbanisation	-0.0408 (0.0261)	-0.1168 (0.3456)	-0.0232 (0.0534)	-0.0297 (0.0503)	-0.0315 (0.4620)	-0.0407 (0.3487)	-0.0482 (0.0753)	-0.3019 (0.2594)	-0.4187 (0.3002)	-0.4014 (0.7645)	-0.4691** (0.1955)
Observations	675	641	675	675	675	675	675	669	675	669	675
Number of region	69	69	69	69	69	69	69	69	69	69	69
Adjusted R-squared	0.8247	0.3880	0.8559	0.5382	0.4875	0.8138	0.7776	0.6154	0.6961	0.1142	0.3566
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: Crisis Countries: Portugal, Ireland, Greece, Spain											
Log Percentage Unemployment	-0.0016 (0.0166)	-0.0407 (0.1569)	-0.0450*** (0.0137)	-0.0076 (0.0144)	0.0149 (0.0473)	0.3769** (0.1601)	0.0485 (0.0331)	-0.0888 (0.0900)	-0.2495** (0.1056)	-0.1171 (0.2280)	-0.0023 (0.1870)
Log Household Income	0.1512* (0.0858)	-0.4361 (0.7206)	0.1586* (0.0879)	0.1182* (0.0685)	0.9558* (0.5158)	1.0461 (1.2778)	0.2222 (0.1790)	0.7726* (0.3823)	0.1215 (0.5061)	0.5032 (1.3314)	-1.8365** (0.7683)
Education	0.0012 (0.0030)	-0.0421* (0.0246)	-0.0005 (0.0014)	0.0012 (0.0016)	-0.0082 (0.0097)	-0.0254 (0.0191)	0.0062 (0.0058)	0.0133 (0.0187)	-0.0498*** (0.0171)	-0.0809** (0.0317)	0.0430* (0.0229)
Degree of urbanisation	-0.0213 (0.0453)	-0.0749 (0.5187)	-0.0612 (0.0564)	0.1021 (0.0731)	0.4494 (0.2891)	1.4585** (0.7107)	-0.1233 (0.1054)	-0.1383 (0.3290)	0.5004 (0.3593)	-0.2550 (0.7204)	-0.5639 (0.6797)
Observations	273	272	273	273	273	273	273	264	272	264	272
Number of region	35	35	35	35	35	35	35	35	35	35	35
Adjusted R-squared	0.6843	0.3568	0.7927	0.5893	0.3524	0.2792	0.5948	0.3957	0.7322	0.1513	0.1836
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. The independent variables of interest are the logarithms of unemployment and household income in the first two rows of each panel. Panel A depicts the results for non-crisis countries (Austria, Belgium, Germany, Netherlands, Sweden), whereas panel B displays the results for crisis countries (Portugal, Ireland, Greece, Spain). All specifications include controls for education and degree of urbanisation and year-fixed effects. Furthermore, year-fixed effects, regional-fixed effects and region-specific time trends are accounted for. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

A.5 Cross-country Analysis

This appendix displays the relationship between unemployment and household income with cause-specific mortality rates on a cross-country level.

Looking at panel A, we observe that higher unemployment is followed by a decrease in mortality rates due to cardiovascular diseases. A similar observation can be made for mortality rates due to other external causes and traffic accidents. Household income and mortality rates due to nutritional diseases depict a positive relationship. Panel B includes country-specific time trends and results are somewhat different. Although the relationship between unemployment and deaths due to other external causes as well as traffic accidents is similar, the relationship between unemployment and cardiovascular diseases turns insignificant. Household income, however, positively impacts all-cause mortality rates unlike the specification excluding country-specific time trends. When including a lagged dependent variable in panel C, the latter relationship turns insignificant.

Table A.2 Unemployment and Household Income on Mortality Rates across Countries[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Panel A: basic specification											
Log Percentage Unemployment	-0.0267 (0.0275)	-0.2494 (0.1537)	-0.0578* (0.0263)	0.0301 (0.0318)	0.0752 (0.1111)	-0.5328 (0.3585)	-0.0569 (0.0627)	-0.1788** (0.0689)	-0.1709* (0.0876)	0.0238 (0.1517)	0.1439 (0.1145)
Log Household Income	0.0377 (0.1496)	-0.9268 (0.9125)	0.0190 (0.2334)	0.0190 (0.1604)	2.0727* (0.9854)	-0.3259 (1.2097)	-0.0879 (0.3475)	0.1836 (0.3729)	-0.5565 (0.7165)	-0.1778 (0.7040)	-0.3332 (0.4874)
Education	-0.0039* (0.0021)	0.0183 (0.0127)	-0.0025 (0.0044)	-0.0050 (0.0030)	-0.0354 (0.0256)	-0.0819*** (0.0185)	-0.0045 (0.0056)	-0.0044 (0.0055)	-0.0196 (0.0156)	0.0047 (0.0091)	0.0073 (0.0044)
Degree of urbanisation	0.0266 (0.0596)	-0.4889 (0.2934)	0.0568 (0.0763)	0.0397 (0.0551)	-0.1357 (0.6636)	0.5647 (0.5975)	-0.1590 (0.1139)	0.0987 (0.1076)	-0.0688 (0.1827)	-1.1880** (0.3861)	0.1653 (0.3060)
Observations	74	77	74	74	74	74	74	74	74	74	74
Number of region	9	9	9	9	9	9	9	9	9	9	9
Adjusted R-squared	0.6544	0.5848	0.8852	0.3106	0.2090	0.3336	0.2807	0.6095	0.8532	0.3548	0.1815
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: basic specification including country-specific time trends											
Log Percentage Unemployment	-0.0181 (0.0179)	-0.1059 (0.1225)	-0.0135 (0.0503)	-0.0075 (0.0122)	-0.0380 (0.1778)	0.1496 (0.1900)	-0.0331 (0.0411)	-0.1392** (0.0437)	-0.2799*** (0.0207)	-0.1210 (0.0846)	-0.0905 (0.0592)
Log Household Income	0.1283* (0.0614)	-0.6208 (0.7324)	0.1857 (0.2367)	0.0258 (0.0948)	-0.0523 (0.4995)	2.3929* (1.2296)	-0.0629 (0.3717)	0.2020 (0.3594)	-0.6727 (0.4677)	0.5123 (1.1897)	-0.5421 (0.6747)
Observations	74	77	74	74	74	74	74	74	74	74	74
Number of region	9	9	9	9	9	9	9	9	9	9	9
Adjusted R-squared	0.8800	0.7753	0.9183	0.7823	0.6293	0.6566	0.6228	0.7087	0.9245	0.4572	0.3716
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel C: basic specification including country-specific time trends and lagged dependent variables											
Log Percentage Unemployment	-0.0287 (0.0162)	-0.1139 (0.1113)	-0.0179 (0.0411)	0.0042 (0.0163)	-0.0740 (0.0554)	0.1419 (0.1053)	-0.0080 (0.0579)	-0.2021*** (0.0376)	-0.2254*** (0.0549)	-0.1011 (0.0943)	-0.1099 (0.0840)
Log Household Income	0.1332 (0.0804)	-0.9238 (0.7753)	-0.0626 (0.1822)	0.0341 (0.1364)	-1.1567 (0.7237)	2.2406* (1.1681)	0.0507 (0.2664)	0.0365 (0.4250)	-0.4464 (0.2695)	0.6510 (1.1394)	-0.8034 (0.6889)
Observations	68	75	68	68	68	68	68	68	68	68	68
Number of region	9	9	9	9	9	9	9	9	9	9	9
Adjusted R-squared	0.8816	0.7767	0.9362	0.7848	0.7394	0.8183	0.6378	0.7593	0.9669	0.4958	0.5103
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged Dependent Variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. The key independent variables of interest are the logarithms of unemployment and household income in the first two rows of each panel. All specifications include controls for education and degree of urbanisation. The panels are ordered in order of robustness: Panel A includes year-fixed and country-fixed effects. Panel B adds country-specific time trends and panel C adds a lagged dependent variable. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

A.6 Welch's T-test - Difference in Coefficients on Regional versus National Level

This appendix displays the differences in coefficients between unemployment and household income when comparing them between the regional and national sample. As can be seen from table A.3, there are a number of cause-specific mortality rates that have different coefficients on a regional versus national basis for both unemployment and household income. This confirms our expectation that conducting an analysis on a regional basis instead of a country basis may add value and render different results.

Welch's T-test is a test used to test for the significance of differences in coefficients when two samples have equal or unequal sample sizes and unequal variances. When we compare the samples on a regional versus national basis, we deal with both unequal variance between variables and unequal samples size.¹⁷ Welch's T-test is calculated as follows:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}}}$$

where $\bar{X}_i$, s_i^2 , and N_i are the i^{th} sample mean (hence the coefficient), sample variance (hence the squared standard error), and sample size, respectively. The degrees of freedom v associated with this variance estimates is approximated using the Welch-Satterthwaite equation:

$$v \approx \frac{(\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2})^2}{\frac{s_1^4}{N_1^2 v_1} + \frac{s_2^4}{N_2^2 v_2}}$$

where $v_i = N_i - 1$

Table A.3 Welch's T-test: Regional versus National Analysis[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Panel B-1: Region-specific specification including region-specific time trends											
Log Percentage Unemployment	-0.0152*** (0.0050)	-0.0314 (0.0566)	-0.0106 (0.0095)	-0.0014 (0.0059)	-0.0679 (0.0452)	0.0649 (0.0546)	-0.0197* (0.0116)	-0.1309*** (0.0349)	-0.1459*** (0.0458)	-0.1259 (0.1232)	0.0038 (0.0606)
Log Household Income	0.1145*** (0.0415)	0.2628 (0.4326)	0.1460** (0.0578)	0.0268 (0.0454)	0.1619 (0.2475)	0.5122 (0.5505)	0.0705 (0.0983)	0.3464 (0.2438)	0.0239 (0.2711)	0.4600 (0.8020)	-0.0074 (0.5346)
Observations	948	913	948	948	948	948	948	933	947	933	947
Panel B-2: Country-specific specification including country-specific time trends											
Log Percentage Unemployment	-0.0181 (0.0179)	-0.1059 (0.1225)	-0.0135 (0.0503)	-0.0075 (0.0122)	-0.0380 (0.1778)	0.1496 (0.1900)	-0.0331 (0.0411)	-0.1392** (0.0437)	-0.2799*** (0.0207)	-0.1210 (0.0846)	-0.0905 (0.0592)
Log Household Income	0.1283* (0.0614)	-0.6208 (0.7324)	0.1857 (0.2367)	0.0258 (0.0948)	-0.0523 (0.4995)	2.3929* (1.2296)	-0.0629 (0.3717)	0.2020 (0.3594)	-0.6727 (0.4677)	0.5123 (1.1897)	-0.5421 (0.6747)
Observations	74	77	74	74	74	74	74	74	74	74	74
Two-tailed Welch's T-test - Difference in Coefficients on a Regional versus National basis											
Difference in Log Percentage Unemployment	0.0029	0.0745***	0.0029	0.0061***	-0.0299	-0.0847***	0.0134***	0.0083	0.134***	-0.0049	0.0943***
Degrees of Freedom	74	79	73	76	74	74	74	81	138	99	85
Difference in Log Household Income	-0.0138* 78	0.8836*** 81	-0.0397 74	0.0010 76	0.2142*** 76	-1.8807*** 75	0.1334*** 74	0.1444*** 78	0.6966*** 77	-0.0523 78	0.5347*** 80

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. The independent variables of interest are the logarithms of unemployment and household income in the first two rows of panel B-1 and B-2. The bottom panel displays the difference in coefficients (and significance) for unemployment and household income between the region- and country-specific specifications. The specifications have the same controls as used in Table 5. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

¹⁷In the unlikely event that variances for variables would be equal between samples, Welch's T-test provides the same result as a test specifically designed for unequal sample sizes and equal variances.

