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ABSTRACT

Lives Saved during Economic Downturns: Evidence from Australia*

Worldwide, countries have been restricting work and social activities to counter an emerging public health crisis due to the coronavirus pandemic. These measures have caused dramatic increases in unemployment in the short run, with an expected deepening of the recession in the long run. Some commentators argue that the "draconian measures" will do more harm than good due to the economic contraction, despite a large literature that finds mortality rates decline during recessions. We estimate the relationship between unemployment, a widely accepted proxy for economic climate, and mortality in Australia, a country with universal health care. Using administrative time-series data on mortality that varies by state, age, sex, and cause of death collected for the years 1979-2017, we find no relationship between unemployment and mortality on average. However, we observe beneficial health effects in economic downturns for young men aged 25 to 34 associated with a reduction in vehicle transport accidents. Our estimates imply 425 fewer deaths if Reserve Bank of Australia expectations of a doubling of unemployment rates are realized by the end of 2020. For the early 1980s, we also find a procyclical pattern in the mortality rates of infants. However, this pattern disappears starting from the mid-1980s, coincident with the full implementation of universal health care in Australia in 1984. Our results suggest that universal health care may insulate individuals from the health effects of macroeconomic fluctuations. We conclude that the economic recession is an unlikely mediator for pandemic-related deaths in Australia.

JEL Classification: I12, E32, E24

Keywords: mortality, health, recessions, unemployment, macroeconomic conditions, Australia, COVID-19, pandemic, universal health care

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1. Introduction

The emergence of the novel coronavirus (Covid-19) has reinvigorated an international debate about the trade-offs between public health measures to contain viral pandemics and the economic costs that will emerge due to an impending economic crisis. Some predict the Great Lockdown to be as destructive as the Great Depression (Gopinath 2020). In April, the International Monetary Fund (IMF) forecast a three percent contraction of global output in 2020, with skyrocketing unemployment rates in OECD countries most affected by the Great Lockdown (IMF 2020). Among advanced economies that have been flagged as most likely to be strongly affected, are Australia, France, Germany, Italy, and the United States.

Australia is seemingly an outlier in this list of countries. Comparatively it has been only mildly affected by the virus as it spread through the continental Europe, Great Britain, and the United States, and then to many low-income countries. Some Australian commentators (see for example, ABC 2020 and Benson 2020) have emphasized that the lockdown measures are disproportionate relative to the virus infection rate and the economic harm they cause. The IMF has predicted a contraction in the Australian economy of 6.7 percentage points in terms of GDP by the end of 2020 (IMF 2020). The Reserve Bank of Australia has predicted a spike in the Australian unemployment rate to 10 percent, the highest rate since 1994 (RBA 2020).

As a consequence, critics have cautioned that the lockdown measures will exacerbate excess death statistics and macroeconomic conditions due to the associated economic crisis. In this paper, we seek to contribute to both the domestic and international debate by examining the relationship between macroeconomic conditions and mortality in Australia – a country with consistent universal health care coverage since 1984. We take advantage of administrative time-series data on cause-specific mortality between 1979 and 2017 that varies by state, sex, and age. We follow Stevens et al. (2015), building on the seminal work of Ruhm (2000, 2015), to estimate the impact of changes in the unemployment rate on the mortality rate.

Our paper contributes to a burgeoning international literature on the health benefits of economic downturns, which we review in detail in Section 2. Our estimation results are surprising. Overall, we find little evidence of a link between recessions and mortality. The only consistent finding is that periods of higher unemployment are associated with a lower number of vehicle accident deaths. For each percentage point (p.p.) increase in the unemployment rate, 70 lives are saved per annum. Most of these lives are saved among young men (aged 15-34).

Higher unemployment rates (weaker economic conditions) are also associated with lives saved at or shortly after birth. Every additional 1 p.p. increase in the unemployment rate is associated with almost ten female babies saved. However, this effect on babies disappears from the mid-1980s. A plausible explanation for this is that Australia's universal health care system, instituted in 1984, plays an important role in moderating the impact of fluctuating economic conditions on modifiable causes of death. We find no significant increase in suicide rates in response to rising unemployment. This finding stands in contrast to findings from the US but is in line with many studies based on European or Asia-Pacific countries. This is also an important result in light of recent suggestions of a spike in suicides (Benson 2020) due to the coronavirus lockdown, although our findings on mortality certainly do not preclude an impact on wellbeing or mental health from the recession or from the lockdown itself.

The evidence from the past four decades suggests that in Australia, economic downturns have very little impact on mortality, except to reduce vehicle transport deaths. Nevertheless, we do not dispute that the pandemic itself and the lockdown, both the economic and health impacts alike, are likely to have a significant impact on individual and household welfare. Our findings allow us to propose an estimate for the likely impact of the recession caused by the Great Lockdown on mortality. If unemployment rates rise from the February 2020 (pre-lockdown) rate of 5.1 percent to 10 percent as predicted by the Reserve Bank of Australia, we expect almost 425 fewer deaths due to vehicle transport deaths.

2. Literature review

Early work by Christopher Ruhm explored the possibility that macroeconomic downturns have positive consequences on the health of a nation (Ruhm 2000). In the literature this relationship is described as procyclical mortality, as death rates are higher in periods of economic growth and lower in recessions or times with higher rates of unemployment. The argument was that even though economic downturns usually come with financial hardship, they leave people with more time to seek medical treatment, to socialise and care for their relatives, and to engage in healthier lifestyles. People are also expected to have fewer accidents, because they spend fewer hours in cars and are less likely to be exposed to hazardous workplaces if unemployed. Thus, at the aggregate level, unemployment could be associated with better mental and physical health, and thus lower mortality rates.

