Business Cycles and Mortality Rates

Aggregate Data for the EU-15 Countries 1990-2012

LUND UNIVERSITY

Authors:
Martin Nilsson
Anette Brose Olsen

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Supervisor:
Ulf Gerdtham

Abstract

The relationship between business cycles and mortality has been a highly debated subject in the field of economics. The majority of previous studies, using the unemployment rate as the main proxy for macroeconomic conditions, have found ambiguous effects largely depending on how the effect is estimated. This thesis follows the methodology used by Ruhm (2000), but instead applies aggregate data for a sample of European countries; namely the EU-15 countries. Our sample period stretches from 1990 to 2012, extending upon previous research by looking at the associated relationship in more recent times. Using fixed-effects estimations with the unemployment rate as the main proxy for macroeconomic conditions, we investigate the effect of joblessness on total mortality rates, age-specific mortality, sex-specific death rates as well as cause-specific mortality rates. Our findings demonstrate evidence of a significant procyclical relationship between unemployment and mortality, implying that aggregate average health improves as the economy deteriorates. The procyclical association is found to be significant for age groups 15-44 and 60-74, and the male sub-sample seemed to benefit more from increased unemployment than female counterparts. The thesis also contributed to the existing literature by showing that alternative business cycles, such as GDP growth, follow a similar pattern as unemployment rates.

Key words: Mortality, Business Cycles, Unemployment, Fixed-effects, EU-15.

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1. Introduction

The effect of unemployment on mortality rates have for many years been debated in the field of economics. It has been a rather controversial subject, as different researchers have found ambiguous effects, largely depending on how the effect is estimated. Conventionally, economic downturns and unemployment have been believed to worsen health at the individual level and increase mortality rates at the aggregate level, at least in a short run horizon. For instance, the seminal work by Brenner (1971, 1973, 1975, 1979, 1987) estimated that economic downturns increased overall death rates as well as several different death causes such as infant deaths and deaths from cardiovascular disease, cirrhosis, suicide and homicide.

However, in recent times, these conclusions have been challenged by new research. For instance, Ruhm (2000, 2005) and Gerdtham and Ruhm (2006) have, in contrast to earlier studies, shown that rising unemployment might be beneficial to health and decrease mortality rates. These effects can partially be explained by reductions in external sources of death, such as traffic accidents or other accidents related to macroeconomic fluctuations. Individuals that are unemployed are less exposed to hazardous working conditions and face a lower risk of work related accidents. Changes in traffic accidents might explain a part of the decrease, as fewer individuals purchase and drive cars during economic downturns. One important part of the decrease in mortality seems to be explained by changes in lifestyle behavior in response to economic downturns. For instance, individuals that are unemployed could have healthier dietary habits during recessions as consumption of tobacco and alcohol would decrease as a consequence of the income loss. Individuals that are unemployed might also be able to invest more of their time in physical activity.

Earlier research in this field has primarily examined high- and middle-income countries with a great deal of attention on the United States. Furthermore, as far as we are concerned, the aggregate studies focusing on European countries have looked at periods up until 1997. Ruhm (2000) examines within-state variations in the United States over the period 1972-1991 and finds, as previously mentioned, that mortality rates decrease as unemployment increase. Neumayer (2004) uses a similar methodology on German states over the period 1980-2000 and confirms some of Ruhm's findings. However, Neumayer also finds that some mortality causes are unaffected by economic downturns. Gerdtham and Ruhm (2006), examines the

relationship within 23 OECD countries from 1960-1997. These aggregate level studies, however, do not cover the financial crisis that struck the world in 2007-2008, or the European sovereign debt crisis that emerged in 2009. There are some country-specific studies that include data after the financial crisis. Regidor et al. (2013) uses aggregate data on Spain over the period 1995-2011. Their result confirms earlier results that mortality rates decline during economic turndowns. Zavras et al., (2012), uses individual level data for Greece and concludes that the financial crisis has not increased the health status of Greece individuals. The authors argue that the decline in health status is associated with reduced food consumption, less health care utilization and lower usage of medical care due to lower income levels. The most recent study by Ruhm (2015) uses data from the United States and covers the period from 1976-2010. The study shows a shift in the association between unemployment and mortality rates, from being significant procyclical, to being weakly or unrelated in recent years. However, the study does not give much attention to or comment on the economic downturn of 2007-2008.

In this study, we will follow the methodology used by Ruhm (2000), but instead use aggregate data for a sample of European countries, namely the EU-15 countries. We will use fixed effects estimations to control for unobserved, time-invariant characteristics within countries. In addition to previous aggregate studies, we will cover some years of the financial crisis by including data from 1990-2012. By doing so, we extend the existing literature on business cycles and mortality by including observations on more recent years for the EU-15 countries. We also aim to provide some indications on how the recent recession has affected mortality levels. The recession of 2008 and the sovereign debt crisis in Europe have had a substantial effect on the macroeconomic conditions in the affected countries. Karanikolos et al. (2013) argue that the recession could have a large impact on health and mortality levels among affected countries. In 2009, the GDP in real terms fell in all European countries, except Poland, with a mean of 4.3 %. In the following years, unemployment rose quickly in many countries, especially in Spain, Greece, Portugal and Ireland. Karanikolos et al. (2013) argue that it is crucial to perform a study on the how the health outcomes and mortality rates were affected by the macroeconomic conditions and policy responses that followed the recession of 2009 and onwards.

A further contribution of the thesis is the inclusion of additional business cycles indicators, in addition to unemployment. Following Gerdtham and Johannesson (2005), we include both the GDP growth rate and the capacity utilization rate in our analysis. Furthermore, we also apply the Hodrick-Prescott (HP) filter on the unemployment rate and the GDP growth rate in order to de-trend the data.

The thesis is structured as follows: In section 2, we will present some theoretical background on the relationship between business cycles and mortality, including some of the potential mechanisms at work behind this association. Section 3 reviews some of the previous research in the field and their related findings. The data applied and methodology used in this thesis is then described in section 4. Section 5 presents the results from the econometric estimations, followed by a discussion of the findings in section 6. The last section gives the concluding remarks.

2. Theoretical Background

Individual and public health are arguably linked to both financial stability and economic well-being (Burgard, Ailshire & Kalousova, 2013). Recessionary conditions, affecting housing and financial markets as well as labor conditions and employment levels, are therefore expected to have an impact on health outcomes and health behaviors. The existing body of research assessing these associations usually follows one of two different approaches. Research focusing on the individual-level, generally find that health (in terms of morbidities or lifestyles) among those experiencing job loss, unemployment and other kinds of material hardship such as housing and or food insecurity, worsens during periods of economic downturns (Burgard et al., 2013:195). The other body of research focus on aggregate-level associations between business cycle indicators, normally unemployment rates, and mortality rates on state or country level. These studies have shown more ambiguous effects, but evidence from high- and middle-income countries generally demonstrate evidence that mortality declines during periods of economic downturns characterized by rising unemployment (Suhrcke & Stuckler, 2012).

Mortality levels in a country can be affected by a variety of factors, such as demographic characteristics, educational levels, access to medical care, improvements in technology and so on. Economic modeling of the relationship between mortality and macroeconomic conditions

in terms of unemployment have found theoretical ground in models in which health can be seen as a capital stock that produces healthy time. In one of the most influential papers in the field of health economics, Grossman (1972) focuses on this health production aspect and the demand for 'good health'. In this model, health is both a consumption good that raised direct utility in terms of life satisfaction, but also an investment good that increases the number of 'healthy days' an individual can perform productive work and earn income. Health is consequently determined by several factors, for instance the consumption of medical inputs, the amount of leisure-time and the consumption of other goods not related to health. Grossman also predicts that the level of education and wage rage of an individual has an impact on the capital invested in health. In this context, higher educated individuals are assumed to have a higher return of health investments and consequently better health due to the assumption that they have better knowledge of for instance the harmful effects of smoking and unhealthy food. Higher wages also generally tend to increase health investments, since it increases the return of health capital. However, it could also raise the opportunity cost of time in producing health such as participation in healthy activities (e.g. physical exercise).

A number of recent studies have assessed the mechanisms behind the relationship between macroeconomic conditions and mortality, hypothesizing several different pathways linking recessions to health at the aggregate level. First, individuals might experience a change in time use and consumption patterns. The time availability hypothesis suggests that individuals will use increases in available time resulting from unemployment or reduced work hours for more leisure, sleep, exercise and healthful food preparation (Burgard et al., 2013; Ruhm, 2005). This is also related to the opportunity cost of leisure, which is higher when individuals are employed meaning that it is more costly for individuals to undertake healthy activities (e.g. exercise) during economic upturns. Furthermore, economic and employment volatility of recessions could also change spending patterns in various ways (Burgard et al., 2013). For instance, health-damaging consumption of normal goods, such as alcohol and tobacco, might increase with income during economic expansions (Freeman, 1999; Ruhm & Black, 2002).

Second, health may be used as an input into production of goods and services (Ruhm, 2000). Job-related stress and the physical exertion of employment might result in negative health effects, especially during short-lasting economic expansion where job hours are extended. The extra hours of work also reduce sleep, which is related to increased stress, decreased alertness, higher injury risk and greater risk of obesity and experiencing symptoms linked to

both physical and mental health (Tapia-Granados, 2005). Furthermore, during weaker economic periods with a slower pace of production, workplace accidents might be reduced in construction and in other cyclically sensitive industries with hazardous working condition.