A.7 Within-country Regional Effects

This appendix displays the regional fixed effects analysis separated by country. As can be observed, Ireland and Sweden are not depicted due to insufficient observations.

Table A.4 Unemployment and Household Income on Mortality Rates within Countries[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Austria											
Log Percentage Unemployment	0.0006 (0.0142)	0.1681 (0.1690)	-0.0017 (0.0388)	0.0268 (0.0228)	-0.0177 (0.1153)	-0.1768 (0.2288)	0.0165 (0.0319)	-0.1152 (0.1760)	-0.1593 (0.1012)	0.1980 (0.3845)	-0.0084 (0.1253)
Log Household Income	0.3864 (0.5301)	-0.3398 (3.8741)	0.0683 (0.5076)	0.7058* (0.3442)	2.6055 (3.1538)	-6.9878** (2.3467)	1.2931 (1.1544)	-2.4500 (1.6717)	-3.4478 (2.2116)	-2.2332 (7.9347)	0.3005 (1.6602)
Observations	88	88	88	88	88	88	88	82	88	82	88
Number of region	8	8	8	8	8	8	8	8	8	8	8
Adjusted R-squared	0.8245	0.4211	0.9203	0.4075	0.9605	0.6841	0.7942	0.6326	0.6903	0.2075	0.4746
Belgium											
Log Percentage Unemployment	0.0018 (0.0074)	0.1753 (0.1484)	0.0070 (0.0180)	-0.0147 (0.0130)	0.1561 (0.1144)	-0.0480 (0.0620)	0.0162 (0.0392)	-0.0203 (0.0460)	-0.0067 (0.1602)	-0.3245 (0.3813)	0.0434 (0.0743)
Log Household Income	-0.9086** (0.3459)	2.9713 (5.3186)	-0.7004 (0.3981)	-0.8801 (0.8062)	-3.5615 (2.3989)	5.4779** (2.1677)	-1.3597** (0.4642)	-2.8375 (1.7609)	-1.3576 (4.4842)	10.7376 (15.3032)	-3.5897 (2.1417)
Observations	95	110	95	95	95	95	95	95	95	95	95
Number of region	10	10	10	10	10	10	10	10	10	10	10
Adjusted R-squared	0.8387	0.2098	0.9086	0.4703	0.2418	0.6262	0.7585	0.7726	0.7066	0.0638	0.3008
Germany											
Log Percentage Unemployment	-0.0039 (0.0101)	-0.0664 (0.1831)	0.0295 (0.0207)	-0.0181 (0.0177)	-0.4403** (0.1812)	-0.2204 (0.2302)	0.0352 (0.0296)	-0.0254 (0.0934)	-0.0825 (0.0899)	0.1461 (0.3914)	0.0774 (0.0889)
Log Household Income	0.1191 (0.0927)	2.1765 (1.4001)	0.4242** (0.1706)	0.1124 (0.1492)	-2.8335 (1.6799)	2.6265 (2.3712)	-0.2390 (0.3060)	0.3072 (1.0707)	2.2333* (1.2035)	0.6569 (2.9390)	0.0010 (0.8732)
Observations	354	317	354	354	354	354	354	354	354	354	354
Number of region	36	36	36	36	36	36	36	36	36	36	36
Adjusted R-squared	0.8757	0.3658	0.8109	0.6062	0.3065	0.8480	0.8894	0.6437	0.8085	0.1644	0.4644
Greece											
Log Percentage Unemployment	0.0733 (0.0540)	0.5320 (1.1246)	0.0929 (0.0825)	0.1099 (0.1033)	-0.1967 (0.3104)	0.4938 (0.9376)	0.0043 (0.0803)	0.0776 (0.4568)	0.3738 (0.3117)	-0.4213 (0.9339)	0.2865 (0.7035)
Log Household Income	-0.0882 (0.0987)	0.5498 (1.6559)	0.0113 (0.1621)	-0.3461*** (0.1129)	0.4168 (0.8903)	1.6123 (3.3546)	-0.0060 (0.2916)	-1.0906 (1.2631)	0.5170 (1.2657)	-0.4430 (1.7963)	-0.8741 (1.5365)
Observations	59	59	59	59	59	59	59	58	59	58	59
Number of region	13	13	13	13	13	13	13	13	13	13	13
Adjusted R-squared	0.5118	0.3591	0.7209	0.3596	0.5102	0.0300	0.8459	0.2450	0.5416	0.2198	0.0431
Netherlands											
Log Percentage Unemployment	0.0168 (0.0104)	-0.0669 (0.1411)	0.0117 (0.0146)	0.0229 (0.0206)	0.0772 (0.0560)	-0.0034 (0.0474)	0.0104 (0.0191)	0.0075 (0.0801)	0.2847** (0.1141)	-0.6320 (0.5507)	0.0255 (0.1219)
Log Household Income	-0.0122 (0.1079)	-1.5472 (1.2900)	-0.1254 (0.2595)	0.0075 (0.1398)	0.5274 (0.7705)	-0.8452** (0.3747)	0.1331 (0.2221)	-0.4971 (1.1749)	1.8617* (0.9942)	-4.5795 (3.2366)	-0.3170 (0.7836)
Observations	132	120	132	132	132	132	132	132	132	132	132
Number of region	12	12	12	12	12	12	12	12	12	12	12
Adjusted R-squared	0.8480	0.5568	0.9325	0.5743	0.7055	0.7875	0.6685	0.4580	0.5231	0.0452	0.1867
Portugal											
Log Percentage Unemployment	0.0065 (0.0377)	-0.3148 (0.2110)	-0.0389 (0.0503)	-0.0477** (0.0144)	-0.0117 (0.0731)	0.5131 (0.3762)	0.1114 (0.0542)	-0.3491* (0.1223)	-0.4176 (0.4278)	-0.7181 (0.7951)	-0.4902 (0.4649)
Log Household Income	0.1475 (0.2672)	-9.7097 (5.6342)	0.9360 (0.4543)	-0.1535 (0.2518)	0.4360 (1.5154)	-11.1297** (2.4588)	-0.4000* (0.1428)	0.6443 (1.9289)	10.3633* (3.2683)	20.2881* (7.7887)	0.3589 (3.5097)
Observations	39	39	39	39	39	39	39	39	39	39	39
Number of region	4	4	4	4	4	4	4	4	4	4	4
Adjusted R-squared	0.7794	0.7691	0.9803	0.8391	0.7807	0.9188	0.8167	0.3150	0.7461	0.5553	0.6398
Spain											
Log Percentage Unemployment	0.0153 (0.0210)	0.1169 (0.1980)	-0.0239 (0.0146)	0.0181 (0.0192)	-0.0193 (0.1094)	0.1509 (0.1312)	0.0523 (0.0462)	0.0847 (0.1075)	-0.2381 (0.1725)	-0.3051 (0.3420)	-0.0688 (0.3395)
Log Household Income	0.3145** (0.1309)	-0.9439 (1.7415)	0.2770 (0.2869)	-0.1169 (0.2029)	3.7723** (1.4405)	-3.0247** (1.1484)	0.5020 (0.3482)	0.8812 (0.7757)	-2.3569* (1.2585)	1.4897 (4.5057)	-0.4837 (1.5779)
Observations	171	170	171	171	171	171	171	163	170	163	170
Number of region	16	16	16	16	16	16	16	16	16	16	16
Adjusted R-squared	0.7287	0.1430	0.7585	0.6656	0.3389	0.3707	0.5971	0.5234	0.7872	0.1697	0.2196
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. The independent variables of interest are the logarithms of unemployment and household income in the first two rows of each panel representing a separate country. All specifications include controls for education and degree of urbanisation. Furthermore, year-fixed effects, regional-fixed effects and region-specific time trends are accounted for. Ireland and Sweden drop out due to an insufficient amount of observations. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

A.8 Long- versus Short-term Unemployment during Crises

This appendix displays the relationship between cause-specific mortality rates and our two key variables of interest, unemployment and household income, in the presence of crises, with unemployment separated in long- and short-term unemployment. A general interpretation across the four panels for the different crisis definitions is that the impact of unemployment on cause-specific mortality rates, whether positive or negative, comes from long-term unemployment. As seen before, short-term unemployment does not significantly impact the cause-specific mortality rates. It only has a (borderline) negatively significant relationship with all-cause mortality rates. The interaction terms between long- and short-term unemployment and the crisis dummies across the four panels on average do not render significant nor stable results. The only somewhat stable result across the four crisis definitions relates to deaths due to residual causes. Although long-term unemployment negatively impacts mortality rates due to residual causes, short-term unemployment does not display a significant relationship with mortality. However, the interaction term between short-term unemployment and the crisis dummy is (borderline) significant across the four panels. This would imply that when short-term unemployment goes up in a crisis region, mortality rates due to residual causes go up, whereas the same does not hold true for a non-crisis region.