Although a controversial hypothesis[1], the evidence base from a broad range of countries (US, Canada, Mexico, Germany) and regions (OECD, Asia-Pacific) is overwhelmingly in favour of the suggestion that in times of higher unemployment, the aggregate number of deaths falls (see for example, Ruhm 2000, Gerdtham & Ruhm 2006, Miller et al. 2009, Ariizumi & Schirle 2012, Lin 2009, Neumayer 2004, Gonzalez & Quast 2011[2]). The estimated associations are not dramatically large, but they indicate that for every 1 percentage point (1 p.p.) increase in unemployment, mortality rates decline by around 0.5 percent in the US (Ruhm 2000, Gerdtham & Ruhm 2006, Miller et al. 2009). The estimates range from 0.4 percent on average using a sample of OECD countries (Gerdtham & Ruhm 2006) and 1.1 percent in Germany (Neumayer 2004) and the Asia-Pacific (Lin 2009).

While it is widely shown that lives are saved during downturns, some argue that economic downturns also lead to more deaths by suicide. In some countries, suicide rates indeed seem to increase during economic downturns, with significant countercyclical evidence. Estimates range from increases of between 0.5-1.9 percent in suicides among the working age population for each 1 p.p. rise in the unemployment rate in the US (Ruhm 2000, Miller et al. 2009, Stevens et al. 2015) and some European countries (Breuer 2015). Nevertheless, many other studies find no significant effects, for instance in Asia-Pacific

[1] Analysis of microdata usually finds that individuals who are laid off are more unhappy, have worse mental health (Cygan-Rehm, Kuehnle & Oberfichtner 2017) and are more likely to develop physical health problems (Schmitz 2011). Sullivan & von Wachter (2009) estimate that the probability of death after job loss is 10-15% higher for relatively young, male workers who were displaced from their jobs at a young age. Although contradicting the previous literature, this study is based on workers with a great deal of job security in Pennsylvania. This paper also concedes that an additional three months of non-employment through sick leave or temporary layoff reduces mortality by 9%, under the assumption that income and income variability were held constant, stating the effect is, "perhaps, consistent with the finding of Ruhm (2000)" (p. 1281). Coile et al. (2014) suggest that any short-term gains in health due to unemployment are likely to be offset by long-term health deteriorations.

[2] Note, Gonzalez & Quast (2011) identify macroeconomic downturns as changes in GDP, and not as changes in unemployment. For this reason, the magnitude of the estimated effects cannot be compared to the other studies. The study finds that for a 1000 peso increase in state GDP per capita, mortality increases by 1-2 percent depending on the specification. The effects are strongest for 20-49 years olds. There is no effect for infants, 50-64, and 65 plus year olds. Effects are significant for cancer (0.8 percent), vehicle accidents (3.5 percent), suicide (6.8 percent) and homicide (4.7 percent).

countries (Lin 2009), France (Brüning & Thuilliez 2019) and the OECD countries overall (Gerdtham & Ruhm 2006). Germany is the only country where suicide mortality is significantly procyclical (Neumayer 2004).

Another point of contention is whether economic downturns have beneficial effects on causes of mortality associated with stress and sedentary lifestyles. Ruhm (2000) reasoned in his early work that downturns come hand-in-hand with reductions in stress and adoption of healthy lifestyles because time resources become more abundant. Furthermore, downturns imply that people spend less time in cars commuting. These channels should lead to a reduction in deaths from non-communicable diseases such as heart attack, diabetes, or cancer, and from car accidents. Indeed, lower mortality rates during economic downturns are most consistently explained across studies and jurisdictions by reductions in vehicle accidents. The number of deaths by vehicle accidents is reduced by around 2-3 percent for every 1 p.p. increase in unemployment (Ruhm 2000, Neumayer 2004, Gerdtham & Ruhm 2006, Lin 2009, Ariizumi & Schirle 2012, Brüning & Thuilliez 2019).

Empirical evidence also shows that mortality due to cardiovascular disease is procyclical, that is, it declines during economic downturns (Ruhm 2000, Gerdtham & Ruhm 2006, Miller et al. 2009, Brüning & Thuilliez 2019, Neumayer 2004, Lin 2009). This is consistent with the hypothesis of a behavioural lifestyle channel through which unemployment affects mortality. Only one study finds no significant relationship (Ruhm 2015).

However, no consistent evidence is found for deaths by cancer. Ruhm (2000) explains that a zero finding is consistent with patterns of disease progression: "it would be surprising to observe significant variation in cancer fatalities, since deaths from this source are unlikely to respond much to short term changes in medical care or lifestyles. The lack of any effect for cancer therefore serves as an internal check of the validity of the results" (p. 632). In his later work, he finds in fact that cancer mortality increases with unemployment rises (Ruhm 2015). One explanation is that in more recent years the cost of cancer treatment has risen dramatically. Weak economic conditions may constrain access to such treatment, an argument also made by Maruthappu et al (2016).

Despite this strong evidence, some argue that the channels outlined by Ruhm (2000) to explain the procyclical nature of mortality cannot be right. Miller et al. (2009) caution that in times of high unemployment, most of the averted deaths due to cardiovascular disease are observed for the very old and retired. For this age group, the opportunity costs of exercise are low, and unemployment does not change everyday life. They argue that it is "external" factors, rather than changes in behaviour by job losers that drive the association. Stevens et al. (2015) demonstrate that the higher number of deaths in the United States during boom phases emerges from a higher number of female deaths, that occur mainly in nursing homes. They find evidence that staffing quality in nursing homes is countercyclical. Coile et al. (2014) find for older workers in the United States affected by a recession just before retirement, health temporarily improves, but these health benefits are more than offset by long-term health costs. Importantly, they find no impact of a recession on the health of workers who were eligible for Medicare, which is universal health care for the elderly. This suggests that universal health care may buffer against business-cycle exposures, because access to health is maintained irrespective of economic climate.