Third, external sources of death might be affected by economic up- and downturns. This explanation emphasizes that the relationship between mortality and business cycles reflects the impact of external factors that fluctuate with the economy. In periods of economic slowdowns, changes in the population's behavior might lead to less traffic and traffic-related accidents as well as lower air pollution (Burgard et al., 2013). During good times, people are more likely engage in risky activities such as drink and drive cars. So when the economy deteriorates, driving and consequently motor vehicle fatalities decrease as well (Ruhm, 2000, 2006). Outcomes of economic activity, such as traffic congestion and air pollution (from both motor vehicles and industrial emissions) also affect vulnerable groups of the population, not part of the workforce, such as infants and senior citizens (Clancy et al., 2002; Chay & Greenstone, 2003; Peters et al., 2004). Furthermore, other external sources of death are also affected by economic conditions. For instance, suicides are generally found to increase during recessions. One explanation might be that high unemployment rates and financial market volatility can lead to perceived or actual economic insecurity for individuals resulting in increased stress which in turn can predict poorer mental health and higher suicide mortality (Burgard et al., 2013).

The net effect of these hypothesized pathways is ambiguous and ultimately an open empirical question. In the next section we will review some of the previous research investigating the relationship between business cycles and mortality and the mechanisms at work.

3. Previous Research

The relationship between short-term economic fluctuations and health status has received a great deal of interest since the seminal work by Brenner (1971, 1973, 1975, 1979, 1987). Using aggregated time-series data, he finds that economic recessions demonstrate a negative effect on health by increasing overall mortality, infant deaths and deaths from cardiovascular disease, cirrhosis, suicide and homicide. His empirical work also demonstrates an increase in morbidities, alcoholism and admissions to mental hospitals. However, his analysis has been criticized for displaying serious flaws and errors such as choice of lag length and covariates,

inconsistent data series, model miss-specification and poor data documentation. Furthermore, various studies correcting the problems in Brenner's analysis failed to replicate his results (e.g. Kasl, 1979; Gravelle et al., 1981; Wagstaff, 1985; Cook and Zarkin 1986), calling for better specified models and statistical techniques.

Addressing Brenner's methodological flaws and the potential problem with omitted variables bias, Ruhm (2000) estimates fixed-effects models with state-level observations for the period 1972-1991 in the United States. Exploiting the within-state changes and controlling for various demographics, he finds that state unemployment is negatively and significantly related to total mortality and 8 out of 10 specific death causes, with suicide being an important exception (Ruhm, 2000:617). His findings demonstrate that a one-percentage point increase in the unemployment rate is associated with a 0.5 to 0.6 percent decrease in total mortality. Hence his results display strong evidence of a procyclical relation where health improves when the economy temporarily deteriorates, findings contrasting Brenner's countercyclical evidence. The results are also found to be strongest for the age groups and death causes in which fluctuations are most plausible, where fatalities amongst young adults demonstrate greater variation than those concentrated among older adults. By including an additional analysis applying micro data for the period 1987-1995, Ruhm finds support for his aggregated results through the effect of unemployment on individual lifestyle behaviors. His results imply that increased unemployment is associated with a healthier lifestyle through reduced smoking and obesity, increased physical activity and improved diet.

Neumayer (2004) extends Ruhm's original analysis by investigating the effect of state unemployment rates, as well as economic growth rates, on mortality in the states of Germany over the period 1980-2000. Like Ruhm, he applies fixed-effects estimations but further develops the statistical techniques by using standard errors robust towards heteroscedasticity and autocorrelation, as well as clustering at state level. In his static model he finds robust evidence that recessions lower aggregate mortality rates for all age groups taken together as well as for all specific age groups separately. The results demonstrate that a one-percentage point increase in the state unemployment rate decreases the overall mortality rate with 1.10 percent. The mortality rate for the age group consisting of individuals 65 years and older experienced the largest decrease of 1.24 percent, while the 20-45 and 45-65 age groups demonstrated a decrease of 1.10 and 0.54 percent respectively. Regarding the cause-specific death rates, he finds a negative effect for cardiovascular diseases, pneumonia and influenza,

motor vehicle accidents and suicides when estimating the effect for both sexes taken together. He does not, however, find a significant effect for liver diseases and other external effects, which contradicts Ruhm's results for the United States. Furthermore, when estimating a dynamic version of the model using Arellano and Bond's (1991) generalized method of moments (GMM) estimator or when replacing the unemployment rate with the real GDP growth rate as indicator of economic fluctuations, his results are generally rather similar as in the baseline analysis.

Finding similar evidence of a procyclical relationship for 23 Organization for Economic Cooperation and Development (OECD) countries are Gerdtham and Ruhm (2006). Estimating fixed-effects models for the 1960-1997 period and controlling for year effects, country-specific time trends as well as demographic characteristics, they find that a 1 % decrease in the national unemployment rate leads to a 0.4 % growth in total mortality. Their results also demonstrate that deaths from a variety of causes increases when labor markets strengthen where a one point fall in unemployment is estimated to raise deaths from cardiovascular disease, influenza/pneumonia, liver disease, motor vehicle accidents and other accidents by a statistically significant 0.4, 1.1, 1.8, 2.1 and 0.8 % respectively. They also find that countries with weak social insurance systems, as proxied by public social expenditure as a share of GDP, display more pronounced effects.

Tapia-Granados (2005) and Ariizumi and Schircle (2012) also confirm the procyclical relationship between unemployment and mortality rates. The former study, using fixed effects estimations and data on Spain for the period 1980-1997, finds that a one percentage increase in province unemployment leads to a drop of approximately 0.11% in total mortality, in addition to having a negative effect on sex-specific mortality and major causes of death. Ariizumi and Schircle (2012), on the other hand, estimate the predicted relationship for Canadian provinces using time-series data for the period 1977-2009. Using fixed effects estimations with a focus on age-specific mortality rates they find evidence of a strong procyclical relationship among middle-aged Canadians where a one percentage point increase in the unemployment rate lowers the mortality rates of individuals in their 30s by approximately 2 percent. Regarding the mortality rates of infants and seniors, no significant cyclical pattern is detected.

Various other studies have also tested the validity and sensitivity of Ruhm (2000)'s initial analysis to other methodological specifications, countries and time periods. Economou et al. (2008) investigate the effects of national unemployment rates on overall age and cause-specific mortality rates in a panel sample of 13 European Union countries for the sample period 1977-1996. When replicating Ruhm's analysis as closely as possible they find a negative, but statistically insignificant relationship between unemployment and mortality rates. When estimating their preferred augmented version of the model, including lifestyle, health prevention, demographic and environmental indicators, the relationship reverses and a 1 per cent increase in national unemployment rates is associated with a 1.54 percent increase in the mortality rate. Miller et al. (2009) extend Ruhm's analysis by using additional data on sex, age and ethnicity. The aim of the study is to distinguish between mortality that are related to an individual's own health behavior, and mortality that emerges from externalities related to business cycles. The authors find that it is unlikely that work-related cyclical mortality is a key determinant of aggregate mortality, but is instead largely affected by changes in transport accidents. Furthermore, they find that it is important to decompose the data by age groups since mortality rates among elderly represent a large part of the total mortality.

In his recent article, Ruhm (2015) re-visits the earlier established procyclical relationship between mortality rates and unemployment in the United States by extending the time period to cover years 1976-2010. When dividing the sample into two subsamples, 1976-1995 and 1991-2010, he finds that the estimated association changes over time. Total mortality shifts from being strongly procyclical in the first subsample where a one point increase in unemployment predicts a statistically significant 0.43 % reduction in mortality, to being weakly or unrelated to macroeconomic conditions demonstrating an insignificant 0.10 % decrease in the latter sample. When addressing the various sources of deaths the results are more mixed. Fatalities due to cardiovascular disease, as well as transport accidents to a smaller extent, continue to be procyclical, while cancer and some external sources of death demonstrate a countercyclical pattern. Stevens et al. (2011), also focusing on the U.S. and applying similar methods and data as Ruhm (2000), discover a changing relationship as well. From 1978 to 1991 they find that a one percentage point increase in the state unemployment rate resulted in a 0.40 % decrease in total mortality, and when extending the analysis through 2006 the estimated effect reduces to 0.19 %.

The studies we have looked at so far, have taken a population-level focus on the relationship between business cycles and health in terms of mortality. However, the separate body of research focusing on individual-level health and behavioral consequences of recessionary conditions should also be mentioned. A common finding in population-level studies is that mortality behaves in a procyclical way, but that does not imply that other aspects of poor health behaves in the same matter (Ruhm, 2003). Evidence from individual-level studies often finds recession-type events to be associated with poorer health for the individuals who experience them. These studies normally assess a wider range of health consequences including mental and physical health outcomes that can be affected in both the short term and long term, in addition to changes in health behaviors over time (Burgard et al., 2013:200). Some studies also look at the relationship between business cycles and mortality risk. For instance, Gerdtham and Johannesson (2005) investigate this relationship in Sweden by applying a large individual level data set covering over 40,000 individuals aged 16-84 that are followed for 10-16 years. They test if the annual mortality risk is connected to the business cycles using probit models and six different business cycle indicators. The results demonstrate a significant countercyclical relationship for four out of six indicators for men, while no significant effect was detected for women. When looking at different causes of death, a significant countercyclical pattern was found for men for cardiovascular mortality, cancer mortality and suicides. Hence, their results show that recessions adversely affect mortality for men, but not for women.

In the body of research focusing on individual-level associations, Ruhm has made several contributions. Applying data from the National Health Interview Survey in the U.S. covering the period 1972-1981, he finds that most aspects of health worsens when the economy temporarily improves (Ruhm, 2003). Furthermore, the deterioration in health is especially pronounced for individuals of prime-working age, employed persons under the age of 65 and males. In later research he focuses on lifestyle behaviors using microdata from the Behavioral Risk Factor Surveillance System (BRFSS) for the period 1987-2000 (Ruhm, 2005). His results demonstrate that smoking and excess weight among adults in the U.S. decline during temporary economic downturns whereas leisure-time physical activity levels increase. He argues that declining work hours and increasing non-market time may be one possible explanation for the improved health status. Furthermore, he concludes that the demonstrated behavioral changes could be one mechanism for the procyclical variation in mortality and morbidity observed in recent research.