Table A.5 Long- versus Short-term Unemployment during Crises[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Panel A: Recession											
Log Percentage Long-Term Unemployment	-0.0116*** (0.0042)	-0.0260 (0.0342)	-0.0048 (0.0070)	0.0021 (0.0048)	-0.0890** (0.0376)	0.1318*** (0.0470)	-0.0235*** (0.0081)	-0.0783*** (0.0250)	-0.0819** (0.0320)	-0.1337 (0.0943)	-0.0157 (0.0364)
Log Percentage Short-Term Unemployment	-0.0068 (0.0066)	-0.0592 (0.0796)	-0.0045 (0.0088)	-0.0007 (0.0094)	-0.0219 (0.0598)	-0.1501* (0.0776)	0.0074 (0.0193)	0.0241 (0.0393)	-0.0656 (0.0724)	-0.0561 (0.1399)	0.0173 (0.1234)
Log Household Income	0.0576 (0.0359)	0.1950 (0.4830)	0.0286 (0.0558)	-0.0257 (0.0518)	0.0326 (0.2909)	1.4271* (0.7232)	0.1231 (0.0895)	0.4855* (0.2781)	-0.1331 (0.3833)	-0.1023 (0.9373)	0.2682 (0.6368)
Recession	-0.1318 (0.1276)	0.0099 (1.1392)	0.2075 (0.2604)	-0.0433 (0.1713)	-3.9612*** (1.0030)	-0.3538 (1.3475)	-0.3821 (0.2355)	0.5380 (0.5830)	0.8955 (0.8198)	-1.3610 (3.6374)	0.3586 (1.2359)
Interaction Log Perc Long-Term Unemployment and Recession	0.0011 (0.0033)	0.0097 (0.0359)	0.0049 (0.0092)	-0.0040 (0.0059)	0.0627* (0.0316)	-0.0418 (0.0440)	0.0043 (0.0087)	0.0053 (0.0190)	-0.0019 (0.0302)	-0.1564 (0.1077)	-0.0429 (0.0274)
Interaction Log Perc Short-Term Unemployment and Recession	0.0085 (0.0059)	0.0598 (0.0622)	-0.0106 (0.0115)	0.0039 (0.0087)	0.0190 (0.0455)	0.0284** (0.0767)	-0.0351 (0.0120)	0.0237 (0.0291)	0.1658 (0.0359)	0.0776 (0.1450)	0.0481 (0.0481)
Interaction Log household income and Recession	0.0154 (0.0150)	0.0438 (0.1309)	-0.0254 (0.0312)	0.0025 (0.0195)	0.4695*** (0.1168)	0.0466 (0.1528)	0.0482* (0.0278)	-0.0672 (0.0679)	-0.1115 (0.0990)	0.1189 (0.4228)	-0.0209 (0.1421)
Observations	803	780	803	803	803	803	803	797	802	797	803
Adjusted R-squared	0.7695	0.3873	0.8398	0.5312	0.3442	0.7414	0.7485	0.6001	0.7584	0.1593	0.2488
Panel B: Mass Unemployment											
Log Percentage Long-Term Unemployment	-0.0092** (0.0040)	-0.0389 (0.0342)	-0.0036 (0.0067)	0.0038 (0.0046)	-0.0624* (0.0360)	0.1246*** (0.0453)	-0.0187** (0.0078)	-0.0801*** (0.0238)	-0.0793** (0.0328)	-0.1825** (0.0909)	-0.0243 (0.0370)
Log Percentage Short-Term Unemployment	-0.0095* (0.0056)	0.0006 (0.0805)	-0.0068 (0.0104)	-0.0049 (0.0082)	0.0101 (0.0520)	-0.1034 (0.0728)	-0.0003 (0.0148)	0.0177 (0.0373)	-0.0179 (0.0502)	-0.0704 (0.1244)	-0.0571 (0.0574)
Log Household Income	0.0567 (0.0356)	-0.0210 (0.4649)	0.0270 (0.0493)	-0.0161 (0.0531)	0.4941* (0.2942)	1.2773* (0.7055)	0.0798 (0.0866)	0.5449** (0.2640)	-0.1463 (0.2870)	-0.3471 (0.8875)	-0.1807 (0.3950)
Massunemployment	-0.1778 (0.4701)	-2.2829 (5.6560)	-0.5049 (0.8220)	-0.8103 (0.5645)	2.3065 (2.0016)	-1.6657 (2.8057)	1.0585 (0.7394)	-3.6904 (2.5640)	3.3289 (3.9799)	-18.4493* (10.7858)	-4.2008 (4.7442)
Interaction Log Perc Long-Term Unemployment and Massunemployment	0.0107 (0.0144)	-0.0327 (0.1627)	0.0186 (0.0218)	0.0062 (0.0161)	-0.0500 (0.0568)	-0.0840 (0.0985)	0.0027 (0.0154)	0.1514** (0.0709)	-0.1377 (0.1360)	0.5017 (0.3326)	0.0662 (0.1518)
Interaction Log Perc Short-Term Unemployment and Massunemployment	-0.0006 (0.0062)	0.2441** (0.1173)	-0.0283 (0.0263)	0.0095 (0.0152)	-0.0332 (0.0481)	0.1299 (0.0812)	0.0401** (0.0195)	-0.0837 (0.0868)	-0.1196* (0.0662)	0.4329 (0.3082)	-0.0790 (0.1006)
Interaction Log household income and Massunemployment	0.0204 (0.0567)	0.2637 (0.6808)	0.0521 (0.0978)	0.0902 (0.0666)	-0.2671 (0.2364)	0.1735 (0.3361)	-0.1124 (0.0863)	0.4253 (0.2979)	-0.3929 (0.4829)	2.2482* (1.2609)	0.5034 (0.5700)
Observations	808	784	808	808	808	808	808	802	807	802	808
Adjusted R-squared	0.7741	0.3693	0.8425	0.5332	0.3361	0.7439	0.7538	0.5968	0.7788	0.1569	0.3717
Panel C: Crisisdefinition1											
Log Percentage Long-Term Unemployment	-0.0089** (0.0043)	-0.0429 (0.0346)	-0.0026 (0.0069)	0.0037 (0.0048)	-0.0640* (0.0367)	0.1310*** (0.0452)	-0.0196** (0.0081)	-0.0833*** (0.0243)	-0.0796** (0.0334)	-0.1518 (0.0957)	-0.0107 (0.0356)
Log Percentage Short-Term Unemployment	-0.0137** (0.0061)	0.0277 (0.0865)	-0.0139 (0.0101)	-0.0046 (0.0096)	0.0221 (0.0562)	-0.0843 (0.0766)	-0.0065 (0.0169)	0.0121 (0.0420)	-0.0402 (0.0501)	-0.0818 (0.1403)	-0.0800 (0.0668)
Log Household Income	0.0439 (0.0371)	0.0754 (0.4635)	0.0164 (0.0557)	-0.0118 (0.0532)	0.5295* (0.3050)	1.4871** (0.7197)	0.0288 (0.0812)	0.4322 (0.2736)	-0.0640 (0.2808)	-0.2305 (0.8574)	-0.0669 (0.3755)
crisisregion definition 1	0.0179 (0.0875)	-0.9606 (1.3157)	0.1909 (0.1732)	0.0324 (0.1964)	-0.2770 (0.9289)	1.8099 (1.5860)	-0.2575 (0.2472)	-0.6637 (0.8189)	0.2753 (1.1593)	-1.9018 (2.2616)	0.0973 (0.7791)
Interaction Log Perc Long-Term Unemployment and Crisisregion1	-0.0056 (0.0041)	0.0175 (0.0488)	-0.0052 (0.0080)	-0.0057 (0.0070)	0.0456 (0.0278)	-0.0738 (0.0509)	-0.0151 (0.0102)	0.0283 (0.0233)	-0.0160 (0.0397)	-0.0957 (0.0814)	-0.0399 (0.0258)
Interaction Log Perc Short-Term Unemployment and Crisisregion1	0.0005 (0.0049)	0.0365 (0.0735)	-0.0138 (0.0108)	0.0020 (0.0102)	-0.0305 (0.0365)	0.0264 (0.0589)	0.0215* (0.0116)	-0.0374 (0.0344)	-0.0532 (0.0438)	0.1944 (0.1301)	0.0619 (0.0432)
Interaction Log household income and Crisisregion1	-0.0034 (0.0106)	0.1306 (0.1550)	-0.0268 (0.0210)	-0.0052 (0.0223)	0.0544 (0.1055)	-0.2081 (0.1808)	0.0276 (0.0288)	0.0769 (0.0945)	-0.0443 (0.1408)	0.2169 (0.2681)	0.0074 (0.0914)
Observations	808	784	808	808	808	808	808	802	807	802	808
Adjusted R-squared	0.7691	0.3666	0.8413	0.5245	0.3291	0.7464	0.7518	0.5915	0.7742	0.1528	0.3646
Controls and Interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel D: Crisisdefinition2											
Log Percentage Long-Term Unemployment	-0.0091** (0.0044)	-0.0449 (0.0356)	-0.0022 (0.0068)	0.0029 (0.0049)	-0.0700* (0.0375)	0.1306*** (0.0467)	-0.0186** (0.0081)	-0.0857*** (0.0246)	-0.0747** (0.0329)	-0.1640* (0.0960)	-0.0164 (0.0343)
Log Percentage Short-Term Unemployment	-0.0122* (0.0062)	0.0424 (0.0888)	-0.0143 (0.0099)	-0.0012 (0.0101)	0.0214 (0.0612)	-0.0825 (0.0787)	-0.0049 (0.0162)	0.0209 (0.0416)	-0.0328 (0.0519)	-0.0313 (0.1486)	-0.0847 (0.0703)
Log Household Income	0.0459 (0.0372)	0.0490 (0.4697)	0.0253 (0.0566)	-0.0143 (0.0525)	0.4585 (0.2981)	1.4967** (0.7402)	0.0416 (0.0821)	0.4293 (0.2706)	-0.0231 (0.2782)	-0.2518 (0.8641)	-0.1071 (0.3747)
crisisregion definition 2	0.0154 (0.0729)	-1.0210 (1.3765)	0.2626* (0.1564)	-0.0684 (0.1837)	-1.1923 (0.8549)	1.0463 (1.3523)	-0.1008 (0.2065)	-0.3649 (0.7267)	0.2866 (0.8670)	-2.1084 (2.4787)	-0.2117 (0.6848)
Interaction Log Perc Long-Term Unemployment and Crisisregion2	-0.0050 (0.0035)	0.0456 (0.0463)	-0.0046 (0.0068)	-0.0039 (0.0069)	0.0475* (0.0262)	-0.0836* (0.0473)	-0.0154* (0.0083)	0.0472** (0.0217)	-0.0329 (0.0347)	-0.0728 (0.0883)	-0.0148 (0.0302)
Interaction Log Perc Short-Term Unemployment and Crisisregion2	0.0029 (0.0045)	-0.0079 (0.0761)	-0.0118 (0.0100)	0.0047 (0.0106)	-0.0228 (0.0328)	0.0537 (0.0512)	0.0209* (0.0107)	-0.0495 (0.0306)	-0.0429 (0.0424)	0.2242* (0.1258)	0.0680 (0.0439)
Interaction Log household income and Crisisregion2	-0.0021 (0.0088)	0.1311 (0.1570)	-0.0322* (0.0187)	0.0061 (0.0204)	0.1552 (0.0967)	-0.1210 (0.1545)	0.0102 (0.0242)	0.0475 (0.0840)	-0.0539 (0.1053)	0.2526 (0.3025)	0.0564 (0.0850)
Observations	808	784	808	808	808	808	808	802	807	802	808
Adjusted R-squared	0.7688	0.3670	0.8400	0.5252	0.3292	0.7469	0.7500	0.5928	0.7748	0.1548	0.3684
Number of regions	100	100	100	100	100	100	100	100	100	100	100
Controls and Interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. Each panel has a different crisis definition and should be read as follows: The first three rows indicate the impact of long- and short-term unemployment and household income on (cause-specific) mortality rates for non-crisis regions. The third row is a dummy measuring the impact of when a region is in a state of crisis on (cause-specific) mortality rates. The interaction terms in the fourth, fifth and sixth row specify the additional impact long- and short-term unemployment and household income have on (cause-specific) mortality rates when a region experiences a crisis. Considering that most interaction terms are insignificant across panels, long- and short-term unemployment and household income do not appear to impact (cause-specific) mortality rates differently between non-crisis and crisis regions. All specifications include controls for education and degree of urbanisation (and interactions of controls with the crisis dummy). Furthermore, year-fixed effects, regional-fixed effects, and region-specific time trends are accounted for. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

A.9 Quintile Analysis - Income across Countries, Long- and Short-term Unemployment

This appendix displays the relationship between cause-specific mortality rates and our two key variables of interest, unemployment and household income, across income brackets *across* countries, with unemployment separated in long- and short-term unemployment. A general interpretation across the four panels for the different crisis definitions is that the impact that unemployment has on cause-specific mortality rates, whether positive or negative, mostly comes from the long-term unemployment. As seen before, short-term unemployment does not significantly impact cause-specific mortality rates (with the exception of positively impacting suicides). Most interaction terms between the quintile dummies for income groups are either insignificant or borderline significant for both long- and short-term unemployment. Hence, we do not find significant differences across income groups with regard to the relationship between long- and short-term unemployment and mortality rates. The only result worth mentioning is that the impact of short-term unemployment on deaths due to mental diseases and suicides appears to be significantly more negative in higher income groups.