Finally, the literature remains divided over whether men and women are affected differently by economic downturns. For instance, Ruhm (2000) and Ruhm (2015) find no sex differences in the mortality effects of higher unemployment rates. In contrast, Stevens et al. (2015) find that women are more affected than men: while older men (62 years and older) have a semi-elasticity of -0.19%, women have one of almost -0.4% at 62 years and older and -0.2% at 45-61 years of age. Men and women are likely to be differently affected because of differences by gender in labour supply and in the response to economic conditions as proxied by unemployment rates.

In this study, we contribute to the international literature in three important ways. We are the first to produce an estimate of the link between economic downturns and mortality for Australia, a rich OECD country with universal health care and a relatively generous social safety net. Second, we analyse data over almost 40 years (1979-2017), which allows us to separately explore the relationship before and after universal health care was introduced. Third, we have not only state, age-, and cause-specific mortality rates, but also sex-specific mortality rates. Thus, we can assess whether mortality rates of men respond differently to economic downturns than mortality rates for women.

3. Empirical framework

Our empirical specification follows the prior literature (Ruhm 2000, Ruhm 2015, and Stevens et al. 2015).[3] Our main regression takes the following form:

$$M_{jt} = \alpha_t + \mathbf{X_{jt}}\gamma + U_{jt}\beta + S_j + S_j t + \varepsilon_{jt}$$

where M_{jt} is the natural log of the age-adjusted mortality rate in state j and year t and U_{jt} is the state-specific unemployment rate in year t which proxies for economic conditions. $\mathbf{X_{jt}}$ is a vector of state and time varying demographic controls including the fraction of population who are less than 5 years old, 5 to 24 years old, 25 to 54 years old, greater than 65 years old, university graduates and Australian born individuals. The fixed effect S_j controls for time-invariant state characteristics, α_t accounts for Australia-wide year effects, and state-specific time trends $(S_j t)$ are included. The estimate of the coefficient β captures the impact of within-state deviations in the unemployment rate after accounting for nation-wide yearly changes and state trends.

We also estimate the model for each age group separately. This allows all coefficients in the model, including state and year fixed effects coefficients, to vary for each age group. We then provide sex-specific estimates for each age group. To explore the plausible mechanisms driving the main findings, we then investigate mortality by cause. In these regressions our dependent variable is the log of the age-adjusted mortality rate for a specific cause in state j and year t. In all regressions, we weight observations by the number of individuals in the age group and state and cluster standard errors at the state level to account for serial correlation of the error term. Recognizing problems associated with having few clusters (eight states and territories), we report corrected 95 percent confidence intervals and p-values using the wild cluster bootstrap approach (Cameron & Miller 2015).[4]

[3] An alternative strategy is to use age-specific intercepts in the mortality equation and estimate an empirical model as in Ariizumi & Schirle (2012). We have done this as well and our results remain qualitatively unchanged and are available upon request.
[4] We used the command "boottest" available in STATA (Roodman et al. 2019). Note that the wild cluster bootstrap does not assume normality and therefore does not calculate standard errors.

4. Data

Our age- and sex-specific state-year mortality rates are based on death counts data provided by Australian Institute of Health and Welfare (AIHW). Deaths are counted according to year of occurrence of death.[5] State-by-age-by-sex-by-year population counts are sourced from demographic statistics provided by the Australian Bureau of Statistics (ABS 2020a). The data covers the period from 1979 to 2017. We use information for ten age groups (0-4; 4-15; 15-24; 25-34; 35-44; 45-54; 55-64; 65-74; 75-84; 85+), by the underlying cause of death (12 groups constructed from ICD-9 and ICD-10 codes, see Anderson et al. 2001). Data were obtained by special agreement with the AIHW. We age-adjust these data to create a measure of the mortality rate that holds the age distribution constant over time (benchmarked against 1998). Figure 1 plots our age-adjusted and unadjusted mortality rates over time. In 1979, almost 1 percent of the population died each year. By 2017, this rate halved to almost 0.5 percent. The importance of the age adjustment is evident; because the Australian population is aging, the unadjusted series appears to be relatively flat, while the age-adjusted series shows declining mortality over time.

[Fig 1 about here]

Figure 2 illustrates the variation in age-adjusted mortality rates by states/territories and time. The ranking of each state's age-adjusted mortality rates relative to the other states is stable across years. For example, the highest rate belongs to South Australia (SA) and Tasmania (TA) in all years, in part reflecting that they have the oldest populations (approximately 600 deaths per 100,000 people in 2017). The smallest territories, which have the youngest populations, the Northern Territory (NT) and Australian Capital Territory (ACT), have the lowest age-adjusted mortality rates (fewer than 400 deaths per 100,000 in 2017).

[Fig 2 about here]

The most common causes of deaths are cancer (28 percent) and heart disease (19 percent) (Table A1, Online Appendix). There is a slightly larger number of deaths for men, reflecting

[5] This is an alternative to using the count of deaths in year of the "registration of death" as the numerator. We prefer using the year of the occurrence of the death as the registration based data is subject to the problem that a proportion of deaths that occur in a given calendar year might be registered in the subsequent year (e.g. coronial deaths or deaths which occur in December may not be registered until the following year). As a robustness check we have confirmed our estimates using deaths based on "registration of death" in the numerator of our mortality calculations. The results are similar and available from the authors.

their lower life expectancy. Overall, men and women have comparable risks of dying from most diseases with three important exceptions. Men are twice as likely to die from liver cirrhosis and three times more likely to die either by suicide or from vehicle/transport accidents. Women are almost twice as likely to die from dementia.