4. Data and Methodology

In this section we will describe the data used in the analysis and present the methodological estimation strategies for investigating the relationship between business cycles/macroeconomic conditions and mortality rates.

Our sample is restricted to the EU-15 countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the United Kingdom) and the time period investigated is 1990-2012. The inclusion of countries is in line with Economou et al. (2008) who also investigated EU countries, with the exception of Luxembourg and Germany, which they excluded due to lack of data. However, for the time period investigated in this thesis, this is not the case and Germany and Luxembourg are therefore included in the study. Furthermore, countries that became members of the EU in the enlargement of 2004 and onwards is excluded from the study due to lack of data for several main independent and dependent variables for these countries.

4.1 Dependent Variables

In the empirical estimations we include total mortality for all age groups taken together as well as total mortality for four specific age groups (15-44, 45-59, 60-74, 75+). We also include nine specific mortality causes: malignant neoplasms (cancer), major cardiovascular diseases (heart), pneumonia and influenza, chronic liver diseases and cirrhosis, transportation accidents, other accidents, suicide and intentional self-harm, homicide and assault and infant deaths (per 1 000 live births). The mortality rates are age-standardized per 100,000 population in order to make them comparable across countries and over time by taking into account differences in the age structure of the populations (OECD, 2014). We also look at gender-specific mortality rates in order to investigate if there are any significant differences between the genders. The data has been collected from the OECD Health Statistics Database, except the data on age-specific mortality rates that have been extracted from the World Health Organization (WHO)'s European Health for all Database.

Since our sample contains 15 different European countries there are variations in when, during our sample period, the different countries switched from the International Classification of Diseases (ICD)-9 to ICD-10. We are fully aware of the potential problems

regarding data consistency following this transition and the changing in the coding rules. The consequences of the transition from ICD-9 to ICD-10 have been investigated in the United States and the United Kingdom (England and Wales). In the UK, they found an impact on the reported number of deaths assigned to circulatory disease (increase of 3-4 per cent), malignant neoplasms (increase of approximately 2 percent) and pneumonia (decrease of around 38 per cent) (Griffiths et al. 2004; Brock et al. 2004; Brock et al. 2006). In the US, Anderson et al. (2001), found the change in malignant neoplasms to remain stable but saw an impact on deaths from pneumonia and cerebrovascular diseases due to change in Rule 3. However, as pointed out by Ruhm (2015), the issues with comparability of death rates reported under the two different codes are typically minor when looking at broad causes of death (e.g. those from cardiovascular disease). Still, we cannot entirely exclude the possibility that the transition to ICD-10 have led to an overestimation of observed decreases in mortality causes in some countries. For detailed information regarding the ICD codes see Table 10 and Table 11 in the appendix.

As noted by several researchers (e.g. Wagstaff, 1985 and Ruhm, 2000) it would be more ideal if we could have used morbidity in stead of mortality data, as mortality data captures only the extreme fatal consequences of bad health and hence do not fully account for changes in non-life-threatening health conditions. However, due to limited data availability few are able to analyze the effect of macroeconomic conditions on morbidity as Ruhm (2015) points out. We are also restricted by this limited data availability problem as we do not have data on morbidity for a sufficient time period and are therefore left with mortality data. Mortality data are, however, considered to be objectively and relatively well measured since diagnosis normally does not depend on access to the medical system (Ruhm, 2015). Another delimitation applying to our study is the so-called 'ecological fallacy' problem, the issue of whether one can make conclusion about relationships at an individual level from studies using ecological (i.e. aggregated) data, implying that it would be better to use individual rather than aggregated data. However, as pointed out by Gravelle, Wildman and Sutton (2002), aggregate data analysis is still informative, even if one needs to be careful drawing conclusions from the aggregate level to individual behavior.

4.2. Explanatory Variables: Measuring Business Cycles

Following previous studies (e.g. Ruhm, 2000, 2015; Gerdtham and Ruhm, 2006; Neumayer, 2004), the unemployment rate is used as our main proxy for macroeconomic conditions. We are using the harmonized unemployment rate, which gives the number of unemployed persons as a percentage of the labor force, where the definitions follow the International Labour Organization (ILO) guidelines with the exception that employment and unemployment estimates are based on labor force surveys that cover only private households and exclude all people living in institutions (OECD, Main Economic Indicators). Note that since we are using aggregated data, the unemployment rate is used to indicate the underlying macroeconomic conditions rather than health effects of individual job losses (Ruhm, 2007).

Alternative specifications are also estimated where the unemployment rate is replaced with the annual real GDP growth rate and the capacity utilization index. The unemployment rate and the GDP growth rate were extracted from the OECD Statistical Database, while data on the capacity utilization index was taken from Thomson Reuters DataStream (DS).

4.3. Other Controls

Following Ruhm (2000) we also control for differences in age structure by including control variables capturing three different age ranges: the percentage of the population under 15 years, the percentage of the population 15-64 years and the percentage 65 years and over. We also include the percentage male of the population as a further control for population characteristics, as these characteristics may independently affect death rates. Both these variables are collected from the OECD Statistical Database.

Educational attainment is also controlled for in the analysis. Like Economou et al. (2008) we include two different levels capturing the percentage of the population (age 15+) with no education and the percentage with post-secondary education. The data on educational levels is taken from the Education Statistics (EdStats) of the World Bank (Barro-Lee Dataset 2014). The levels are calculated at 5-year intervals from 1970-2010, so for the years between the intervals we used linear interpolation to estimate fill in missing observations with data. It could be problematic to fill in missing observations using linear interpolation since it implies less variation in the data. However, the data from the World Bank indicates that it might be

less problematic in the case of educational attainment in the countries included. The data shows a clear pattern that post-secondary education increases for each period, and the number of individuals with no education decreases. We will assume that this trend holds and that the linear interpolation yields reliable estimates of the true educational attainment level in the countries included.

As further control variables, net national disposable income per capita collected from the OECD Statistical Database is included. The variable is expressed in thousands of US dollars and is measured in constant prices and constant PPP with 2010 as a reference year. Health care is considered a normal good so when income rises, all other things equal, people will spend more of their money on health-preserving investments and mortality rates should go down (Neumayer, 2004). However, as many health-damaging consumption goods such as alcohol and tobacco products are also likely to be normal goods the effect of average income level on aggregate mortality is therefore ambiguous (Freeman, 1999; Ruhm and Black, 2002; Xu, 2013). Interpretation of results in models controlling for incomes should be done with caution, since as Ruhm (2004) discusses, the interpretation becomes more complicated seeing that permanent growth may improve health but transitory increases need not. Furthermore, since incomes fall during temporary downturns, their inclusion is likely to absorb and possibly explain a portion of the macroeconomic effect.

4.4. Estimation Strategy

We apply linear regression to estimate the relationship between macroeconomic conditions and death rates. Applying the subscripts *j* and *t* to indicate country and year, the basic panel specification is given by:

$$M_{jt} = \alpha_t + \beta X_{jt} + \gamma E_{jt} + C_j + \varepsilon_{jt}$$

where M_{jt} is the natural logarithm of the mortality rate, E_{jt} is the proxies for macroeconomic conditions, X_{jt} is a vector of control variables discusses above, α represents year-specific effects, C_j is country fixed-effects, ε_{jt} is the error term and $\hat{\gamma}$ provides the estimated macroeconomic effect of interest.

In the estimations, the year effects (α_t) hold constant determinants of health that vary uniformly across countries over time (e.g. advances in widely used medical technologies) while the country fixed-effects (C_j) controls for factors that differ across countries but are time-invariant (e.g. some country-specific institutions or persistent heterogeneity in lifestyles). The impact of the macroeconomy is therefore given by within-country variations in unemployment, relative to fluctuations occurring in other areas (Ruhm, 2007).

The basic specification does not, however, capture confounding factors that vary over time within countries that are not accounted for by the vector of covariates. By adding a vector of country-specific linear time trends ($C_j \times T$) to the model specification, the problem can be substantially reduced and we now get the following equation:

$$M_{jt} = \alpha_t + \beta X_{jt} + \gamma E_{jt} + C_j + C_j \times T + \varepsilon_{jt}$$

So by including these country-specific time trends, in addition to the already included controls, country fixed-effects and time effects, we assume that all systematic determinants of mortality that are spuriously correlated with macroeconomic conditions are more or less accounted for. Hence, the potential for omitted variables bias is substantially reduced, but not completely eliminated.

Following Ruhm (2000), the regressions are estimated by least squares weighted by the square root of the national population in order to account for heteroskedasticity and to avoid overestimation of the influence of small countries on the regression estimates. Furthermore, we also employ standard errors that are robust towards arbitrary autocorrelation as well as heteroskedasticity. All regressions and analysis is conducted by using the STATA Statistical Software package (Stata version 13).

4.5. Descriptive Statistics

Summary statistics are listed in Table 1 below and are largely self-explanatory. As previously mentioned, the mortality rates refer to deaths per 100,000 persons with the exception being the infant mortality rate that are per 1,000 live births. For female and male cause-specific mortality rates see Table 12 in the appendix. The majority of the included mortality rates have demonstrated a substantial decrease during the sample period. Between 1990 and 2012, the average overall age-standardized mortality rate in the countries in our sample fell by

approximately 30 per cent (from approximately 1120.1 to approximately 764 deaths per 100,000 individuals)[1].