Table A.6 Quintile Analysis - Income across Countries, Long- and Short-term Unemployment[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Log Percentage Long-Term Unemployment	-0.0180** (0.0086)	-0.2490** (0.1115)	-0.0346* (0.0181)	-0.0217 (0.0137)	-0.0224 (0.0488)	0.0623 (0.1061)	0.0054 (0.0298)	-0.0474 (0.0731)	-0.1221 (0.1020)	-0.2474* (0.1427)	-0.3663** (0.1404)
Log Percentage Short-Term Unemployment	0.0038 (0.0107)	0.1401 (0.1042)	-0.0189 (0.0205)	0.0004 (0.0163)	0.0948 (0.0803)	0.2966 (0.1844)	0.0198 (0.0294)	-0.0574 (0.0803)	-0.0591 (0.1387)	0.3228 (0.2351)	0.3979** (0.1471)
Log Household Income	0.1383** (0.0598)	-0.3654 (0.9095)	0.0162 (0.0978)	0.0271 (0.0612)	0.5693 (0.4004)	1.9316** (0.9128)	0.2781 (0.1694)	0.9735** (0.4505)	-0.0804 (0.5544)	-0.6781 (1.0712)	-1.6906* (0.9401)
Quintile 2 household income	-0.2259 (0.6528)	0.8984 (8.1811)	-1.2823 (1.0913)	0.3691 (0.7854)	-1.2031 (4.1298)	9.3827 (8.4955)	0.3997 (1.6564)	6.5275 (4.7110)	7.6993 (6.4589)	-3.7414 (12.8504)	-9.4265 (8.1741)
Quintile 3 household income	2.0102** (0.7666)	-0.7824 (9.1421)	-0.3659 (1.1922)	1.4650* (0.8811)	1.7405 (4.6176)	8.3734 (10.5164)	5.0154*** (1.7762)	8.9245 (5.9911)	6.2706 (6.3770)	4.8898 (13.4398)	-5.4060 (8.4741)
Quintile 4 household income	1.4150** (0.6947)	-7.4568 (8.3447)	-0.6619 (1.1631)	0.8911 (0.8141)	7.0970 (6.1896)	12.9931 (8.2225)	3.9479** (1.6992)	3.1339 (5.4181)	3.8162 (6.4182)	-2.2550 (12.8606)	-10.5578 (8.1371)
Quintile 5 household income	1.8518** (0.7499)	1.7037 (9.3875)	-0.6786 (1.2877)	1.2952 (1.0572)	7.6547 (6.4728)	9.0957 (9.3198)	6.1299*** (1.9916)	3.7880 (5.6781)	2.9102 (6.7698)	7.9602 (13.1904)	-11.2316 (8.0367)
Interaction Q2 with log perc long-term unemployment	0.0071 (0.0096)	0.1746 (0.1461)	0.0366* (0.0201)	0.0298* (0.0153)	-0.0490 (0.0736)	0.0166 (0.1398)	-0.0318 (0.0316)	-0.1015 (0.0813)	0.0309 (0.1086)	-0.0233 (0.2306)	0.2889* (0.1510)
Interaction Q3 with log perc long-term unemployment	0.0163* (0.0094)	0.2092* (0.1199)	0.0388* (0.0198)	0.0254* (0.0146)	-0.0043 (0.0629)	0.0089 (0.1109)	-0.0222 (0.0320)	-0.0019 (0.0753)	0.0546 (0.1060)	0.1655 (0.1845)	0.4066*** (0.1455)
Interaction Q4 with log perc long-term unemployment	0.0077 (0.0091)	0.2866** (0.1140)	0.0281 (0.0195)	0.0297* (0.0151)	-0.0952 (0.0875)	-0.0891 (0.1175)	-0.0130 (0.0325)	0.0001 (0.0746)	0.0267 (0.1085)	0.0944 (0.1635)	0.3567** (0.1495)
Interaction Q5 with log perc long-term unemployment	0.0068 (0.0094)	0.2033* (0.1193)	0.0266 (0.0223)	0.0282* (0.0164)	-0.0142 (0.0942)	0.1182 (0.1247)	-0.0255 (0.0324)	-0.0247 (0.0799)	0.0071 (0.1113)	0.0483 (0.1812)	0.3812** (0.1487)
Interaction Q2 with log perc short-term unemployment	0.0065 (0.0129)	-0.1973 (0.1339)	0.0144 (0.0155)	-0.0149 (0.0169)	0.0654 (0.0896)	-0.0599 (0.1770)	0.0119 (0.0344)	0.0806 (0.0821)	-0.0647 (0.1178)	-0.1567 (0.2551)	-0.2375 (0.1655)
Interaction Q3 with log perc short-term unemployment	-0.0303** (0.0130)	-0.1871 (0.1438)	-0.0133 (0.0220)	-0.0111 (0.0179)	-0.0394 (0.0919)	-0.4500** (0.2036)	-0.0414 (0.0314)	0.0190 (0.0909)	0.0028 (0.1331)	-0.5154* (0.2638)	-0.4197** (0.1752)
Interaction Q4 with log perc short-term unemployment	-0.0117 (0.0124)	-0.1099 (0.1289)	0.0052 (0.0211)	-0.0086 (0.0187)	-0.1211 (0.1038)	-0.4412** (0.2206)	-0.0035 (0.0347)	0.0644 (0.0972)	-0.0116 (0.1412)	-0.1985 (0.3106)	-0.4038** (0.1620)
Interaction Q5 with log perc short-term unemployment	-0.0204* (0.0119)	-0.1659 (0.1294)	0.0143 (0.0233)	-0.0012 (0.0199)	-0.2537** (0.1089)	-0.5180** (0.2190)	-0.0433 (0.0355)	0.1163 (0.0889)	0.0095 (0.1519)	-0.2087 (0.3040)	-0.4482*** (0.1664)
Interaction Q2 with log household income	0.0225 (0.0714)	-0.0554 (0.8903)	0.1553 (0.1200)	-0.0291 (0.0859)	0.1412 (0.4339)	-0.8945 (0.9294)	-0.0758 (0.1834)	-0.7228 (0.5170)	-0.8004 (0.7115)	0.2977 (1.3961)	0.9996 (0.8995)
Interaction Q3 with log household income	-0.2161*** (0.0799)	0.0878 (0.9779)	0.0471 (0.1270)	-0.1477 (0.0927)	-0.1607 (0.4883)	-0.8355 (1.0989)	-0.5641*** (0.1915)	-0.9762 (0.6253)	-0.6178 (0.6992)	-0.6964 (1.3907)	0.6493 (0.9176)
Interaction Q4 with log household income	-0.1461** (0.0718)	0.8303 (0.8905)	0.0791 (0.1245)	-0.0771 (0.0865)	-0.8184 (0.6767)	-1.3967 (0.8550)	-0.4272** (0.1836)	-0.2887 (0.5683)	-0.3475 (0.7004)	0.0357 (1.3634)	1.2148 (0.8974)
Interaction Q5 with log household income	-0.1878** (0.0762)	-0.2567 (0.9786)	0.0835 (0.1380)	-0.1102 (0.1096)	-0.8477 (0.6764)	-0.8390 (0.9511)	-0.6470*** (0.2071)	-0.4125 (0.5971)	-0.2377 (0.7165)	-1.1310 (1.3567)	1.3247 (0.9048)
Observations	845	820	845	845	845	845	845	838	844	838	845
Number of region	100	100	100	100	100	100	100	100	100	100	100
Adjusted R-squared	0.7851	0.3695	0.8448	0.5884	0.3974	0.7332	0.7465	0.5903	0.7681	0.1412	0.2901
Controls and Interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. The table should be read as follows: the first three rows indicate the impact of long- and short-term unemployment and household income on (cause-specific) mortality rates, for the bottom quintile (Q1) of household income. Hereafter, quintile dummies for different income brackets across countries are given in increasing order of household income, measuring purely how (cause-specific) mortality rates depend on a region's income bracket. The following twelve rows depict interaction terms between quintile dummies for income brackets and long- and short-term unemployment (or household income). These interaction terms measure the additional impact long- and short-term unemployment (or household income) has on (cause-specific) mortality rates across income brackets. All specifications include controls for education and degree of urbanisation (and interactions of controls with the crisis dummy). Furthermore, year-fixed effects, regional-fixed effects, and region-specific time trends are accounted for. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

A.10 Quintile Analysis - Income within Countries, Long- and Short-term Unemployment

This appendix displays the relationship between cause-specific mortality rates and our two key variables of interest, unemployment and household income, across income brackets *within* countries, with unemployment separated in long- and short-term unemployment. A general interpretation across the four panel for the different crisis definitions is that the impact that unemployment has on cause-specific mortality rates, whether positive or negative, mostly comes from long-term unemployment. As seen before, short-term unemployment does not significantly impact cause-specific mortality rates (with the exception of positively impacting suicides). Most of the interaction terms between the quintiles and long/short-term unemployment are either insignificant or borderline significant. It appears that there is not a lot of difference in the relationship between long/short-term unemployment and cause-specific mortality rates across income groups within countries. The only somewhat noteworthy result is that the positive interaction found between unemployment and quintile 3 with respect to cardiovascular mortality flows mostly from long-term unemployment. However, no substantial trend can be found here whether poorer or richer regions within a country are impacted more by long-and short-term unemployment or household income.