Unemployment rates are drawn from the Labour Force Survey monthly estimates (ABS 2020b) and represent the percentage of the labour force over the age of 15 that is unemployed. Naturally, there is both temporal and spatial variation in unemployment rates. Unemployment was generally relatively low at the end of the 1970s and during the 2010s at approximately 6 percent, and relatively high in the mid-1980s and 1990s (greater than 10 percent). Australia was not strongly affected by the Global Financial Crisis (GFC) in 2008. While a general national trend in unemployment rates over the business cycle is apparent in Figure 3, the business cycle does not affect all states uniformly. For example, the unemployment rate is often larger in Western Australia (WA), a state with a high concentration of mining activity, and recessions have larger effects on this state. At the same time, WA was not impacted significantly by the GFC in 2008.

[Fig 3 about here]

The residual variation in state-year unemployment rates after controlling for state fixed effects, state trends and demographic variables is 0.11.[6] This value is 0.14 in the first half (1979-1998) and 0.10 in the second half of the sample (1999-2017). Ruhm (2015) reported this value to be 0.09 for the US for the period 1999 to 2010. This shows that the unemployment rate, although not perfect, is a good proxy for macroeconomic conditions in Australia, just as in the United States. We conduct further robustness checks using alternative measures of economic conditions[7], however we focus our attention on results using the unemployment rate for consistency and ease of comparison with the literature.

[6] This is one minus the R-squared from regressing the state unemployment rates on state and year dummy variables, state-specific time trends, and our preferred set of controls.

[7] We find similar results when using the employment rate rather than the unemployment rate as our measure of economic conditions. These results are available from the authors on request.

5. Results

5.1 Are lives saved during economic downturns on average?

Table 1 presents the estimation results for a pooled sample and separately by sex and by broad age groups. Overall, we find no effect of unemployment on all-cause mortality (column (1)). A 1 p.p. increase in the unemployment rate is associated with a zero impact on mortality (-0.02 percent and statistically insignificant). The effect is likewise statistically insignificant when estimated separately for men and women.

In columns (2) to (4) we present the results estimated separately for broad age groups. We observe that mortality is procyclical for the youngest age group (0-24 years) in the pooled sample (-1.8 percent, p-value<0.05) and for men (-1.9 percent, p<0.10) and women (-1.5, p-value<0.10) separately. Hence, there are fewer deaths in times of economic growth for the young. For those 25-64 years and 65 years of age and older, we do not observe any significant relationship.

[Table 1 about here]

Figure 4 summarizes the coefficient estimates and 95 percent confidence intervals separately by sex using narrower age-group definitions (5-year intervals) to identify where in the age distribution lives are saved during recessions (see Table A2, Online Appendix for full estimation results). Here, we observe significant procyclical mortality for men aged 25-34 years. In this age bracket, the estimates range from a decline of 2.5 percent (p-value<0.05) in mortality for men aged 20-24 for a 1 p.p. increase in the unemployment rate to a fall of 4.8 percent (p-value<0.05) for men aged 30-34. We find no statistically significant effects for women, although the estimate for late adolescent women (ages 15-19) is large in magnitude (-4.8 percent, p-value<0.15). Thus, the procyclical mortality found for the 0-24 year old age group is driven by young men aged 20-24 years. This negative effect of unemployment on the mortality rate continues through into the mid-40s age group although it is insignificant. Estimates for older age groups oscillate around zero.

[Fig 4 about here]

Our findings based on Australian data are partially in line with the findings presented in Ruhm (2000), Ruhm (2015) for data before 2000, and Stevens et al. (2015) in the institutional context of the United States, where no universal health care exists. For instance, Ruhm (2000) finds significant procyclicality in mortality for 20-44 year olds (-1.9 percent), and similar to us, no effect for middle-aged or older groups. Stevens et al. (2015) also finds significant procyclicality for 15-29 year old men (and 15-24 year old women), which range in magnitudes between -1.1 and -1.8 percent. Like Stevens et al. (2015), we also find stronger impacts of unemployment on mortality for men than for women.

Since the labour supply of young workers is more sensitive to the business cycle (Evans, Moore & Rees 2018), we might interpret the improvements in mortality during economic downturns as evidence in favour of the improved lifestyle hypothesis. Yet, when we consider cause of death below, the likely source of this finding is the moderating impact of weaker economic conditions on the number of deaths due to traffic accidents.

Another important difference between the US and Australian experience, and where our findings differ from those of Stevens et al. (2015), is that we do not find any impacts on the mortality rates of very young children (0-4 years) and very old adults (65-84 years). Significant reductions in mortality during recessions in these age groups are interpreted by Stevens et al. (2015) as evidence against the lifestyle hypothesis and in favour of an alternative interpretation. Quality of health care in the United States, as Stevens and co-authors argue, relies on the quality of workers that can be hired for hospitals and nursing homes. In countries with universal health care, health care quality may be less affected by business cycle variations because public funding is consistently provided. Thus, universal health care in Australia may play a protective role, serving to insulate the health and wellbeing of groups that are not *directly* affected by fluctuations in the labour market, from variability in economic conditions. A similar point is made by Ariizumi & Schirle (2012) who also find no impact of business cycle variations on the mortality of the very young and older age groups in Canada, a country with a similar health care system to Australia. Gerdtham and Ruhm (2006) show that among OECD countries, those with stronger social insurance systems have weaker procyclicality of mortality.

5.2. Are lives saved from specific causes of deaths during economic downturns?

In Table 2, we examine cause-specific mortality rates to assess whether our findings above are driven by deaths from a particular cause. We find no statistically significant effects of unemployment on any of the causes of deaths, with two important exceptions. First, higher unemployment is associated with fewer vehicle accident (road) deaths. An increase in the unemployment rate by 1 p.p. is significantly associated with a 6 percent decrease in transport accidents (p-value<0.05). This effect is twice as large as found in the international literature and translates into 88 fewer deaths per annum. The number of lives saved are five time larger for men (73 fewer deaths) than for women (15 fewer deaths). This effect is also stronger for the working age population (Table A3, Online Appendix[8]) and consistent with the age effects for men aged 25-34 shown in Figure 4 above.