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev	Min	Max	Observations
Dependent variables					
Age-standardized total mortality rates per 100 000 population					
All ages	956.30	137.77	679.3	1315.3	326
15-44 years old	183.70	48.14	98.79	330.14	309
45-59 years old	440.95	70.41	281.78	608.27	309
60-74 years old	1636.38	317.52	1078.85	2514.96	309
75+ years old	8465.28	1089.92	5910.45	11463.2	309
Male	1209.35	186.51	865.9	1680.9	326
Female	777.80	115.63	521.7	1073.2	326
Cause-specific mortality per 100 000 population					
Malignant Neoplasm	232.30	28.37	176.5	298.9	326
Major Cardiovascular diseases	392.72	107.93	166.4	618.3	326
Influenza/Pneumonia	9.49	3.88	3.2	15.8	324
Chronic liver diseases	13.08	6.30	3.1	31	326
Transport accidents	11.23	5.15	3.2	30.4	326
Other accidents	12.90	7.46	2.7	37.2	326
Suicides and intentional self-harm	12.60	5.74	2.8	30.2	326
Homicides and assaults	1.14	0.56	0.2	3.4	326
Infant mortality rate (per 1 000 live births)	4.83	1.61	1.8	10.9	345
Main independent variables					
Macroeconomic Fluctuations:					
Unemployment rate (%)	8.15	3.81	1.66	24.79	341
GDP growth rate	2.08	2.78	-8.9	10.8	345
Industry capacity utilization (%)	80.36	4.79	64.53	89.68	341
Deviations from Trend:					
Unemployment rate	-0.0000	0.66259	-2.50	2.696	341
GDP growth rate	-0.0000	0.01403	-0.048	0.048	345
Other control variables					
Per capita income	25.07	6.15	13.56	52.40	345
Percentage of population under 15	17.49	2.21	12.8	27.2	345
Percentage of population 15-64	66.69	1.36	61.4	70	345
Percentage of population 65 and over	15.83	2.09	10.8	21.1	345
Percentage male of population	49	0.48	47.7	50.1	345
Percentage of population with no education	4.23	4.22	0	25.85	345
Percentage of population with post-secondary education	11.39	4.81	2.88	28.91	345

Regarding the age-disaggregated mortality rates we merged two categories into one (15-29 and 30-44), since it made more sense when looking at labor market conditions and its effect

[1] The calculations are performed using information for the countries (Austria, Denmark, Finland, Germany, Luxembourg, Netherlands, Spain and Sweden) on which mortality and unemployment data are available throughout the 22-year period in order to avoid changes in sample composition.

on health. The 15-44 age group therefore experienced a quite large decrease in total average mortality during the sample period (approximately 45 per cent) compared to the other categories. The total average mortality rates for individuals aged 45-59 years fell by around 31 per cent. The rate of decrease for age group 60-74 was about 38 per cent, while for individuals aged 75 and above the rate declined by approximately 28 per cent.

According to OECD (2014), there is a significant gender gap in mortality rates in all OECD countries. One can see this from the sex-specific mortality rates in the table where the average male mortality rates demonstrate a higher level than the female mortality rates (around 55 per cent higher). During the sample period male mortality fell by approximately 36 percent, while female mortality fell by around 29 per cent.

Cardiovascular diseases and malignant neoplasm (cancer) constitute some of the main causes of death in the EU countries (OECD, 2014). Deaths due to cardiovascular diseases decreased by approximately 52 per cent, while deaths due to cancer fell by around 18 per cent. The decreasing trend in cardiovascular diseases can partly be explained by decreased tobacco consumption and improvements in medical care (OECD, 2014). Fatalities due to influenza and pneumonia increased by a small 0.4 per cent. The average mortality rate of chronic liver diseases and cirrhosis of the liver for the 15 European Union countries studied decreased by approximately 42 per cent during the 22-year time period. Mortality incidence due to transportation accidents fell by about 70 per cent. The decreased burden of road transport accidents across the EU can partly be explained by adoption and enforcement of new laws and regulations related to speed limits, seatbelt use and drink-driving rules (OECD, 2014). Suicides and intentional self-harm demonstrate a decline of about 37 per cent, while other accidents mortality fell by approximately 34 per cent. The average mortality of homicide and assault fell quite a lot (around 62 per cent) and infant mortality shows a decrease of about 56 per cent during the sample period.

5. Results

In this section we will go through the results from the various estimations and regression specifications. We will also provide a discussion of the results and how they relate to previous research.

5.1. All Cause Age-standardized Mortality

Table 2: Estimated macroeconomic effects on total mortality rates

Regressor	Specification			
	(a)	(b)	(c)	(d)
Unemployment rate	-.0029** (.0013)	-.0015 (.0013)	-.0026* (.0015)	-.0023 (.0016)
Natural log of income		.1223 (.0805)		
Year effects	Yes	Yes	No	Yes
Country-specific trends	Yes	Yes	Yes	No
Fixed-effects	Yes	Yes	Yes	Yes

Note: The dependent variable is the natural logarithm of the total mortality rate. The number of observations is 322. All observations are weighted by the square root of the country population. The specifications also include vectors of country dummy variables and controls for country characteristics listed in section 4. Year dummy variables and country-specific time trends are also controlled for, except where noted. Robust standard errors, clustered at the country level, are in parentheses (*p<0.1, **p<0.05, ***p<0.01).

Table 2 summarizes the results of various econometric models where the variable to be explained is the age-standardized mortality rate per 100,000 individuals. Note that for simplicity, only the coefficient of the unemployment rate and the income variable is shown. In the regressions, the dependent variable is in natural logarithm to allow an easy to understand elasticity interpretation of the results. Our results do not, however, change much when the dependent variable is in level instead of log.

At first glance, all specifications reveal a negative association between total mortality and the unemployment rate for the EU-15 countries. Specification (a) displays the results of regressing the natural log of the total mortality rate on the unemployment rate while controlling for country demographic characteristics (sex and age), educational attainment, country fixed-effects, year effects and country-specific linear time trends. The unemployment coefficient is negative and significant at the five percent level, and implies that a 1 % increase in the unemployment rate decreases number of total deaths by 0.29 %.

Specification (b), includes a control for per capita incomes. When adding the control, the unemployment coefficient becomes smaller and is no longer significant. The income

coefficient in itself is positive, but not significant. Both Ruhm (2000) and Neumayer (2004) find a significant and positive effect in their estimations, where higher incomes are associated with higher total mortality. However, we demonstrate below that the estimated income effects vary substantially across causes of death with limited evidence of a significant relation. For all econometric specifications models income is included to allow comparison of results with and without the control, as well as comparisons to related studies. Prior studies, such as Gerdtham and Ruhm (2006), chose not to include income in their preferred specification. However, in order to avoid a potential omitted variable bias, we have chosen to include it as an alternative specification. Due to the inconsistency of the results including incomes, we have chosen to focus on the estimates excluding incomes but will comment on both specifications if the estimates yield anything of importance.

The next two columns in Table 2 examines the sensitivity of the results by estimating the same regression as in the first, but without controlling for country-specific time trends or year effects depending on the specification. In specification (c), year effects is not controlled for and the unemployment coefficient somewhat shrinks and is now significant only at the ten percent level. Here, a one percentage increase in unemployment is associated with a 0.26 % decrease in total mortality. When the country-specific time trends are excluded (specification (d)), the unemployment coefficients are smaller than in the other specifications and no longer significant indicating that the results are sensitive to the inclusion of country-specific time trends.

Our findings on total mortality rates confirm the previously well-established procyclical relationship with unemployment. With this we find support for the hypothesis stating that when the economy deteriorates and labor markets worsen, average health improves at least in the short run. We are not, however, able to say for certain which of the different pathways (e.g. improved dietary habits, increased exercise, reduction in risky behavior) that might have led to this improved health outcome. For that, individual level data is needed.

Regarding the magnitude of the econometric estimations for total death rates our estimated effects differ from earlier findings. As mentioned in the literature review, Ruhm (2000) discovered an effect of 0.5-0.6 % for the U.S., Neumayer (2004) 1.1 % for German states and Gerdtham and Ruhm (2008) found the effect to be 0.4 % for OECD countries. The fact that our results are smaller in magnitude than previous research can partially be explained by the

time period we are investigating and also the dependency on the chosen sample of countries. Furthermore, it is also in line with Ruhm (2015) who found that the procyclical relationship have become weaker in more recent years. He found it to reduce from a 0.43 % significant decrease to a non-significant 0.10 % when focusing on the latter subsample stretching from 1991-2010 (which is approximately the same time period we are investigating).

When it comes to the various control variables included in the regression, we found educational level to be beneficial for mortality. The percentage of population with no education is positively, but insignificantly, associated with mortality, while the percentage with post secondary education on the other hand demonstrated a negative and significant effect.

5.2. Age-disaggregated Mortality

Table 3: Estimated macroeconomic effects of age disaggregated mortality rates

Regressor	15-44 years old		45-59 years old	
	(a)	(b)	(a)	(b)
Unemployment rates	-.0060** (.0027)	-.0050 (.0029)	-.0017 (.0012)	-.0017* (.0008)
Natural log of income		.0905 (.1053)		-.0048 (.0722)
	60-74 years old		75+ years old	
	(a)	(b)	(a)	(b)
Unemployment rates	-.0038*** (.0011)	-.0040** (.0014)	-.0023 (.0017)	-.0002 (.0018)
Natural log of income		-.0142 (.0753)		.1837 (.1170)

Note: The dependent variables are in natural logarithms. Number of observations is 322, except for infant mortality where it is 341. All specifications include demographic characteristics and above-mentioned controls. Year and country fixed effects as well as country-specific time trends are included. Robust standard errors, clustered at the country level, are in parentheses (*p<0.1, **p<0.05, ***p<0.01).

In Table 3 above, the econometric results for four specific age groups are listed. The effect of unemployment rates on mortality differs among the four age groups, but all directions points towards a negative relationship. For the first age group, 15-44, when not controlling for income, a one percentage point increase in the unemployment rate is associated with a significant 0.6 % decrease in predicted mortality. In specification (b), when including a control for income, the effect becomes somewhat smaller and loses its significance.