Table A.7 Quintile Analysis - Income within Countries, Long- and Short-term Unemployment[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Log Percentage Long-Term Unemployment	-0.0150** (0.0065)	0.0457 (0.0903)	-0.0246** (0.0098)	0.0082 (0.0104)	-0.0579 (0.0512)	0.0874 (0.0636)	-0.0190 (0.0176)	-0.0957** (0.0461)	-0.1294* (0.0721)	-0.2821 (0.1897)	-0.0677 (0.0960)
Log Percentage Short-Term Unemployment	-0.0127 (0.0092)	-0.0370 (0.1268)	-0.0122 (0.0154)	-0.0139 (0.0165)	0.0812 (0.0655)	0.1202 (0.1832)	-0.0351 (0.0251)	-0.0359 (0.0687)	0.0065 (0.1029)	0.3974 (0.2842)	0.2717** (0.1215)
Log Household Income	0.0773 (0.0474)	0.0853 (0.6636)	-0.0168 (0.0832)	0.0880 (0.0739)	0.4619 (0.4192)	2.1639** (0.9544)	0.0197 (0.1240)	0.1707 (0.3108)	0.1680 (0.3789)	0.4766 (1.2680)	0.5605 (0.5019)
Quintile 2 household income	-0.5475 (0.3470)	-11.3435* (5.7369)	-1.7074** (0.6911)	0.6034 (0.6252)	0.6474 (3.4475)	12.9810* (7.5178)	-0.8060 (0.8058)	-3.6420 (3.0218)	4.9658 (3.0336)	4.9223 (9.2919)	4.0635 (4.9955)
Quintile 3 household income	-0.5677 (0.3878)	-6.7133 (5.2328)	-1.9899*** (0.7250)	0.1102 (0.6167)	4.8360 (4.5849)	12.8279* (7.1564)	-0.3896 (1.1650)	-4.6528* (2.6756)	6.3367* (3.7570)	10.3314 (10.8553)	3.4350 (7.4545)
Quintile 4 household income	-0.3724 (0.5369)	2.9325 (5.8354)	-1.4685* (0.8123)	0.8041 (0.7736)	4.6925 (5.9064)	13.3408* (7.4117)	-1.0273 (1.5467)	-8.1164* (4.4231)	7.7363** (3.2408)	17.4197 (12.5244)	6.0035* (3.4498)
Quintile 5 household income	0.3124 (0.6118)	2.6249 (7.6760)	-0.1346 (1.1483)	0.3507 (1.0429)	9.1199 (7.0083)	-3.3168 (8.8125)	-0.4258 (1.4736)	0.4903 (5.4102)	-0.9357 (4.3310)	13.0466 (12.4998)	4.2271 (5.0461)
Interaction Q2 with log perc long-term unemployment	-0.0008 (0.0073)	-0.1505 (0.0907)	0.0170 (0.0136)	-0.0088 (0.0125)	0.0388 (0.0681)	0.0602 (0.0998)	-0.0233 (0.0180)	-0.0279 (0.0508)	0.0605 (0.0718)	0.3688* (0.2117)	0.0474 (0.0948)
Interaction Q3 with log perc long-term unemployment	0.0107 (0.0078)	-0.0408 (0.0946)	0.0471*** (0.0150)	-0.0061 (0.0132)	-0.1136 (0.1020)	-0.0130 (0.0746)	-0.0064 (0.0230)	0.0345 (0.0483)	0.1456* (0.0788)	-0.0547 (0.2302)	0.0672 (0.0941)
Interaction Q4 with log perc long-term unemployment	0.0165 (0.0100)	-0.0461 (0.1062)	0.0222 (0.0155)	-0.0004 (0.0117)	0.0708 (0.0861)	-0.0385 (0.0940)	0.0212 (0.0220)	0.1097* (0.0632)	0.0222 (0.0761)	0.1182 (0.1996)	0.0792 (0.0973)
Interaction Q5 with log perc long-term unemployment	-0.0001 (0.0081)	-0.1079 (0.1040)	0.0202 (0.0150)	-0.0077 (0.0130)	-0.0163 (0.0810)	0.1086 (0.0956)	-0.0126 (0.0236)	-0.0244 (0.0550)	-0.0046 (0.0860)	0.1307 (0.2288)	0.0229 (0.1086)
Interaction Q2 with log perc short-term unemployment	0.0247* (0.0132)	0.1302 (0.1748)	0.0178 (0.0198)	0.0289 (0.0236)	-0.0314 (0.1052)	-0.3999 (0.2438)	0.0674** (0.0327)	0.0831 (0.1079)	-0.0750 (0.1153)	-0.8001** (0.3746)	-0.1678 (0.1613)
Interaction Q3 with log perc short-term unemployment	0.0108 (0.0116)	0.1034 (0.1596)	-0.0107 (0.0186)	0.0034 (0.0225)	0.0037 (0.1290)	-0.3010 (0.2256)	0.0813** (0.0319)	0.0605 (0.0963)	-0.1367 (0.1319)	-0.1427 (0.3612)	-0.1585 (0.1939)
Interaction Q4 with log perc short-term unemployment	-0.0007 (0.0139)	-0.0863 (0.1701)	0.0106 (0.0191)	0.0006 (0.0223)	-0.1983* (0.1117)	-0.2587 (0.2183)	0.0285 (0.0347)	0.0392 (0.0967)	-0.0908 (0.1124)	-0.3142 (0.3740)	-0.2462* (0.1378)
Interaction Q5 with log perc short-term unemployment	0.0026 (0.0120)	0.0130 (0.1598)	0.0011 (0.0222)	0.0345 (0.0246)	-0.2173* (0.1279)	-0.0501 (0.2435)	0.0236 (0.0425)	0.0150 (0.1080)	-0.0226 (0.1437)	-0.4892 (0.3466)	-0.3192* (0.1615)
Interaction Q2 with log household income	0.0556 (0.0398)	1.1815* (0.6677)	0.1852** (0.0786)	-0.0655 (0.0688)	-0.0502 (0.3991)	-1.5379* (0.8503)	0.0761 (0.0871)	0.4258 (0.3214)	-0.4960 (0.3320)	-0.4574 (1.0613)	-0.5120 (0.5562)
Interaction Q3 with log household income	0.0589 (0.0448)	0.7193 (0.6162)	0.2206*** (0.0838)	-0.0201 (0.0698)	-0.6091 (0.5374)	-1.5394* (0.8203)	0.0513 (0.1302)	0.5544* (0.3000)	-0.6395 (0.4339)	-1.1800 (1.2508)	-0.4599 (0.8792)
Interaction Q4 with log household income	0.0340 (0.0643)	-0.5387 (0.6955)	0.1588 (0.0975)	-0.1067 (0.0910)	-0.6439 (0.6990)	-1.7197** (0.8434)	0.1264 (0.1804)	0.9544* (0.5219)	-0.7819** (0.3743)	-2.0905 (1.4876)	-0.7412* (0.3993)
Interaction Q5 with log household income	0.0007 (0.0660)	-0.1376 (0.8523)	0.0288 (0.1291)	0.0222 (0.1146)	-0.9895 (0.7564)	0.3090 (0.9830)	0.0859 (0.1575)	0.1488 (0.5567)	-0.0326 (0.4485)	-1.4842 (1.4010)	-0.5655 (0.6274)
Observations	845	820	845	845	845	845	845	838	844	838	845
Number of region	100	100	100	100	100	100	100	100	100	100	100
Adjusted R-squared	0.7698	0.3871	0.8487	0.5879	0.4070	0.7338	0.7356	0.5802	0.7682	0.1492	0.2030
Controls and Interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. The table should be read as follows: the first three rows indicate the impact of long- and short-term unemployment and household income on (cause-specific) mortality rates, for the bottom quintile (Q1) of household income. Hereafter, quintile dummies for different income brackets *within* countries are given in increasing order of household income, measuring purely how (cause-specific) mortality rates depend on a region's income bracket. The following twelve rows depict interaction terms between quintile dummies for income brackets and long- and short-term unemployment (or household income). These interaction terms measure the additional impact long- and short-term unemployment (or household income) has on (cause-specific) mortality rates across income brackets. All specifications include controls for education and degree of urbanisation (and interactions of controls with the crisis dummy). Furthermore, year-fixed effects, regional-fixed effects, and region-specific time trends are accounted for. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

A.11 Industry Analysis

In this appendix, we analyse how unemployment and household income affect cause-specific mortality rates due to region-specific characteristics. Although it is virtually impossible to account for all the different factors influencing health on a regional level, one micro-level factor influencing health could be the type of work of an employee. In this section, we account for industry variation within regions by incorporating industry composition. Eurostat offers statistics on industry accounts for both Gross Value Added (GVA) per industry and the number of employees working in different industry categories. Although the data are fairly unequally available across regions, making our panel more unbalanced, both data categories offer sufficient observations to incorporate them in our model. We convert the absolute quantity of GVA or number of employees per industry category to a percentage relative to its total per region. The industry categories we look at are the following:¹⁸

- (1) Category A: Agriculture, forestry, and fishing (referred to as *agriculture*)
- (2) Category B-E: Industry including manufacturing (referred to as *industry*)
- (3) Category F: Construction (referred to as *construction*)
- (4) Category G-J: Wholesale and retail trade; transport, accommodation and food service activities; information and communication (referred to as *trade*)
- (5) Category K-N: Financial and insurance activities; real estate activities; professional, scientific and technical activities, administrative and support service (referred to as *professional services*)
- (6) Category O-U: Public administration and defence; compulsory social security; education; human health and social work activities; other services (referred to as *public services*)

The sectors given here are transformed to percentages of total, which means that per region, all sector shares always add up to one. Therefore, we need one sector to serve as the base case scenario and choose *public services*, the largest sector on average across our sample.¹⁹ Furthermore, on a micro level, *public services* is a sector that is unlikely to have a negative impact on an employee's health. It seems more likely that working in for instance the sectors *industry* or *construction* would affect the worker's health. We not only look at how the industry composition, but also how changes therein affect mortality rates.

Table A.8 displays the impact that regional industry variation has on cause-specific mortality rates. Regional industry variation is measured as the GVA of a sector compared to the total GVA of a region. Furthermore, panel B adds the percentage change between years in the aforementioned percentage GVA per sector to see whether increases or decreases in the industry variation impact health.

¹⁸The industry categories are defined according to the Statistical classification of economic activities in the European Community (NACE) Rev.2 classification.

¹⁹On average, *public services* form 23.5% of the total GVA and 30.2% of the total number of employees across countries. This makes it the largest sector on average both looking at the GVA and the number of employees.

A.11.1 Results

When looking at panel A of *Table A.8*, we observe that the variables measuring the GVA per sector are mostly insignificant or borderline significant, with a number of exceptions. It appears that particularly the percentage of *construction* in a region has an impact on certain cause-specific mortality rates. When the GVA of *construction* goes up by 1 percentage point, mortality due cardiovascular diseases goes down by -2.5573%, whereas cancer goes up by 1.7252%. Furthermore, deaths due to nutritional diseases surprisingly go up by 20.0435% and suicides by 8.1879%. Deaths due to nutritional diseases also seem to increase when the percentage of *industry* increases; a 1 percentage point increase in *industry* is accompanied by a 8.248% increase in mortality due to nutritional diseases. Furthermore, a higher share of *agriculture* is associated with more deaths due to residual diseases. Mortality in the category residual causes seems quite sensitive to industry variation in the sense that for a 1 percentage point increase in respectively (i) *agriculture*, (ii) *industry*, (iii) *trade*, and (iv) *professional services*, the mortality rates in this category go up by (i) 3.4692%, (ii) 1.0973, (iii) 1.4873%, and (iv) 1.8413%. Adding growth rates to this specification leaves most of the observations made before intact and adds a number of observations. We observe that when the growth rates of GVA of *industry* and *professional services* increase by 1 percentage point, mortality rates due to cardiovascular diseases decrease by -0.1592% and -0.1903%, respectively. In most cases, adding growth rates renders insignificant coefficients and the explanatory power of our model as measured by its adjusted R-squared does not always increase (and sometimes even decreases).

Table A.9 displays the impact that regional industry variation has on cause-specific mortality rates. Regional industry variation is measured as the percentage of employees working in a sector compared to the total number of employees in a region. Furthermore, panel B adds the percentage change between years in the aforementioned percentage employees per sector to see whether increases or decreases in the industry variation impact health. With regard to the number of employees in each sector, an interesting but somewhat confusing finding is that more employees in *trade* and *construction* go hand in hand with less people dying due to other external causes. Overall, most coefficients relating to the percentage of employees in a certain sector and their corresponding growth rates are insignificant. Moreover, the explanatory power of the model as measured by its adjusted R-squared including industry variation is mostly lower than it is in the basic workhorse model we employ at the beginning. Furthermore, the size of the coefficients appears to be large compared to what one would intuitively expect. Hence, these findings should be read with caution. A more detailed overview is given in *Table A.9*.

Quite strikingly, both the direction and the significance of our key variables, unemployment and household income, change when including industry variation. This leads us to interpret the findings related to industry variation in two ways: First, it appears that there is a possibility that industry variation and potentially other confounding factors do impact health on a regional level. Second, it makes us believe that the findings with regard to industry variation should be interpreted cautiously and that further research is required in this direction.

The results of our industry analysis are inconclusive.