Procyclicality of road accident mortality has been consistently documented in the US and in other countries. We might expect similarities between Australia and the US within the working age population, as deaths due to motor vehicle accidents are not likely affected by access to health care but rather appear to be a by-product of the level of economic activity and commuting between home and the workplace.

[TABLE 2 about here]

Second, higher unemployment rates save lives at birth, but only for female babies. For female babies, mortality is reduced by 4 percent (p-value<0.05) for a 1 p.p. increase in the unemployment rate. This reduction translates into ten fewer deaths per year. Although this result is in line with the US findings, it is surprising to observe it in Australia. With universal access to pre- and postnatal care, one would not expect infant and neonatal mortality to respond to economic fluctuations. A period of higher unemployment will however increase mothers' available time for self- and baby-care, which should improve health outcomes of newborns (Dehejia & Lleras-Muney 2004). What is surprising is that we find that only female baby lives are saved during economic downturns. Baby girls are generally more robust and better able to survive harsh conditions than baby boys (see for example, Drevenstedt et al. 2008 and Zarulli et al. 2018). We provide further discussion of this finding below.

In contrast to Stevens et al. (2015), we do not find a significant relationship between unemployment and mortality due to suicide, heart disease, respiratory deaths,

[8] The data by age and cause are not available at the single age year or 5-year age group level of disaggregation due to small cell sizes. Thus, we consider broader age groups in our analysis by cause of death and age.

cerebrovascular disease, pneumonia or influenza. We find a small, albeit weakly significant effect on diabetes, which we also discuss in the next section.

5.2 Robustness checks

5.2.1 Sample periods

Lam & Piérard (2017) and Ruhm (2015) highlight the possibility that the estimated coefficients may change over time. We therefore test for the sensitivity of estimated coefficients to the chosen sample periods. In Figure 5 (Panel 1), we show the impact of unemployment when varying the starting year from which the time series is drawn. This means that the sample period always ends in 2017 but the starting date varies from 1979 to 1999.[9] There are four separate graphs: all-cause mortality (A1), diabetes (B1), transport accidents (C1) and for perinatal conditions (D1) for the sub-sample of baby girls. The second panel (A2, B2, C2 and D2) shows the association with the unemployment rate using 20-year rolling sample windows beginning in the specified year.

First, for all-cause mortality, the results show that our benchmark finding of a zero average effect of unemployment on mortality is not sensitive to the sample period chosen (Panels A1 and A2). Second, the procyclicality of deaths due to transport accidents (C1 and C2) is not sensitive to the time period chosen – transport accidents are more frequent in periods with better macroeconomic conditions. Third, our finding that unemployment increases diabetes-related mortality is entirely driven by the early years of our sample. Panel B1 shows that the positive association is statistically significant before 1985, but no longer statistically significant when excluding these earlier observations. Finally, the negative association between unemployment rates and perinatal mortality is also driven by observations before 1985 (Panels D1 and D2).

It is important to note that Australia's universal health care system (better known as Medicare) was instituted in February 1984.[10] Commentators have noted that in the period

[9] In Figure A1 in the Online Appendix, we also vary the sample period by adjusting the ending year of the sample. The sample always starts 1979 but the final year varies from 1999 to 2017.

[10] Between 1979 and 1984, bulk billing (direct billing to the government not the patient) of visits to a general practitioner was restricted to holders of health care cards. From 1981 to 1984, free hospital and medical care was only provided to pensioners with health care cards, sickness benefit recipients and others meeting strict means tests (Biggs 2004).

from 1979 to 1984, hospital and medical expenses could often lead to bankruptcy (Hermant 2019). Thus, we interpret our findings on diabetes and perinatal care, as well as our main result of no effect of macroeconomic conditions on mortality for young children (0-4 years) and seniors 65 years and older, as suggestive evidence that universal health care plays a protective role for the health of a nation in times of economic downturns.

Diabetes-related mortality is higher in recessions in Australia only in the period with no universal health care, suggesting that at that time, recessions constrained household budgets and thus access to the necessary medical care. In contrast, mortality due to perinatal conditions is lower in recessions in Australia, but again only in the period without universal health care. We suggest a plausible argument for this result is that first, perinatal conditions are susceptible to time investments by parents and especially mothers, and parents will be less time constrained in periods of higher unemployment. Second, as we only find an impact in the pre-Medicare era, the effect of mothers' additional time on mortality is only significant in the absence of universal health care.[11]

Following the introduction of universal health care, the only significant impact that economic downturns have on mortality is through reduced transport accidents (Panels C1 and C2). We observe that the estimated fall in motor vehicle deaths is larger when more recent data is used (for example, starting the sample in 1995). Between 1979 and 1995, the effect size is an approximate 5 percent decline in mortality for each 1 p.p. increase in the unemployment rate. From 1995 onwards, the effect size is larger. This finding is consistent with increased traffic congestion and commuting times, associated with overcrowding in cities due to increases in net migration.[12]

[Fig 5 about here]

[11] There is a third channel suggested by Stevens et al (2015). In their US study, mortality in adults 65 years and over is higher in times with strong economic conditions and this is driven by variation in the quality of carers in nursing homes, with the quality of care being lower in strong economic conditions and tight labour markets. This mechanism could have a role here also in explaining the results in the pre-Medicare era in Australia, but we suspect this channel is less likely to play a role for perinatal conditions as nurses employed in perinatal care settings tend to be highly skilled and unlikely to change in quality significantly over the business cycle.

[12] Australia's population grew by 37.4 percent between 1995 and 2017 from 17.9 million to over 24.6 million people, and only by 24.3 percent between 1979 and 1995 from 14.4 million to 17.9 million.