The effect in specification (a) is also one of the greatest in magnitude, compared to the estimates for the other age groups included. Young adults are the ones expected to have the highest rate of labor force participation and therefore also expected to be the ones most affected by macroeconomic conditions. Ruhm (2000) found in his analysis that the age group

20-44 experienced the largest cyclical fluctuations in fatalities where the predicted death rate for this age group was lowered by 2.0% following a one percentage point rise in state unemployment. Ariizumi and Schirle (2012) find similar evidence on individuals in the age group if 20-44, although with a smaller magnitude. In their study, a one percentage point increase in unemployment lowered the predicted mortality by 1%.

The estimations for the mortality rate for age group 45-59 demonstrates a 0.17 % decrease in the mortality rate, in both specifications, following a one percentage point increase in the unemployment rate. The effect becomes significant when controlling for personal incomes, but the income variable itself is not significantly related to mortality. Our findings for this age group are in line with both Neumayer (2004) and Ruhm (2000) who found the effect of unemployment on mortality weakest for the age group 45-65.

The 60-74 age group displays a surprisingly significant coefficient for both specifications where the negative effect varies from 0.38-0.40 %. This group consists mainly of the retired population who rarely participates in the labor force and should therefore not be affected by labor market conditions, and the strength of this effect is therefore unexpected. However, Neumayer (2004) found in his analysis on German states the effect to be strongest for the age group consisting of individuals 65 years and older, where this group surprisingly experienced the largest decrease (1.24 %) in fatalities. Also Miller et al. (2009) found small and significant negative effects for retired people in their sample. The authors argue that factors that reflect business cycle externalities must have an important role in explaining fluctuations in mortality rates. For instance, just as Ruhm (2000), they find that transport accidents makes up the largest estimated coefficient. These findings therefore demonstrate that the effects are not restricted to working age persons.

Lastly, the oldest age group capturing the predicted death rate of individuals aged 75 and over shows a small and insignificant reduction. This is in line with earlier research (e.g. Neumayer, 2004) who also did not detect any significant patterns for the older age groups.

5.3. Cause-specific Mortality

In Table 4 below, the results from the fixed-effects regressions for mortality due to different causes of death are reported.

Table 4: Estimated macroeconomic effects on cause-specific mortality.

	Specification					
	Malignant neoplasms		Major cardiovascular disease		Influenza and Pneumonia	
	(a)	(b)	(a)	(b)	(a)	(b)
Unemployment rate	.0006	.0008	-.0012	.0003	.0208*	.0181*
	(.0011)	(.0013)	(.0014)	(.0023)	(.0114)	(.0100)
Natural log of income		.0179		.1341		-.2430
		(.0792)		(.1630)		(.6151)

	Specification					
	Chronic liver disease		Transport accidents		Other accidents	
	(a)	(b)	(a)	(b)	(a)	(b)
Unemployment rate	-.0018	.0037	-.0120*	-.0154*	.0013	.0140
	(.0067)	(.0077)	(.0061)	(.0076)	(.0096)	(.0123)
Natural log of income		.4900		-.3041		1.1435*
		(.3214)		(.2409)		(.5353)

	Specification					
	Suicides and self-intended harm		Homicide		Infant mortality	
	(a)	(b)	(a)	(b)	(a)	(b)
Unemployment rate	.0322	-.0064	-.0264***	-.0305**	-.0153	-.0049
	(.0813)	(.0068)	(.0075)	(.0116)	(.0872)	(.0042)
Natural log of income		-.2919		-.3700		-.1442
		(.2851)		(.6806)		(.2571)

Note: The dependent variables are in natural logarithms. Number of observations is 322, except for infant mortality where it is 341. All specifications include demographic characteristics and above-mentioned controls. Year and country fixed effects as well as country-specific time trends are included. Robust standard errors, clustered at the country level, are in parentheses (*p<0.1, **p<0.05, ***p<0.01).

In line with previous research (e.g. Ruhm, 2000, 2015; Neumayer, 2004, Gerdtham and Ruhm, 2006) we find a negative and statistically significant relationship between unemployment and deaths caused by transport accidents. We find that when the unemployment rate increases by 1 %, predicted fatalities due to transport accidents drops by 1.2-1.5 %. This result lends support to the hypothesis stating that in good economic times, when more people are working, there are more traffic and roadways are more congested, leading to a greater probability of being involved in fatal traffic-related accidents. Earlier research has also established evidence in support of this mechanism and the procyclical nature of the relationship. Ruhm (2000) found motor vehicle fatalities to be the most sensitive to the business cycle than any other of the investigated specific-causes of deaths. Earlier evidence

also supports this by finding a negative relationship between unemployment and crash involvement in the U.S. (e.g. Wagenaar, 1984).

Unlike evidence from earlier research (e.g. Ruhm, 2000; Neumayer, 2004), we find that fatalities from influenza and pneumonia demonstrate a significant and positive association with the unemployment rate. The number of fatalities is estimated to increase by 1.8-2.1 % following a one percentage increase in joblessness. Influenza and pneumonia predominantly strikes very young or old individuals, but it is also related to poorly functioning immune systems, as well as the existence of underlying chronic diseases (American Lung Association, 2008). Furthermore, there is evidence of a causal link between stress, decreased immunity, and higher incidence of infections (Kiecolt-Glaser et al., 2002). Earlier work has found infectious disease mortality to increase during economic expansions (e.g. Ruhm, 2000). However, Cornwell (2001) demonstrates that economic downturns in terms of high levels of state unemployment in the United States are associated with increased incidence of influenza activity, which could be explained by increased stress as well as reduced access to health care and vaccination.

Fatalities from homicides and assault display a negative and significant pattern. Here, a one percentage increase in unemployment is predicted to decrease deaths from this specific cause by 2.6-3.1%. This result contradicts with earlier research finding a positive, but often insignificant, effect (e.g. Economou et al. 2008; Gerdtham and Ruhm, 2006; Neumayer, 2004). Ruhm (2015), however, finds a positive (but not significant) association between the state unemployment and fatalities due to homicide for the subsample 1991-2010. His first subsample investigating earlier years (1976-1995) demonstrates a negative relationship, giving indications that the effect might have changed in more recent years.

Regarding the rest of the cause-specific mortality rates (malignant neoplasms, major cardiovascular disease, chronic liver disease, suicides, other accidents and infant mortality) we did not detect any statistically significant patterns, but we are able to comment on the direction of the estimated effects. Fatalities due to malignant neoplasms (cancer), demonstrate a positive association with the unemployment rate. This association is, however, small and as previously mentioned insignificant. The result is not surprising since cancer fatalities have been found to be unrelated to macroeconomic conditions in previous research (Neumayer, 2004; Ruhm, 2000). This is reasonable since a short-run impact of even substantial changes in

behavior will unlikely have much of an impact of the timing of this source of death, as emphasized by Ruhm.

The insignificant association for the infant mortality rate indicates that number of infant deaths decreases when unemployment increases, implying that the direction of the associated relationship is in line with earlier findings (e.g. Economou et al., 2008). Furthermore, other studies also found that infant mortality seems to be unaffected by macroeconomic conditions (Neumayer, 2004; Ruhm & Gerdtham, 2006). The estimated results for cardiovascular disease, chronic liver disease and suicides are mixed depending on whether the income variable is included or not.

The last group of fatalities belonging to external effects is other accidents (non-transport accidents). This category includes fatalities due to accidental falls and accidental poisonings. The econometric results are insignificant, but indicate a positive relationship with macroeconomic conditions represented by the unemployment rate. The estimated effect indicates a 0.13 % rise when income is not controlled for and 1.4 % when it is. The income coefficient in itself is also rather large and significant at the ten percent significance level. One possible explanation for the positive and significant effect of income on this cause-specific mortality could be due to accidental poisoning. As income increases, people with problems related to mental health might be more induced to spend more on prescription drugs and illegal drugs and hence increase the probability of fatal outcomes. The positive relationship between other accidents and unemployment is in line with Ruhm (2015) who found the relationship between unemployment and non-transport accidents to be weakly significant and positive for the latter subsample (1991-2010) where a one percentage increase in unemployment predicted an increase of 0.86 % in fatalities.

Regarding the inclusion of personal incomes in the various models we find that the variable have an insignificant effect on all specific causes of death, except for fatalities due to other accidents. Furthermore, its inclusion results in mixed and inconsistent results. Ruhm (2000) and Neumayer (2005) also find mixed and inconsistent results when including income as an additional covariate in estimations, where income is sometimes positively and other times negatively correlated with mortality.

5.4. Sex-specific Mortality

In the following two tables, the sample has been divided into two subsamples, in which Table 5 shows the results of the female specific regression, whereas Table 6 shows the results of the male specific regression. The dependent variables for these regressions are the standardized death rates per 100 000 females and males respectively.

The result from Table 5 below shows no significant results for female death rates in the specification where the income variable is not included. When the income variable is included, death rates from homicides and assaults are significant and negatively related to the unemployment rate. The fact that unemployment rates have low and insignificant effect on death rates among women is in line with prior research by Gerdtham and Johannesson (2005), who cannot reject the null hypothesis of no effect for any of their included business cycle indicator on female mortality risk.

Table 6 below, shows that total mortality rates for males are statistically significant and negatively related with unemployment rates. A one percent increase in unemployment rates decreases total mortality among males by 0.34%, all else equal. Also transport accidents and homicides and assaults are significant and negatively related with unemployment. A one percent increase in unemployment decreases transport accidents by 1.32%, whereas homicides and assaults decrease by 2.97%. Hence, our data suggests that increasing unemployment will imply a significant decrease in male deaths, at least due to transport accidents and homicides. However, for women we find no significant effect at all for any of our included mortality causes.