Table A.8 Industry Analysis - Gross Value Added[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Panel A: GVA per industry as a percentage of total											
Log Percentage Unemployment	0.0061 (0.0068)	0.0947 (0.1042)	0.0462*** (0.0168)	-0.0119 (0.0108)	-0.3142*** (0.0943)	-0.1391 (0.1129)	0.0208 (0.0204)	-0.0241 (0.0507)	-0.0691 (0.0783)	-0.0415 (0.2121)	0.0525 (0.0733)
Log Household Income	0.0701* (0.0411)	-0.8298 (0.6665)	0.1071 (0.0847)	-0.0082 (0.0545)	0.4183 (0.4802)	2.0872* (1.2151)	-0.0070 (0.1120)	0.3782 (0.3068)	0.0772 (0.4165)	2.9108*** (0.9930)	-0.0934 (0.5616)
GVA agriculture	-0.0771 (0.5409)	-2.7335 (7.0682)	-1.7562 (1.1942)	-0.2731 (0.7570)	7.7120 (6.2441)	-1.1989 (8.7073)	3.4692*** (1.1932)	-4.6152 (4.5360)	-2.5888 (4.5461)	-6.0434 (13.5939)	1.6672 (4.8497)
GVA industry	0.2416 (0.1766)	1.9836 (2.6483)	-0.3469 (0.3532)	0.4359 (0.3764)	5.8248** (2.6247)	-1.3382 (4.0697)	1.0973* (0.5861)	0.4017 (1.6062)	0.1066 (2.2769)	-0.0223 (5.7224)	-0.8504 (1.8148)
GVA construction	0.4315 (0.2737)	6.8300 (5.0799)	-2.5573*** (0.7829)	1.7252*** (0.5513)	20.0435*** (4.9190)	4.2313 (6.9211)	1.2034 (1.0050)	2.4263 (2.4323)	0.2693 (3.8216)	-8.8145 (10.5803)	8.1879** (3.2071)
GVA trade	0.3082 (0.2571)	2.5008 (3.6958)	-0.1336 (0.5297)	0.5246 (0.5352)	6.3918* (3.5622)	1.1598 (5.7100)	1.4873** (0.7098)	-1.5059 (2.5678)	1.8693 (3.1070)	0.1805 (8.7893)	-2.9600 (2.9421)
GVA professional services	0.2704 (0.2153)	0.7680 (2.8451)	-0.5353 (0.5102)	0.2497 (0.5629)	4.2744 (3.4151)	-4.0205 (6.5041)	1.8413*** (0.6680)	0.6986 (2.4749)	-0.4376 (2.5711)	6.1743 (6.6112)	-2.7201 (1.7965)
Observations	726	688	726	726	726	726	726	716	725	716	726
Number of region	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.7818	0.3993	0.8075	0.5321	0.5286	0.7220	0.7544	0.5968	0.6811	0.1507	0.3923
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: GVA per industry as a percentage of total and yearly GVA growth rates											
Log Percentage Unemployment	0.0121 (0.0075)	0.1173 (0.1112)	0.0622*** (0.0175)	-0.0142 (0.0144)	-0.3575*** (0.1054)	-0.1504 (0.1418)	0.0383* (0.0228)	-0.0098 (0.0574)	-0.0947 (0.0839)	-0.1047 (0.2700)	0.0246 (0.0835)
Log Household Income	0.0127 (0.0497)	-1.1254 (0.7218)	0.1196 (0.0942)	-0.1269 (0.0779)	-0.1084 (0.7341)	0.8333 (1.1487)	0.0450 (0.1356)	-0.0988 (0.4028)	-0.1267 (0.4881)	2.1766** (0.9924)	-0.0145 (0.5676)
GVA agriculture	-0.2090 (0.5665)	-4.4254 (8.6396)	-3.3681*** (1.1008)	0.3337 (0.8861)	16.1068* (8.3055)	5.7277 (11.4276)	4.2321*** (1.4852)	-2.8339 (4.2812)	2.3210 (5.5616)	2.3946 (12.0674)	-0.7505 (5.8025)
GVA industry	0.3852 (0.2750)	1.8013 (3.5513)	-0.6069 (0.5582)	1.5234*** (0.5534)	10.2242*** (3.6650)	5.7294 (5.4738)	0.6689 (0.9366)	1.6728 (2.1256)	4.5037 (3.1091)	-3.9430 (5.2037)	1.3328 (2.4780)
GVA construction	0.9024** (0.3838)	10.3030 (9.0223)	-3.8002*** (0.9606)	3.3906*** (0.8619)	33.0337*** (7.7883)	13.0266 (8.8856)	1.2490 (1.5924)	10.8286*** (3.7270)	4.5070 (5.1049)	-6.5729 (12.8873)	4.7299 (4.6000)
GVA trade	0.2565 (0.3630)	3.8806 (4.9822)	-1.0088 (0.6873)	1.5883** (0.7259)	13.2682** (5.1681)	7.5253 (8.0249)	1.2416 (1.0570)	-1.0286 (3.2956)	6.7837* (3.9482)	-0.0626 (7.8594)	-2.4234 (3.2457)
GVA professional services	0.2239 (0.3270)	-2.3557 (4.1474)	-0.4825 (0.7218)	1.0020* (0.5979)	6.4436 (4.7076)	-1.5805 (8.1906)	1.0108 (1.1122)	2.3560 (3.5415)	3.3649 (3.6212)	5.2228 (6.5884)	-0.4277 (2.8182)
growth rate GVA agriculture	0.0003 (0.0023)	0.0432 (0.0378)	0.0008 (0.0040)	0.0035 (0.0035)	-0.0653* (0.0347)	0.0610 (0.0386)	-0.0001 (0.0058)	0.0003 (0.0231)	0.0302 (0.0218)	0.0616 (0.0676)	-0.0119 (0.0218)
growth rate GVA industry	-0.0285 (0.0360)	0.3670 (0.4397)	-0.1592*** (0.0589)	-0.0543 (0.0505)	0.5895* (0.3422)	-0.3636 (0.7576)	0.0906 (0.0920)	0.3531 (0.2800)	-0.0881 (0.3062)	1.8802** (0.8022)	0.1524 (0.3630)
growth rate GVA construction	-0.0375** (0.0189)	0.0134 (0.2756)	-0.0375 (0.0364)	-0.0435 (0.0361)	-0.1150 (0.1916)	-0.4766* (0.2477)	0.0005 (0.0502)	-0.3464** (0.1591)	-0.0870 (0.1521)	-0.5864 (0.4007)	0.2539 (0.1910)
growth rate GVA trade	0.0193 (0.0401)	-0.2039 (0.4785)	-0.0263 (0.0730)	-0.0907 (0.0691)	0.0072 (0.4744)	-0.1823 (0.6932)	0.0910 (0.1100)	0.4388 (0.3451)	0.0185 (0.3265)	1.4717 (1.0398)	0.6944** (0.3501)
growth rate GVA professional services	0.0318 (0.0352)	0.6998 (0.5173)	-0.1903*** (0.0691)	0.0236 (0.0735)	1.1224** (0.5083)	0.9341 (0.7802)	0.1757 (0.1066)	0.1351 (0.3355)	0.1601 (0.5989)	0.0734 (0.9081)	0.2546 (0.4125)
growth rate GVA public services	0.0093 (0.0452)	-0.4410 (0.6378)	-0.0614 (0.0865)	0.2194* (0.1125)	0.3734 (0.4931)	0.8595 (0.7775)	-0.0359 (0.1181)	0.5270 (0.4142)	0.0617 (0.4479)	-0.2916 (0.9294)	0.2249 (0.4159)
Observations	671	639	671	671	671	671	671	663	670	663	671
Number of region	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.7722	0.3947	0.8140	0.5282	0.4565	0.7421	0.7660	0.6013	0.7213	0.1985	0.4226
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. The table should be read as follows: the first two rows indicate the impact of unemployment and household income on (cause-specific) mortality rates, for the public service sector. Panel A includes variables to check how the gross value added (GVA) of a specific sector in a region as a percentage of total gross value added impacts mortality rates to check whether industry variation matters. Panel B adds the growth rates of the specific sectors to check whether changes in industry variation matter. All specifications include controls for education and degree of urbanisation (and interactions of controls with the crisis dummy). Furthermore, year-fixed effects, regional-fixed effects, and region-specific time trends are accounted for. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

Table A.9 Industry Analysis - Number of Employees[†]