5.2.2. Model specification

One final concern arises due to the nature of the data. In our main specifications we use the natural log of age-adjusted deaths. This transformation will drop observations where the number of deaths is zero and is more likely to be problematic in our analysis of disease-specific mortality. In a robustness check, we use the non-transformed mortality rate as the dependent variable and estimate the model with a Poisson pseudo-maximum likelihood (PPML) model. While there are some small differences in the coefficient estimates, our results are robust to using this alternative specification (Table A4, Online Appendix).

6. Conclusion

Our main results show no significant relationship between all-cause mortality and macroeconomic conditions. This stands in contrast to studies in other countries where mortality is procyclical, that is, where mortality rates increase in times of good macroeconomic conditions. For example, a 1 p.p. increase in unemployment is associated by a reduction in mortality by -1.4% in Asia-Pacific countries, -1.1% in Germany, -0.5% in the United States, -0.4% in OECD countries and Canada, -0.1% in Spain and -0.07% in France (see Drydakis 2016 for a review). In Australia, our estimates are close to zero in magnitude and not statistically significant.

Consistent with the literature is our finding that mortality is reduced for young men, driven by fewer fatalities in motor vehicle accidents, when macroeconomic conditions are weaker. Our estimates are twice as large as commonly found in the international literature (about 6 percent versus 3 percent). This relationship has become particularly strong in the past 20 years, when population growth was fastest, and city life became more congested.

It is positive to note that universal health care appears to act as a buffer against the influence of fluctuations in macroeconomic conditions on health outcomes and mortality. Our finding that diabetes-related mortality increased during economic downturns is entirely explained by data points measured before Medicare, Australia’s public health care system, was introduced. Similarly, the baby lives saved during economic downturns are also exclusively explained by pre-Medicare periods. Moreover, in contrast to findings from US studies, our results do not reveal any significant effect of macroeconomic conditions on mortality for seniors or young children. As discussed by Stevens et al. (2015), these age groups have no or low labour market attachment and hence the impact of macroeconomic conditions must be indirect. The effect of economic downturns may instead affect these groups either through time allocation (mothers spend more time on their child's health) or through the quality of the health care they receive (higher quality staff and nurses are employed in nursing homes). It is plausible that in countries with universal health care such as Australia, these beneficial effects of recession are muted.

Importantly, in light of recent suggestions of a spike in suicides (Benson 2020) due to the coronavirus lockdown, we find no significant increase in suicide rates in response to rising unemployment and weaker economic conditions. This finding stands in contrast to findings from the US, but in line with many studies based on data from European or Asia-Pacific countries. We would thus predict that any additional deaths by suicide observed in Australia following the Covid-19 pandemic would be related to lockdown measures rather than due to economic insecurity per se.

Our findings allow us to propose an estimate for the likely impact of the recession associated with the pandemic and the Great Lockdown on mortality. If unemployment rates rise from the February 2020 rate of 5.1 percent to 10 percent as predicted by the Reserve Bank of Australia, we would expect almost 425 fewer deaths due to vehicle transport accidents. This reduction in the number of deaths is equivalent to approximately 30 percent of all transport accidents in 2017.

References

Anderson, R. N., Mininõ, A. M., Hoyert, D. L., & Rosenberg, H. M. (2001). Comparability of cause of death between ICD-9 and ICD-10: Preliminary estimates (National Vital Statistics Reports, No. 49/2). Hyattsville, MD: National Center for Health Statistics

Ariizumi, H. & Schirle, T. (2012) Are recessions really good for your health? Evidence from Canada. Social Science & Medicine, 74(8):1224-1231.

Australian Broadcasting Corporation (ABC), 2020. 'Extreme' COVID-19 epidemic better than lockdown argues economist, but others strongly disagree. [Online] Available at: https://www.abc.net.au/news/2020-04-20/economists-warn-against-early-lifting-of-coronavirus-lockdown/12165934 [Accessed 07/09/2020].

Australian Bureau of Statistics (ABS) (2020a), Australian Demographic Statistics, Catalogue No. 3101.0. [Online] Available at: https://www.abs.gov.au/ausstats/abs@.nsf/mf/3101.0 [Accessed 29/07/2020]

Australian Bureau of Statistics (ABS) (2020b), Labour Force Australia, Catalogue No. 6202.0. [Online] Available at: https://www.abs.gov.au/ausstats/abs@.nsf/mf/6202.0 [Accessed 29/07/2020]

Benson, S. (2020) Coronavirus Australia: suicide's toll far higher than virus. The Australian. [Online] Available at: https://www.theaustralian.com.au/nation/suicides-toll-far-higher-than-coronavirus/news-story/25a686904b67bdedbdcd544b1cab7f96 [Accessed 05/07/2020]

Biggs, A. (2004) Medicare – Background Brief, *Australian Parliamentary e-Brief*, [Online] Available at: https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/Publications_Archive/archive/medicare [Accessed 09/09/2020]

Breuer, C. (2015) Unemployment and Suicide Mortality: Evidence from Regional Panel Data in Europe. *Health Economics*, 24:936-950.

Brüning, M. & Thuilliez, J. (2019) Mortality and Macroeconomic Conditions: What can we learn from France? *Demography*, 56(5):1747–1764.

Cameron, A.C. & Miller, D. (2015) A Practitioner's Guide to Cluster-Robust Inference. *Journal of Human Resources*, 50(2):317-372.

Coile, C.C., Levine, P.B. & McKnight, R. (2014) Recessions, Older Workers, and Longevity: How Long Are Recessions Good for Your Health? *American Economic Journal: Economic Policy*, 6(3):92-119.

Cygan-Rehm, K., Kuehnle, D., & Oberfichtner, M. (2017) Bounding the causal effect of unemployment on mental health: Nonparametric evidence from four countries. *Health Economics*. 26:1844– 1861.

Dehejia, R., & Lleras-Muney, A. (2004). Booms, busts, and babies' health. *The Quarterly Journal of Economics*, 119(3):1091-1130.