Table 5: Female specific mortality rates

	Specification					
	All causes		Malignant neoplasms		Major cardiovascular disease	
	(a)	(b)	(a)	(b)	(a)	(b)
Unemployment rate	-.0025	-.0007	.0001	.0007	-.0004	.0015
	(.0015)	(.0014)	(.0013)	(.0015)	(.0015)	(.0023)
Natural log of income		.1592		.0552		.1759
		(.1091)		(.0936)		(.1759)

	Specification					
	Influenza and Pneumonia		Chronic liver disease		Transport accidents	
	(a)	(b)	(a)	(b)	(a)	(b)
Unemployment rate	-.0052	.0073	.0001	.0055	-.0059	-.0106
	(.0131)	(.0183)	(.0070)	(.0089)	(.0070)	(.0087)
Natural log of income		1.1304		.4863		-.4242
		(.7564)		(.3610)		(.2979)

	Specification					
	Other accidents		Suicides and intentional self-harm		Homicide and assault	
	(a)	(b)	(a)	(b)	(a)	(b)
Unemployment rate	.0057	.0219	.0004	-.0016	-.0124	-.0238***
	(.0127)	(.0159)	(.0065)	(.0087)	(.0076)	(.0060)
Natural log of income		1.4509**		-.1819		-1.0369**
		(.5904)		(.3090)		(.4435)

Note: See note in Table 4. The number of observations is 322.

Table 6: Male specific mortality rates

	Specification					
	All causes		Malignant neoplasms		Major cardiovascular disease	
	(a)	(b)	(a)	(b)	(a)	(b)
Unemployment rate	-.0034**	-.0024**	0.0010	.0010	-.0024	-.0014
	(.0012)	(.0011)	(.0013)	(.0014)	(.0014)	(.0023)
Natural log of income		.0883		.0023		.0942
		(.0704)		(.0696)		(.1464)

	Specification					
	Influenza and Pneumonia		Chronic liver disease		Transport accidents	
	(a)	(b)	(a)	(b)	(a)	(b)
Unemployment rate	-.0120	.0027 (.0196)	-.0028	.0029	-.0132**	-.0159
	(.0137)		(.0068)	(.0072)	(.0058)	(.0074)
Natural log of income		1.3171		.5088		-.2414
		(.8137)		(.3205)		(.2354)

	Specification					
	Other accidents		Suicides and intentional self-harm		Homicide and assault	
	(a)	(b)	(a)	(b)	(a)	(b)
Unemployment rate	-.0004	.0098	-.0041	-.0073	-.0296***	-.0335***
	(.0074)	(.0096)	(.0051)	(.0064)	(.0087)	(.0125)
Natural log of income		.9101*		-.2896		.6574
		(.4941)		(.2962)		(.4536)

Note: See note in Table 4. The number of observations is 322.

These results contradict some of the prior studies (Gerdtham and Johannesson, 2005; Gerry, Mickiewicz and Nikoloski, 2013) that have decomposed the sample into males and females. However, the fact that the effect of economic downturns has a more significant effect on males, as compared to females, is in line with earlier research. Studies, both at the aggregate and individual level, have found that males seem to be struck harder by business cycles and unemployment. Gerdtham and Johannesson (2005) finds significant effects on male mortality rates from business cycle fluctuations, concluding that males could be more vulnerable from the income loss of being unemployed. Gerry et al. (2013) finds similar results and argue that males have less good health status and worse lifestyle behavioral habits than women, which exacerbates during economic downturns. Furthermore, men are typically employed in the private sector, which is more vulnerable to macroeconomic fluctuations compared to other sectors (Riva et al., 2011).

5.5. Alternative Business Cycle Indicators

Most studies have used unemployment rates as the sole business cycle indicator. However, as Gerdtham and Johannesson (2005) argue, the unemployment rate might have some disadvantages. First of all, it does not take into account changes in labor force participation and labor market programs assigned by the government in order to increase employment. Furthermore, there might be a lag between the unemployment rate and the business cycle, as the labor market tends to be sticky. Thus, as an additional specification we test the effect of alternative business cycle indicators on total mortality rates.

Following the framework of Gerdtham and Johannesson (2005), we choose to look at the GDP growth rate, the capacity utilization index and the business confidence indicator. The GDP growth rate is a natural measure to use when estimating business cycles, measured in our sample as the annual growth rate in GDP. The capacity utilization rate is an alternative measure that indicates the rate of potential output in a firm that is actually being utilized. The higher the utilization rate, the more of the installed productive capacity is being utilized in a country. The business confidence indicator did not yield any reasonable estimates so it was dropped from the final regressions.

Table 7: Alternative business cycle indicators

Regressor	Specification					
	(a)	(b)	(c)	(d)	(e)	(f)
Unemployment rate	-.0029**	-.0015				
	(.0013)	(.0013)				
GDP growth rate			.0032**	.0021*		
			(.0011)	(.0010)		
Capacity utilization					.0019	.0010
					(.0011)	(.0013)
Natural log of		.1223		.1175		.1736
income		(.0805)		(.0775)		(.1008)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Country-specific trends	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is the natural logarithm of total mortality. All observations are weighted by the square root of the country population. All equations include vectors of country and year dummy variables, controls for country characteristics listed in section 4 and country-specific time trends. Robust standard errors, clustered at the country level, are in parentheses (*p<0.1, **p<0.05, ***p<0.01).

Table 7 above shows the results of the regressions, in which the unemployment rate has been included once again in order to make it easier to compare the results. The results indicate that both the GDP growth rate and the capacity utilization rate have a procyclical relationship. However, only the result from the regression using GDP growth rate was significant. It implies that if the GDP growth rate increases by 1%, the total mortality rate will increase by 0.32%. Since our estimates suggest that unemployment rates are procyclical, it is logical that also the alternative business cycle indicators should follow a procyclical pattern. The results are not in line with the study by Gerdtham and Johannesson (2005) that used a similar framework. However, they used individual-level data and found that also unemployment rates had a countercyclical relation with mortality rates.

In macroeconomics, the business cycle is commonly defined as short-run fluctuations in economic activity around a long-term economic growth trend (Soerensen & Whitta-Jacobsen, 2010: chapter 13). A potential problem related to this definition, recognized by previous research, is that business cycles can be confused with its trend. An alternative way to examine cyclical fluctuations in economic time series is to measure the fluctuations as deviations from their long-run trends (Stock & Watson, 1998). One therefore wants to de-trend the series by decomposing it into a long-term trend component (corresponding to the series growth trend) and a short-run cyclical component (corresponding to the business cycle fluctuations). There are several ways to do this, but a commonly applied method in the business cycle literature is

to use the Hodrick and Prescott (HP) (1980, 1997) filter. The HP filter removes a smooth trend (τ_t) from the given economic series (y_t) by solving:

$$min_{\tau_t} = \sum_{t=1}^{T}((y_t - \tau_t)^2 + \lambda((\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1}))^2)$$

where the residual $(y_t - \tau_t)$ is the deviation from trend and commonly referred to as the business cycle component. The filter also involves a smoothing parameter (λ), which penalizes the accerleration in the trend relative to the business cycle component (Ravn and Uhlig, 2002). For annual data (which is our case) this parameter is normally set to λ= 6.25.

We decided to apply the HP filter to the unemployment rate and the GDP growth rate, since these were the two business cycle indicators that yield significant results in our primary analysis. The table below demonstrates the econometric results for total mortality.

Table 8: Macroeconomic effect of cyclical fluctuations in unemployment and GDP on total mortality (Deviations from smooth trend)

Regressor	Specification			
	(a)	(b)	(c)	(d)
Unemployment rate	-.0008 (.0030)	.0019 (.0043)		
GDP growth rate			.0383 (.0820)	-.3562* (.1928)
Natural log of income		.1754* (.0867)		.2075** (.0968)
Year effects	Yes	Yes	Yes	Yes
Country-specific trends	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes

Note: See note in Table 7. Number of observations is 326.

As seen from the table, the results are rather inconclusive and inconsistent. The unemployment variable shows a small negative coefficient in the first specification, whereas including income results in a shift in the sign. The GDP variable also shifts sign when income is included, and the last specification is significant and rather high. It would imply that an increase in the GDP growth rate results in a large decline in total mortality rates. These variables have not been estimated in other studies, making it hard to discuss whether or not our estimates are in line with expectations. However, the estimates are rather sensitive to the choice of specification, which could raise some concern about the validity of the results. It should be noted that most applications of the HP-filter have been done using quarterly data

(Ravn and Uhlig, 2002), and that the filter tends to give imprecise estimates at the end-points of a time-series. Thus, the inconsistent results of the HP-filter in our study could be a consequence of using annual data for a shorter time-span.

5.6. Alternative Specifications

In order to test whether the chosen sample affected the estimates and as a sensitivity check, we specified a set of regressions in which the sample was restricted to certain countries or years. By restricting the sample to observations for 2009-2012, we attempted to provide some indications on how the recent recession has affected mortality levels. Following Ruhm (2000) we also chose to restrict the sample to countries with no missing data for the dependent and main independent variables, as well as including only the largest countries in the data set.

Table 9: Alternative specifications

Regressor	Specification							
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Unemployment rate	-.0024*	-.0008	.0128**	.0128**	-.0033**	-.0034**	-.0037**	-.0017
	(.0013)	(.0012)	(.0052)	(.0051)	(.0012)	(.0012)	(.0012)	(.0015)
Natural log of income		.1264*		-.0042		-.0174		.2099
		(.0641)		(.4186)		(.1042)		(.1577)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: See note in Table 2. (a) & (b) includes observations prior to 2009. The number of observations is 272. (c) & (d) includes observations 2009-2012. The number of observations is 50. (e) & (f) includes only countries with no missing data for the dependent and main independent variables. The number of observations is 138. (g) & (h) includes the five largest countries in the data set. The number of observations is 105.