VARIABLES	(1) all-cause	(2) infant	(3) cardio	(4) cancer	(5) nutrition	(6) mental	(7) residual	(8) otherext	(9) traffic	(10) homicides	(11) suicides
Panel A: Employees per industry as a percentage of total											
Log Percentage Unemployment	0.0132 (0.0103)	0.1700 (0.1729)	0.0288 (0.0245)	-0.0119 (0.0198)	0.0012 (0.0907)	-0.0559 (0.1513)	0.0345 (0.0223)	-0.0929 (0.0703)	-0.0612 (0.1374)	0.1638 (0.3321)	0.0312 (0.1078)
Log Household Income	0.1020 (0.0668)	-0.8224 (0.8864)	0.0732 (0.1176)	0.0190 (0.0913)	1.1276*** (0.3267)	1.8258* (1.0643)	0.2112 (0.1466)	0.4061 (0.4932)	-0.5241 (0.7770)	3.2363* (1.6617)	0.3670 (0.8275)
Employees agriculture	0.7222 (0.5514)	0.1105 (6.6785)	0.7050 (0.8517)	0.2359 (0.7850)	3.3816 (4.0584)	1.9331 (6.0407)	1.4992 (1.4518)	-2.7064 (3.5493)	-6.5508 (4.1455)	20.3919** (9.4875)	-3.9898 (6.1912)
Employees industry	0.0198 (0.5510)	-2.4416 (10.9106)	0.7513 (0.9907)	-1.0346 (0.9118)	-2.4263 (4.4724)	-19.6840*** (7.2473)	0.0038 (1.3678)	-0.4312 (2.6054)	0.0045 (3.6621)	22.2176 (14.2612)	-4.1598 (6.1949)
Employees construction	0.1414 (0.7120)	0.4392 (10.1640)	1.6988 (1.5193)	-0.1733 (0.8020)	-7.4419 (6.2499)	10.6215 (10.8302)	-1.4280 (1.9458)	-9.2089** (3.5367)	3.5004 (6.5668)	10.5058 (16.0810)	-9.7766 (10.5206)
Employees trade	-0.0970 (0.6292)	-8.9267* (4.7295)	0.3111 (1.1252)	-0.1901 (0.8819)	-1.5160 (6.1453)	9.8275 (8.4869)	0.2204 (1.1764)	-7.0049*** (2.4064)	-3.0732 (3.1171)	18.7597** (8.2265)	-5.6722 (5.0315)
Employees professional services	-0.3133 (0.5123)	4.5786 (8.1618)	0.0827 (1.1536)	0.2256 (0.9955)	6.8203 (6.7737)	-5.7761 (12.1942)	-2.3762 (2.0142)	-1.7288 (3.1860)	-8.4976 (5.8647)	4.8201 (16.0440)	-4.9660 (7.9321)
Observations	458	457	458	458	458	458	458	448	457	448	458
Number of region	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.6592	0.3864	0.7975	0.4610	0.7836	0.4503	0.6045	0.5417	0.5346	0.1388	0.3104
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: Employees per industry as a percentage of total and yearly growth rates Employees per industry											
Log Percentage Unemployment	0.0173 (0.0107)	0.1722 (0.1913)	0.0255 (0.0237)	0.0144 (0.0212)	0.0424 (0.1224)	-0.1406 (0.1802)	0.0364 (0.0309)	-0.1384 (0.0908)	-0.1371 (0.1306)	-0.1581 (0.4625)	-0.0668 (0.1227)
Log Household Income	0.1918** (0.0758)	-0.6481 (1.1953)	0.0821 (0.1284)	0.1725** (0.0831)	2.0066*** (0.4726)	1.4853 (1.1476)	0.4413*** (0.1525)	0.4374 (0.6879)	0.1813 (0.7624)	2.5798 (2.4304)	-0.4579 (0.9141)
Employees, agriculture	0.5892 (0.8033)	6.6034 (6.0300)	1.0363 (1.2229)	-1.5956 (1.3065)	7.4904 (5.4520)	-13.3597 (14.8843)	2.4725 (2.3483)	-3.2312 (5.6839)	-3.3187 (4.7553)	16.4085 (14.5992)	4.4808 (8.3581)
Employees, industry	0.2998 (1.1171)	-5.0528 (12.3674)	0.3624 (1.7210)	-1.1224 (1.0857)	4.7137 (6.9019)	-26.6388* (15.4752)	1.9844 (2.4997)	-2.1967 (4.6764)	1.8206 (6.9558)	21.0097 (22.0654)	0.9231 (7.9361)
Employees, construction	-1.1339 (1.1235)	14.5061 (10.8380)	1.6094 (2.4606)	-3.8369*** (1.2213)	-20.0876** (9.9311)	-3.0095 (18.7062)	-0.9400 (2.6686)	-16.1041** (7.9268)	-3.3585 (5.8774)	-3.9353 (24.0500)	0.4624 (10.5725)
Employees, trade	0.0259 (0.9598)	0.9319 (7.9354)	-0.2152 (1.4171)	-1.0438 (1.1367)	-2.2502 (6.2407)	-3.8876 (21.3963)	3.1704 (2.6032)	-9.0502* (4.8872)	-3.5398 (4.9413)	3.6738 (14.7103)	-1.6428 (7.6501)
Employees, professional services	-0.5802 (0.9772)	-0.9612 (11.7903)	0.5182 (1.4968)	0.6039 (1.6010)	20.6941** (10.3048)	-9.2106 (19.5290)	-4.9100 (3.2499)	-4.2948 (6.0437)	3.5744 (8.2317)	4.7708 (20.0761)	-3.8107 (7.8400)
Growth rate employees, agriculture	0.0084 (0.0238)	-0.2744 (0.2238)	-0.0313 (0.0245)	-0.0109 (0.0232)	0.2773* (0.1589)	-0.3441 (0.3413)	0.0872 (0.0544)	-0.0728 (0.1169)	-0.0162 (0.0705)	0.5203 (0.3997)	-0.0881 (0.1903)
Growth rate employees, industry	-0.0246 (0.0741)	1.0151 (0.9349)	0.0954 (0.0832)	-0.1954 (0.1432)	-0.1134 (0.3774)	-1.6648 (1.9539)	-0.0919 (0.1892)	0.0237 (0.2704)	0.4508 (0.3694)	0.3818 (1.0598)	0.1865 (1.0553)
Growth rate employees, construction	0.0949 (0.0761)	-0.9241 (0.9816)	-0.0069 (0.1214)	0.0065 (0.1326)	1.6464*** (0.4991)	-1.7532 (1.5428)	0.2448* (0.1307)	0.6254 (0.4867)	0.6172* (0.3554)	1.1136 (0.9691)	0.7302 (0.9441)
Growth rate employees, trade	-0.1200 (0.1747)	-1.4452 (1.9700)	-0.0756 (0.2532)	-0.2106 (0.3178)	2.4040** (1.1791)	-1.5682 (2.6868)	-0.2570 (0.4263)	0.3191 (0.6550)	-0.0037 (0.9176)	3.3510 (2.8602)	0.5950 (1.9572)
Growth rate employees, professional services	0.0482 (0.0490)	0.1750 (1.1902)	0.0064 (0.0862)	0.0117 (0.0740)	-0.0814 (0.4460)	-0.1882 (0.8314)	0.2583** (0.1284)	0.5628* (0.2855)	-0.8571* (0.4385)	-0.0938 (1.4433)	1.0519* (0.6037)
Growth rate employees, public services	0.0126 (0.1405)	0.9156 (1.7099)	0.1005 (0.1925)	-0.5380* (0.3043)	1.3586* (0.7587)	-4.2355 (3.3739)	0.3239 (0.3651)	0.1235 (0.5648)	0.9887 (0.6128)	0.5677 (2.1529)	2.2337 (1.8581)
Observations	373	372	373	373	373	373	373	365	372	365	373
Number of region	104	104	104	104	104	104	104	104	104	104	104
Adjusted R-squared	0.6471	0.4192	0.8283	0.4987	0.7775	0.3998	0.6214	0.5319	0.6749	0.3224	0.3866
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[†]The dependent variables, displayed in columns, are the logarithms of all-cause mortality, infant mortality and various cause-specific mortality rates. The table should be read as follows: the first two rows indicate the impact of unemployment and household income on (cause-specific) mortality rates, for the public service sector. Panel A includes variables to check how the number of employees of a specific sector in a region as a percentage of total number of employees impacts mortality rates to check whether industry variation matters. Panel B adds the growth rates of the specific sectors to check whether changes in industry variation matter. All specifications include controls for education and degree of urbanisation (and interaction of controls with the crisis dummy). Furthermore, year-fixed effects, regional-fixed effects, and region-specific time trends are accounted for. Robust standard errors, clustered by NUTS 2 region, are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 per cent levels, respectively.

A.11.2 Discussion

After having investigated how death rates vary depending on crises and the income distribution, an interesting addition is a more detailed analysis of how the industry composition in a region affects health. Considering that a region's health is most likely to be dependent on a number of region-specific features, looking at sector variation is a logical step to push the research frontier even further. On a micro-level, one could hypothesise that working in sectors with intense manual labour such as *construction* is more deteriorating to health than working in a service-based sector such as *public services*. Alternatively, living in a region with a large portion of *industry* may worsen health due to pollution more than living in a region that is mostly *agriculture*-based, providing a seemingly more healthy environment. We expected that the aforementioned examples might materialise on a more macro level, hence regional scale, as well.

Unfortunately, the results accounting for sector variation are neither robust between industry variation proxies (GVA and number of employees) nor clear-cut. Compared to the base case sector, *public services*, we do observe differences in mortality rates depending on industry composition. However, these findings do not always appear intuitive nor are they stable between measurement methods for industry variation. Furthermore, the effect of our key variables, unemployment and household income, on cause-specific mortality rates is distorted when including sector composition and/or change in sector composition. Moreover, the explanatory power of the model even decreases for certain health categories. We thus interpret these findings very cautiously and conclude that industry composition may impact a region's health, but that this finding is neither robust nor is it clear via which channel it has an impact on health.

A.12 Number of Crisis Regions per Year as a Percentage of Total

This appendix depicts the number of crisis regions as a percentage of total regions per year across the four crisis definitions. Most regions that have experienced a crisis can be found in the years after the dot-com bubble and the years after the global financial crisis leading into the European sovereign debt crisis.

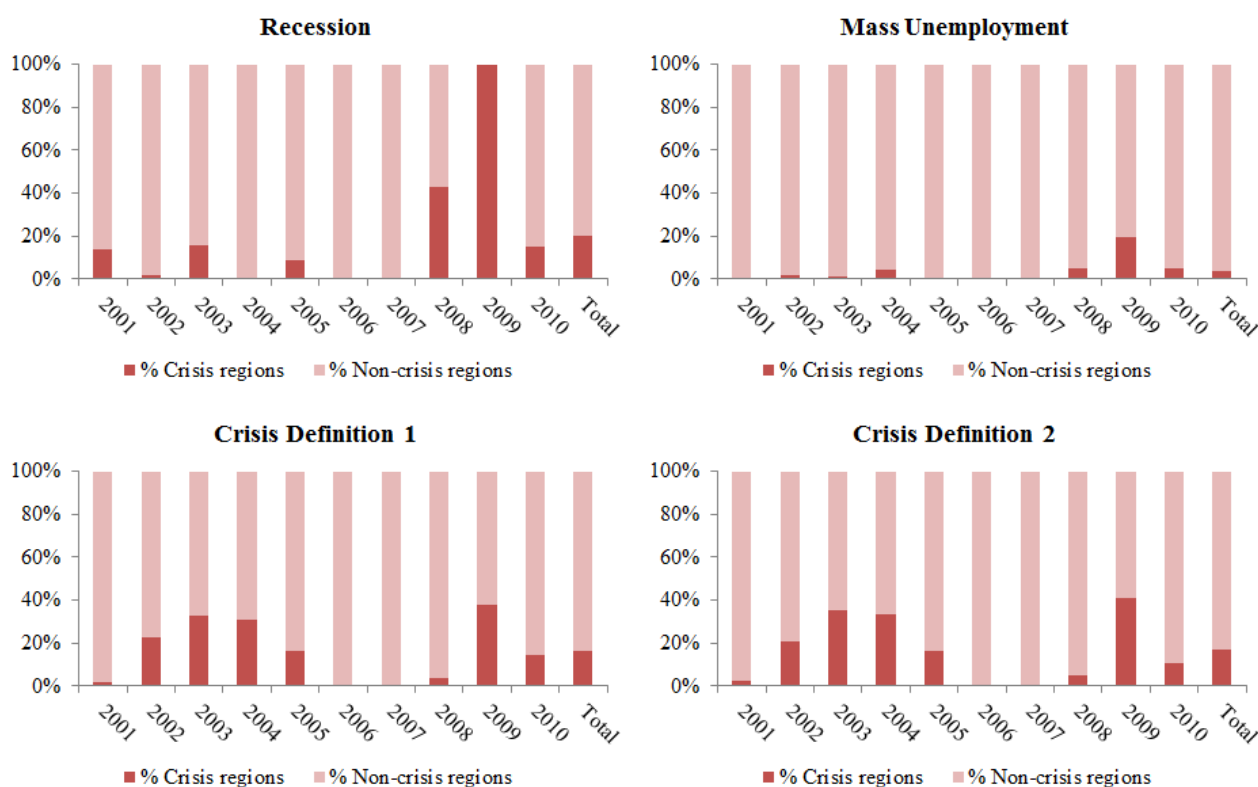


Figure A.3 Number of Crisis Regions per Year as a Percentage of Total

A.13 Long versus Short-term Unemployment over Time

This appendix depicts the percentage of long- and short-term unemployment per year. On average, long-term unemployment is roughly 40% of total unemployment. Furthermore, in the countries that have endured the latest sovereign debt crisis most intensely, unemployment has risen substantially over the last years, especially short-term unemployment.