Drevenstedt, G.L., Crimmins, E.M., Vasunilashorn, S. & Finch, C.E. (2008) The rise and fall of excess male infant mortality. Proceedings of the National Academy of Sciences, April 2008, 105(13):5016-5021.

Drydakis, N. (2016) The relationship between recessions and health. IZA World of Labor, Vol.283.

Evans, R., Moore, A. & Rees, D. (2018) The Cyclical Behaviour of Labour Force Participation. *Reserve Bank of Australia Bulletin,* Sept 2018:1-21.

Gerdtham, U.G. & Ruhm, C. J. (2006) Deaths rise in good economic times: Evidence from the OECD. *Economics and Human Biology*, 4(3):298–316.

Gonzalez, F. & Quast, T. (2011) Macroeconomic changes and mortality in Mexico. *Empirical Economics*, 40:305–319.

Gopinath, G., 2020. The Great Lockdown: Worst Economic Downturn Since the Great Depression. *IMF Blog*. [Online] Available at: https://blogs.imf.org/2020/04/14/the-great-lockdown-worst-economic-downturn-since-the-great-depression/ [Accessed 04/08/2020].

Hermant, N. (2019) Before Bob Hawke's Medicare, a visit to the hospital forced many Australians into bankruptcy, ABS News. [Online] Available at https://www.abc.net.au/news/2019-05-18/bob-hawke-what-did-australia-have-before-medicare/11124180 [Accessed 14/09/2020]

International Monetary Fund (IMF) (2020) *World Economic Outlook - The Great Lockdown*, Washington, D.C.: International Monetary Fund.

Lam, J.-P. & Piérard, E. (2017) The time-varying relationship between mortality and business cycles in the USA. *Health Economics*, 26(2):164–183.

Lin, S.-J. (2009) Economic fluctuations and health outcome: a panel analysis of Asia-Pacific countries. *Applied Economics*, 41(4):519-530.

Maruthappu, M., Watkins, J., Noor, A.M., Williams, C., Ali, R., Sullivan, R., Zeltner, T., & Atun, R. (2016) Economic downturns, universal health coverage, and cancer mortality in high-income and middle-income countries, 1990–2010: a longitudinal analysis. *The Lancet*, 388(10045):684-695.

Miller, D.L., Page, M.E., Stevens, A.H. & Filipski, M. (2009) Why Are Recessions Good for Your Health? *The American Economic Review Papers & Proceedings*, 99(2):122-127.

Neumayer, E. (2004) Recessions lower (some) mortality rates: evidence from Germany. *Social Science & Medicine*, 58(6):1037–1047.

Reserve Bank of Australia (RBA) (2020) *Statement on Monetary Policy* – May 2020. [Online] Available at: https://www.rba.gov.au/publications/smp/2020/may/ [Accessed 04/08/2020].

Roodman D., Nielsen M.Ø., MacKinnon J.G. & Webb M.D. (2019) Fast and wild: Bootstrap inference in Stata using boottest. *The Stata Journal*, 2019;19(1):4-60

Ruhm, C. J. (2000) Are recessions good for your health? *Quarterly Journal of Economics*, 115(2):617–650.

Ruhm, C. J. (2015) Recessions, healthy no more? *Journal of Health Economics*, 42(July):17-28.

Schmitz, H. (2011) Why are the unemployed in worse health? The causal effect of unemployment on health. *Labour Economics*, 18(1):71-78.

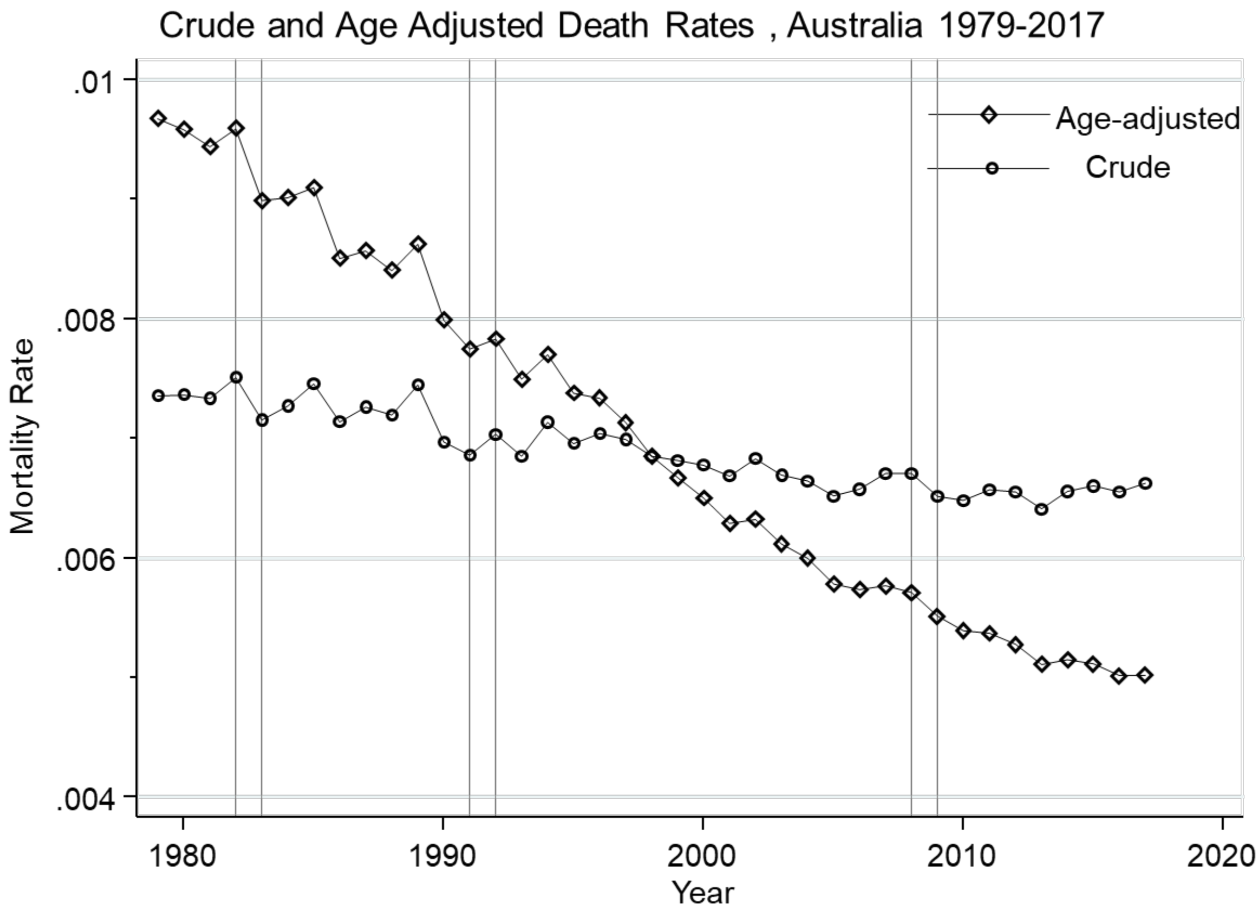
Stevens, A.H., Miller, D.L., Page, M.E. & Filipski, M. (2015) The Best of Times, the Worst of Times: Understanding Pro-cyclical Mortality. *American Economic Journal: Economic Policy*, 7(4):279–311.