In the first column, it can be seen that restricting the sample to observations for 1990-2009 does not alter the signs or estimates in comparison with prior estimates. Using the whole sample, a one percent increase in unemployment resulted in a 0.29% decrease in mortality rates, whereas it now results in a 0.24% decrease. However, restricting the sample to observations from 2009-2012 yields large changes in the estimates. The signs in this regression is now positive, indicating that a one percent increase in unemployment results in a 1.28% increase in mortality. Thus, the relation between mortality rates and unemployment seem to have changed from being procyclical to countercyclical. This result is not in line with the previous work by Ruhm (2000), however, there could be several explanations to why this result is obtained. One apparent problem is the possibility that the observations are not enough in order to draw any conclusions on the financial crisis.

In column (e) and (f) we only looked at countries with no missing data on the dependent and main independent variables. As can be seen, the results from these regressions are significant and similar to those obtained in the original regression. The coefficients are, however, greater in size and demonstrate a more pronounced effect of unemployment on total mortality. In column (g) and (h) we only included the five largest countries to see if it changed the estimates. However, as can be seen, these estimates are also in line with the regressions obtained with the full sample. Thus, these specifications could work as a sensitivity check, in order to see if the selection of countries and year have a significant effect on the results obtained.

6. Discussion

In this study we wanted to investigate the relationship between business cycles and mortality in the EU-15 countries in recent years covering the period 1990-2012, by applying the methodology used by Ruhm (2000). From the estimated results we found some evidence that economic downturns are associated with reductions in mortality rates. In accordance with Ruhm (2000) we detected a significant procyclical relationship between unemployment and total mortality where a one percentage increase in unemployment predicted a 0.29% decrease in number of total deaths. The estimated effect was, however, smaller compared to findings from previous research focusing on earlier time periods. Some of the variations in estimated effects can most certainly be attributed to choice of sample countries and different data. It might also indicate that the relationship has changed and become weaker over time. Gerdtham and Ruhm (2006) investigated a sample of 23 OECD countries, including our chosen sample, and found the estimated effect to be 0.40% for the time period 1960-1997. Although they focused on a larger sample than us, there is at least some indications that the effect was greater in earlier years. Furthermore, in his recent article, Ruhm (2015) found the relationship to diminish over time for the U.S. Regarding the sensitivity of our results; the significant procyclical relationship was confirmed when replacing the unemployment rate with the GDP growth rate as a proxy for macroeconomic conditions.

We divided the sample into observations prior to 2009, and observations from 2009-2012, in order to acquire some knowledge about the effects of the financial crisis. The results from the regression indicate that the relation between unemployment and mortality has changed from

being procyclical to countercyclical as a consequence of the financial crisis. This result is not in line with research that has included more recent years (Ruhm, 2015), however, it might be explained by special circumstances. One possible explanation for the reversed relationship might be the distinction between normal and severe fluctuations in economic conditions, where the economy-health relationship during 'steady-state' business cycle fluctuations may differ substantially from those occurring under exceptional market circumstances such as acute financial crisis (Suhrcke & Stuckler, 2012). However, research has found that during the Great Depression, the health of Americans overall decreased despite rising suicide rates (Fishback, Haines and Kantor, 2007). Therefore, a more logical explanation to this puzzling result is that there are probably not enough observations in the subsample to draw any conclusion on the matter. Ruhm (2015) emphasizes that estimations using samples containing 5-year periods lack sufficient precision to determine whether the effect is real or reflects statistical noise, so investigations of macroeconomic variations in health outcomes and behaviors should with too short samples should be viewed with extreme caution. This subject is thus an interesting aspect to look at, when more data are available for the years following the economic crisis.

By applying the HP-filter to our data, we intended to de-trend the data and obtain the cyclical component. The results of our regression with the HP-filter were, however, inconclusive as both signs and the size of the estimated coefficients was rather sensitive to the chosen specification. As mentioned, one problem could be the use of annual data instead of, for instance quarterly data, which could unveil more information on the cyclical component. As our study was limited to the use of annual data, such a study was out of scope of our research. Using the HP-filter is however an interesting approach that could be further investigated in future studies.

When looking at age-specific mortality rates we found a significant negative effect for age groups 15-40 and 60-74. Concerning the first group, the estimated effect was rather expected since this is probably the group with the greatest labor market participation and therefore the ones most likely to be affected by an economic slowdown and rising unemployment. The other age group, however, consisting of the senior population is somewhat more surprising. As the majority of individuals in this group probably are retired and therefore not directly affected by labor market conditions cyclical fluctuations in mortality are not expected for this age group. However, external effects related to economic conditions are theorized to affect

the health of the non-working population as well as the working. Miller et al. (2009) argue that since retired people represent a large part of annual mortality rates, an individual's own labor market participation may not be the key mechanism behind procyclical fluctuations in total mortality rates. Instead, the authors conclude that, others factors reflecting business cycle externalities, such as transport accidents or other accidents, must also have an important role in explaining fluctuations in mortality rates. Furthermore, pollution from motor vehicles and industrial emissions has been shown to be associated with increases in rates of diseases and death (e.g. Gardner, 1973; Dockery et al., 1993). Since both industrial activity and transport are considered to be procyclical, it is plausible that also air pollution is procyclical. So, during economic slowdowns, air pollution is reduced which acts in a beneficial way for overall health in society and lowers mortality rates.

Concerning the cause-specific mortality rates we detected a significant procyclical pattern for fatalities due to transportation accidents, and homicide and assault. The result demonstrating a reduction in deaths from transportation accidents following an increase in unemployment is in line with previous research. Deaths due to traffic injuries are considered a major factor linking economic upturns with increasing mortality (Tapia-Granados, 2005). Business expansions are considered to increase both commercial and recreational driving, leading to a larger volume of traffic, which in turn implies a greater probability of crash and death. Hence, when the economy slows down and the unemployment increases, motor vehicle fatalities decrease.

The result for homicide and assault are somewhat more surprising as it contradicts most of the earlier findings on mortality and business cycles demonstrating a countercyclical pattern. Articles focusing on the relationship between crime and the business cycle have often found the association to be countercyclical mostly driven by the effect on robbery and burglary, while the effect on homicides has been found to be more ambiguous (Cook & Zarkin, 1985). South and Cohen (1985), argues that the level of unemployment and the annual change in unemployment might have different effect on homicide rates. They base their analysis on the opportunity/motivation framework (Cantor & Land, 1985). They find that the level of unemployment is negatively related to the homicide rate, i.e. high unemployment decreases homicide, since the unemployment level measures the opportunity for crimes such as homicide to occur. Given certain assumptions, high rates of unemployment reduce homicide rates because they remove individuals from transit locations where motivated offenders are apt to be present and capable guardians are likely to be absent (South & Cook, 1985:339).

However, going into further details on human behaviors and crime is out of scope for this thesis.

Unlike earlier research, we found a significant countercyclical relationship for fatalities due to influenza and pneumonia. This specific cause of death are most common among those whose defenses against disease are not operating well, including the very young, very old and those with underlying chronic disease (American Lung Association, 2008). Furthermore, poor lifestyle habits such as unhealthy diet, lack of sleep, low levels of physical exercise and increased levels of stress are known to suppress immune function. However, according to the time availability hypothesis, economic downturns and unemployment leads to more leisure-time that could be spent on health-improving activities (implying less stress, more sleep and exercise as well as healthier food preparation). On the other hand, the burden of unemployment could also imply increased stress and anxiety resulting from having to search and apply for new jobs as well as the potential resulting income loss, economic insecurity and financial difficulties.

Cornwell (2011) examined the relationship between state-level unemployment rate and influenza activity in the United States during the period 1990-2010. His results demonstrate that high rates of state-level unemployment increase the risk of both regional and widespread influenza activity during the following month. He mentions reduced access to health care and vaccination resulting from unemployment as a possible explanation for this relationship. He also connects his findings to previous research on the link between unemployment and influenza activity, which suggests that the relationship could partly be explained by the consequences of unemployment. For instance, Link and Phelan (1995) argues that broader labor market conditions can have an effect on both employed and unemployed individuals through increased stress and suppression of immune functions. This might be due to perceived job insecurity and fear of job loss among employed persons during periods of rising unemployment, as well as the associated stress for the ones that are unemployed.

For this specific cause of death, we are also aware of the possibility that the transition from ICD-9 to ICD-10 might have affected the estimations. Following the transition there was a change in the coding rules (Rule 3), and pneumonia is the cause of death considered to be most affected (Anderson et al., 2001). Anderson found the comparability ratio for influenza to be largely unaffected by the revision, while pneumonia had a ratio of 0.696. Pneumonia is

often the consequence of another condition or injury, and when pneumonia is listed on the death certificate together with another cause of death (with pneumonia obviously being a direct consequence of that other cause), the other cause is selected as the underlying cause of death. In ICD-10, this rule is applied more broadly than in ICD-9 and as a consequence deaths classified as pneumonia in ICD-9 are classified in ICD-10 to many other causes. With this in mind, the results for this specific cause of death should be interpreted with caution.