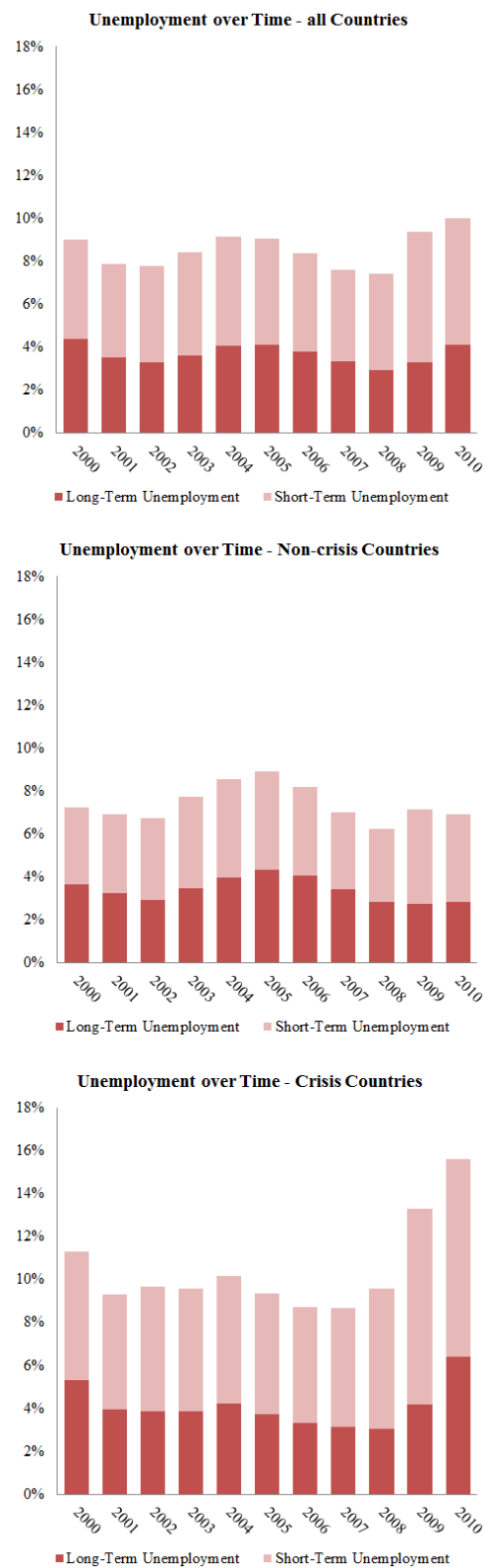


Figure A.4 Long versus Short-Term Unemployment Percentages over Time

References

- Alexander, M., Harding, M., and Lamarchec, C. (2011). Quantifying the impact of economic crises on infant mortality in advanced economies. *Applied Economics*, 43:3313–3323.
- Augusto, G. F. (2012). Cuts in portugal’s nhs could compromise care. *The Lancet*, 379(9814):400.
- Bambra, C. and Eikemo, T. A. (2009). Welfare state regimes, unemployment and health: a comparative study of the relationship between unemployment and self-reported health in 23 european countries. *Journal Epidemiol Community Health*, 63:92–98.
- Barbosa, R. R. (2012). Primary public health care and socioeconomic asymmetries in portugal. Research project, NOVA School of Business and Economics.
- Bartley, M. (1994). Unemployment and ill health: understanding the relationship. *Journal of Epidemiol Community Health*, 48:333–337.
- Bartley, M., Sacker, A., and Clarke, P. (2004). Employment status, employment conditions, and limiting illness: prospective evidence from the british household panel survey 1991–2001. *Journal of Epidemiol Community Health*, 58:501–506.
- Bjarnason, T. and Sigurdardottir, T. J. (2003). Psychological distress during unemployment and beyond: social support and material deprivation among youth in six northern european countries. *Social Science & Medicine*, 56:973–985.
- Brinkmann, H.-J., de Pee, S., Sanogo, I., Subran, L., and Bloem, M. W. (2010). High food prices and the global financial crisis have reduced access to nutritious food and worsened nutritional status and health. *The Journal of Nutrition*, 140:153S–161S.
- Böckerman, P. and Ilmakunnas, P. (2009). Unemployment and self-assessed health: evidence from panel data. *Health Economics*, 18:161–179.
- Catalano, R. D. (2009). Health, medical care, and economic crisis. *The New England Journal of Medicine*, 360(8):749–751.
- Cutler, D. M., Knaul, F., Lozano, R., Méndez, O., and Zurita, B. (2002). Financial crisis, health outcomes and ageing: Mexico in the 1980s and 1990s. *Journal of Public Economics*, 84:279–303.
- Drukker, D. M. (2003). Testing for serial correlation in linear panel-data models. *The Stata Journal*, 3:168–177.
- EC (2010). Report on greek government deficit and debt statistics. Technical report, European Commission, Brussels.
- Economou, A., Nikolaou, A., and Theodossiou, I. (2008). Are recessions harmful to health after all? evidence from the european union. *Journal of Economic Studies*, 35(8):368–384.
- Economou, M., Madianos, M., Theleritis, C., Peppou, L. E., and Stefanis, C. E. (2011). Increased suicidality amid economic crisis in greece. *The Lancet*, 378:1459.

- Eurostat (2013). Eurostat regional statistical database. Accessible via <http://http://epp.eurostat.ec.europa.eu/> (last accessed January 8th, 2014 at 8 PM).
- Fahy, N. (2012). Who is shaping the future of european health systems? *British Medical Journal*, 344(1712):1–4.
- Garcia Rada, A. (2011). Is spanish public health sinking? *British Medical Journal*, 343:1–3.
- Garfield, R. and Santana, S. (1997). The impact of the economic crisis and the us embargo on health in cuba. *American Journal of Public Health*, 87(1):15–20.
- Gerdtham, U.-G. and Johannesson, M. (2003). A note on the effect of unemployment on mortality. *Journal of Health Economics*, 22:505–518.
- Gerdtham, U.-G. and Johannesson, M. (2005). Business cycles and mortality: results from swedish microdata. *Social Science and Medicine*, 60:205–218.
- Gerdtham, U.-G. and Ruhm, C. J. (2006). Death rise in good economic times: Evidence from the oecd. *Economics and Human Biology*, 4:298–316.
- Gili, M., Roca, M., Basu, S., McKee, M., and Stuckler, D. (2012). The mental health risks of economic crisis in spain: evidence from primary care centres, 2006 and 2010. *The European Journal of Public Health*, pages 1–5.
- Gordo, L. R. (2006). Effects of short- and long-term unemployment on health satisfaction: evidence from german data. *Applied Economics*, 38:2335–2350.
- Graetz, B. (1993). Health consequences of employment and unemployment: longitudinal evidence for young men and women. *Social Science and Medicine*, 36:715–724.
- Granados, J. A. T. (2005). Recessions and mortality in spain, 1980-1997. *European Journal of Population*, 21:393–422.
- Greene, W. (2000). *Econometric Analysis*. New York: Prentice Hall.
- Huber, M., Lechner, M., and Wunsch, C. (2011). Does leaving welfare improve health? evidence for germany. *Health Economics*, 20:484–504.
- James, W. (2008). The epidemiology of obesity: the size of the problem. *Journal of Internal Medicine*, 263:336–352.
- Karanikolos, M., Mladovsky, P., Cylus, J., Thomson, S., Basu, S., Stuckler, D., Mackenbach, J. P., and McKee, M. (2013). Financial crisis, austerity, and health in europe. *The Lancet*, pages 1–9.
- Kentikelenis, A., Karanikolos, M., Papanicolas, I., Basu, S., McKee, M., and Stuckler, D. (2011). Health effects of financial crisis: omens of a greek tragedy. *The Lancet*, 378:1457–1458.
- Kentikenelis, A. and Papnicoas, I. (2011). Economic crisis, austerity and the greek public health system. *European Journal of Public Health*, 22(1):5–6.

- Kondilis, E., Giannakopoulos, S., Gavana, M., Ierodiakonou, I., Waitzkin, H., and Benos, A. (2013). Economic crisis, restrictive policies, and the population's health and health care: The greek case. Forthcoming.
- Kuhn, A., Lalive, R., and Zweimüller, J. (2009). The public health costs of job loss. *Journal of Health Economics*, 28:1099–1115.
- Kunst, A. E., Groenhouf, F., Mackenbach, J. P., and the EU Working Group on Socioeconomic Inequalities in Health (1998). Occupational class and cause specific mortality in middle aged men in 11 european countries: comparison of population based studies. *British Medical Journal*, 316:1636–1642.
- Lester, D. (2001). Regional studies of homicide: a meta-analysis. *Death Studies*, 25:705–708.
- Levine, J. A. (2011). Poverty and obesity in the u.s. *Diabetes*, 60:2667–2668.
- Lundin, A., Lundberg, I., Hallsten, L., Ottosson, J., and Hemmingsson, T. (2010). Unemployment and mortality—a longitudinal prospective study on selection and causation in 49321 swedish middle-aged men. *Journal of Epidemiology and Community Health*, 64:22–28.
- Mackenbach, J. P., Stirbu, I., Roskam, A.-J. R., Schaap, M. M., Menvielle, G., Leinsalu, M., and Kunst, A. E. (2008). Socioeconomic inequalities in health in 22 european countries. *The New England Journal of Medicine*, 358:2468–2481.
- Marmot, M. (2002). The influence of income on health: views of an epidemiologist. does money really matter? or is it a marker for something else? *Health Affairs*, 21:31–46.
- Mathers, C. and Schofield, D. (1998). The health consequences of unemployment: the evidence. *The Medical Journal of Australia*, 168:178–182.
- Morgan, D. and Astolfi, R. (2013). Health spending growth at zero - which countries, which sectors are most affected?
- Morrell, S., Taylor, R., Quine, S., Kerr, C., and Western, J. (1994). A cohort study of unemployment as a cause of psychological disturbance in australian youth. *Social Science and Medicine*, 38:1553–1564.
- Murphy, G. C. and Athanasou, J. A. (1999). The effect of unemployment on mental health. *Journal of Occupational and organizational Psychology*, 72(1):83–99.
- Neumayer, E. (2004). Recessions lower (some) mortality rates: evidence from germany. *Social Science and Medicine*, 58:1037–1047.
- Paxson, C. and Schady, N. (2005). Child health and economic crisis in peru. *The World Bank Economic Review*, 19(2):203–223.
- Portela, C. and Thomas, S. (2013). Impact of the economic crisis on healthcare resources: An european approach. Forthcoming.
- Reine, I., Novo, M., and Hammarström, A. (2004). Does the association between ill health and unemployment differ between young people and adults? results from a 14-year follow-up study with a focus on psychological health and smoking. *Public Health*, 118:337–345.

- Roelfs, D. J., Shor, E., Davidson, K. W., and Schwartz, J. E. (2011). Losing life and livelihood:a systematic review and meta-analysis of unemployment and all-cause mortality. *Social Science and Medicine*, 72:840–854.
- Ruhm, C. J. (2000). Are recessions good for your health? *The Quarterly Journal of Economics*, 115(2):617–650.
- Ruhm, C. J. (2005). Healthy living in hard times. *Journal of health economics*, 24(2):341–363.
- Santana, P. (2000). Ageing in portugal: regional iniquities in health and health care. *Social Science and Medicine*, 50:1025–1036.
- Scherer, P. and Devaux, M. (2010). The challenge of financing health care in the current crisis: An analysis based on the oecd data.
- Stuckler, D., Basu, S., and McKee, M. (2010). Budget crises, health, and social welfare programmes. *British Medical Journal*, 341:77–79.
- Stuckler, D., Basu, S., Suhrcke, M., Coutts, A., and McKee, M. (2009). The public health effect of economic crises and alternative policy responses in europe: an empirical analysis. *The Lancet*, pages 1–9.
- Svensson, M. (2007). Do not go breaking your heart: Do economic upturns increase heart attack mortality? *Social Science and Medicine*, 65:833–841.
- Thomas, C., Benzeval, M., and Stansfeld, S. (2005). Employment transitions and mental health: an analysis from the british household panel survey. *Journal of Epidemiol Community Health*, 59:243–249.
- Walberg, P., McKee, M., Shkolnikov, V., Chenet, L., and Leon, D. A. (1998). Economic change, crime, and mortality crisis in russia: regional analysis. *British Medical Journal*, 317:312–318.
- WHO (2009a). The financial crisis and global health. Technical report, WHO.
- WHO (2009b). Health in times of global economic crisis: implications for the who european region. Meeting report, WHO.
- Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data*. The MIT Press.
- Åhs, A. M. H. and Westerling, R. (2006). Mortality in relation to employment status during different levels of unemployment. *Scandinavian Journal of Public Health*, 34:159–167.