When looking at sex-specific mortality rates we found evidence demonstrating that males are somewhat more affected than women by economic downturns, as higher unemployment rates implies a significant lowering of mortality rates among men. This effect is in line with previous research (Gerdtham and Johannesson, 2005; Gerry et al., 2013), which shows that men are more vulnerable to economic downturns than women. Gerdtham and Johannesson (2005) argue that that males could be more sensitive to business cycle fluctuations if they are the primary "breadwinner" of the household. Consequently, males would have larger potential losses from being unemployed, as compared to females. Gerry et al. (2013) argue that another key explanation is that men are more likely to die from chronic conditions as compared to women suffering from the same condition. These conditions (including cardiovascular disease and various cancer diseases) are associated with lifestyle behavior such as smoking, which men are more likely to consume during bad times. Thus, the authors conclude that males are more vulnerable from the external shock that unemployment implies, both since their initial health status is worse but also since their lifestyle choices might worsen it even more. Furthermore, health inequalities by sex could also be explained by differences between men and women according to type of work and industrial sector of employment (Riva et al. 2011). For instance, men are more likely than women to work within the private sector and within sector vulnerable to macroeconomic conditions such as finance and business, manufacturing and construction (Office for National Statistics 2009).

However, in contrast to the previously mentioned studies, our research found that mortality rates among men decreases as unemployment increase. These results could be attributed to the fact that only transport accidents and homicides, which are not directly related to lifestyle behavior, had a significant effect in this study. As previously mentioned, Ruhm (2000) found motor vehicle fatalities to be the more sensitive to the business cycle than any other of the investigated mortality causes. If it is assumed that men are more likely to work within sectors

that are vulnerable to macroeconomic fluctuations, it is also reasonable to assume that driving patterns among men to a higher degree has a procyclical relationship with unemployment.

So why might recessionary conditions improve overall health in terms of total mortality? One scenario, seeking at reconciling the individual and population level evidence, states that at the individual level those that fall into unemployment during a recession might suffer worse health, but at the population level this effect can be more than compensated by improvements in the average health of the rest of the population (Suhrcke & Stuckle, 2012). However, as this study is based on population level data one should be careful drawing conclusion from the aggregate level to individual behavior. Additional investigation of individual level data could help explaining the underlying mechanisms for the results obtained in this thesis, which is left as a suggestion of topic for further research. However, the procyclical relationship between overall mortality and unemployment can largely be explained by a decrease in motor vehicle fatalities during economic downturns, resulting from individuals driving fewer miles. This estimated relationship has been found to be an important part of the decrease in overall death rates in several studies, and have also been found to have a substantial impact in our research. Other studies have also found procyclical associations between unemployment and lifestyle related causes of death, such as fatalities due to cardiovascular diseases and liver diseases (e.g. Ruhm, 2000; Gerdtham & Ruhm, 2006). For instance, Ruhm (2000) demonstrated that two risk factors related to these diseases, smoking and alcohol consumption, exhibits procyclical fluctuations. We did not, however, detect any consistent or significant association for these causes of death and are therefore unable to comment on the potential effect of these specific lifestyle behaviors on our results.

The number of deaths from specific mortality causes has demonstrated a downward trend over the sample. Economou et al. (2008) argue that it is plausible that technological changes and innovations have a large effect on life expectancy. One interesting approach would be to investigate how technological changes over time has affected mortality. Technological changes are however difficult to quantify at an aggregate level and would require an analysis at the hospital level or individual level. Such an analysis is out of scope of this research, however, it could yield some interesting information on how the procyclical relationship is affected by technological shocks and innovations.

Another external factor that would be interesting to look at is the national spending on health care. Gerdtham and Ruhm (2006) theorize that relative levels of social expenditures might have an effect on mortality rates, as a higher degree of social expenditures could reduce the harm of economic downturns. A country with weak social insurance systems, on the other hand, would have larger fluctuations in mortality levels. In this study we tried to include an additional specification, following Gerdtham and Ruhm (2006), by dividing the countries into groups according to their average public social expenditure, as a share of GDP, during the 1990-2012 sample period. We therefore divided the sample into two different specifications, one containing the countries with the lowest share of public social expenditure (Netherlands, Spain, Greece, Luxembourg, UK, Portugal and Ireland) and one containing the ones with the highest share (Sweden, France, Denmark, Finland, Austria, Belgium, Italy and Germany). The results from the regressions are listed in Table 13 in the appendix. The findings demonstrate a negative effect of unemployment on mortality for both specifications. Neither of the estimates is found to be significant, and we did not detect the same pattern as Gerdtham and Ruhm (2006). Furthermore, we also experimented with the GINI coefficient, but doing so resulted in inconclusive estimates.

This objective of this study has been to replicate the framework of Ruhm (2000) and to extend the existing research on the EU-15 with additional years. Although the framework is commonly used to analyze the relationship between mortality and unemployment, there are some limitations in our study. First and foremost, one aim with the study was to get some indication on the effect of the financial crisis. As previously mentioned, the crisis hit Europe around 2008/2009, but unemployment rates did not increase heavily until 2011/2012. Since labor markets are generally sticky, and tend to lag behind business cycles, it is possible that this study would require more years in order to get a more reliable estimate of the crisis. For future research it would be interesting to include more observations in order to get a better understanding of the health effects of the recent financial crisis. Furthermore, as our sample only contains high- and middle-income countries it would be interesting to look at a sample that includes low-income countries as well since it is likely that the aggregate health response to recessions in rich vs. poor countries will be different (Suhrcke & Stuckler, 2012).

7. Conclusion

Aggregate studies on the relationship between mortality rates and unemployment rates have found some evidence that increasing unemployment could decrease mortality rates. The aim of this study has been to replicate the study of Ruhm (2000) for the EU-15 countries and extend the existing literature with recent data and additional specifications. We have used panel data on mortality rates for the time-period 1990-2012, in which we have included specific mortality causes following the framework of Ruhm (2000). By doing so, we have intended to get some indication on how the financial crisis of 2008/2009 and the sovereign debt crisis in Europe have affected mortality rates. We have decomposed the data by sex and age in order to get a deeper understanding of the relationship between mortality and unemployment rates. We have also extended the research by introducing several new variables not used by Ruhm, such as the GDP growth rate, the capacity utilization rate and the HP-filter to de-trend the economic time series.

The first contribution of our study is that we find a significant procyclical relationship between unemployment and total mortality rates for the EU-15 countries. However, the estimated coefficient is smaller in magnitude compared to previous research. A second contribution is that we find that males in general are more positively affected by a rise in unemployment rates, as compared to females. Fluctuations in transport accidents have been hypothesized to be the basis of this positive effect. A third contribution is that we show that alternative business cycles, such as GDP growth, follow a similar pattern as unemployment rates. An increase in the GDP growth rate has been found to increase mortality rates.

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Appendix

Table 10: Transition from ICD-9 to ICD-10

Country	ICD-9	ICD-10
Austria	1980-2001	2002-2012
Belgium	1979-1997	1998-2012
Denmark	- [i]	1994-2012
Finland	1987-1995	1996-2012
France	1979-1999	2000-2011
Germany	1990-1997	1998-2012
Greece	1979-2011	-
Ireland	1979-2006	2007-2010
Italy	1979-2002	2003, 2006-2010
Luxembourg	1979-1997	1998-2012
Netherlands	1979-1995	1996-2012
Portugal	1980-2001	2002-2003, 2007-2012
Spain	1980-1998	1999-2012
Sweden	1987-1996	1997-2012
United Kingdom	1979-1999	2001-2012

Note: Information extracted from OECD Health Statistics 2014.
[i] Denmark used ICD-8 until 1994 when it changed to ICD-10.

Table 11: ICD-coding

	ICD-10 code	ICD-9 code
Malignant neoplasm	C00-C97	140-175, 179-208
Major cardiovascular diseases	I00-I99	390-459
Influenza and pneumonia	J10-J18	480-487
Chronic liver diseases, cirrhosis	K70, K73-K74	571
Transport accidents	V01-X59, Y85-Y86	E800-E848
Other accidents	X40-X49, W00-W20	E850-E869, E880-E888
Suicides and intentional self-harm	X60-X84, Y87.0	E950-E959
Homicides and assaults	X85-Y09, Y87.1	E960-E969
Infant deaths	-	-

Table 12: Descriptive statistics of sex-specific mortality rates

Variable	Mean	Std. Dev	Min	Max	Observations
Cause-specific mortality per 100 000 population					
Females					
Malignant Neoplasm	179.86	29.61	129.2	260.1	326
Major Cardiovascular diseases	331.54	95.45	133	536.8	326
Influenza/Pneumonia	27.46	20.29	3.8	100.6	326
Chronic liver diseases	7.75	3.59	2.4	17.7	326
Transport accidents	5.37	2.44	1.5	13.6	326
Other accidents	9.75	5.76	1.7	28.2	326
Suicides and intentional self-harm	6.31	3.14	0.7	15.9	326
Homicides and assaults	0.75	0.41	0	2.7	326
Males					
Malignant Neoplasm	312.92	40.93	224.1	409.8	326
Major Cardiovascular diseases	477.32	132.60	211.6	794.3	326
Influenza/Pneumonia	42.07	27.04	6.4	127.2	326
Chronic liver diseases	19.30	10.03	3.5	49.7	326
Transport accidents	17.57	8.25	4.9	49.8	326
Other accidents	16.52	10.34	3.9	56	326
Suicides and intentional self-harm	19.90	9.16	4.6	50.8	326
Homicides and assaults	1.55	0.84	0.3	4.9	326

Table 13: Econometric estimates for total mortality, as a function of public social expenditure as a share of GDP

	Specification			
	Lowest		Highest	
	(a)	(b)	(a)	(b)
Unemployment rate	-.0007	-.0002	-.0020	-.0021
	(.00130)	(.0020)	(.0021)	(.0019)
Natural log of income		.0722		-.0062
		(.1007)		(.0740)

Note: See note in Table 2. Countries are ranked according to their average public social expenditure, as a share of GDP, during the 1990–2012 period. The lowest category includes Netherlands, Spain, Greece, Luxembourg, UK, Portugal and Ireland. The highest category contains Sweden, France, Denmark, Finland, Austria, Belgium, Italy and German.