Sullivan, D. & von Wachter, T. (2009) Job Displacement and Mortality: An Analysis Using Administrative Data. *The Quarterly Journal of Economics*, 124(3):1265-1306.

Zarulli, V., Barthold Jones, J.A., Oksuzyan, A., Lindahl-Jacobsen, R., Christensen, K. & Vaupel, J.W. (2018) Women live longer than men even during crises. *Proceedings of the National Academy of Sciences* Jan 2018, 115(4):E832-E840.

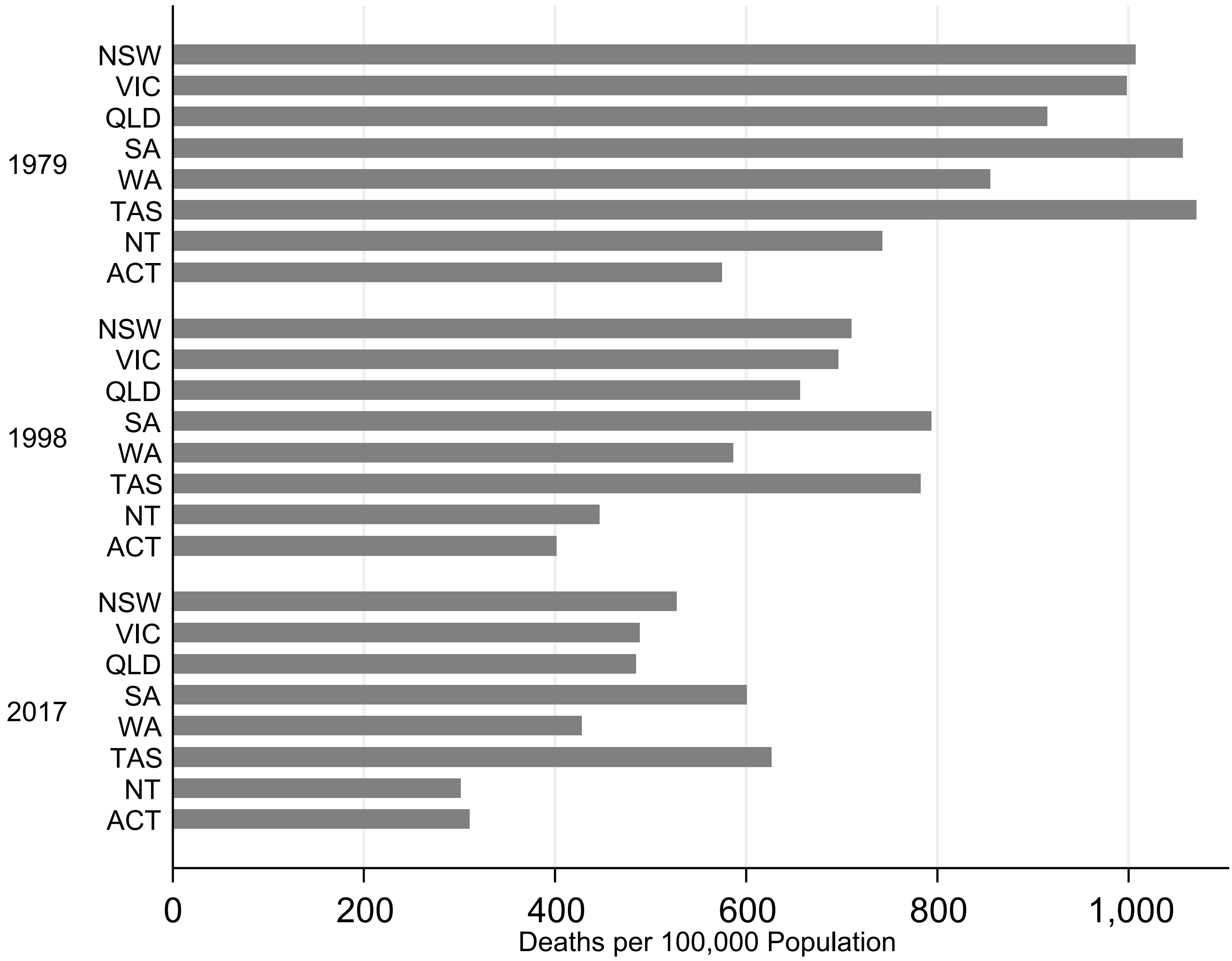
Figures

Figure 1: Crude and Age Adjusted Death Rates: 1979-2017



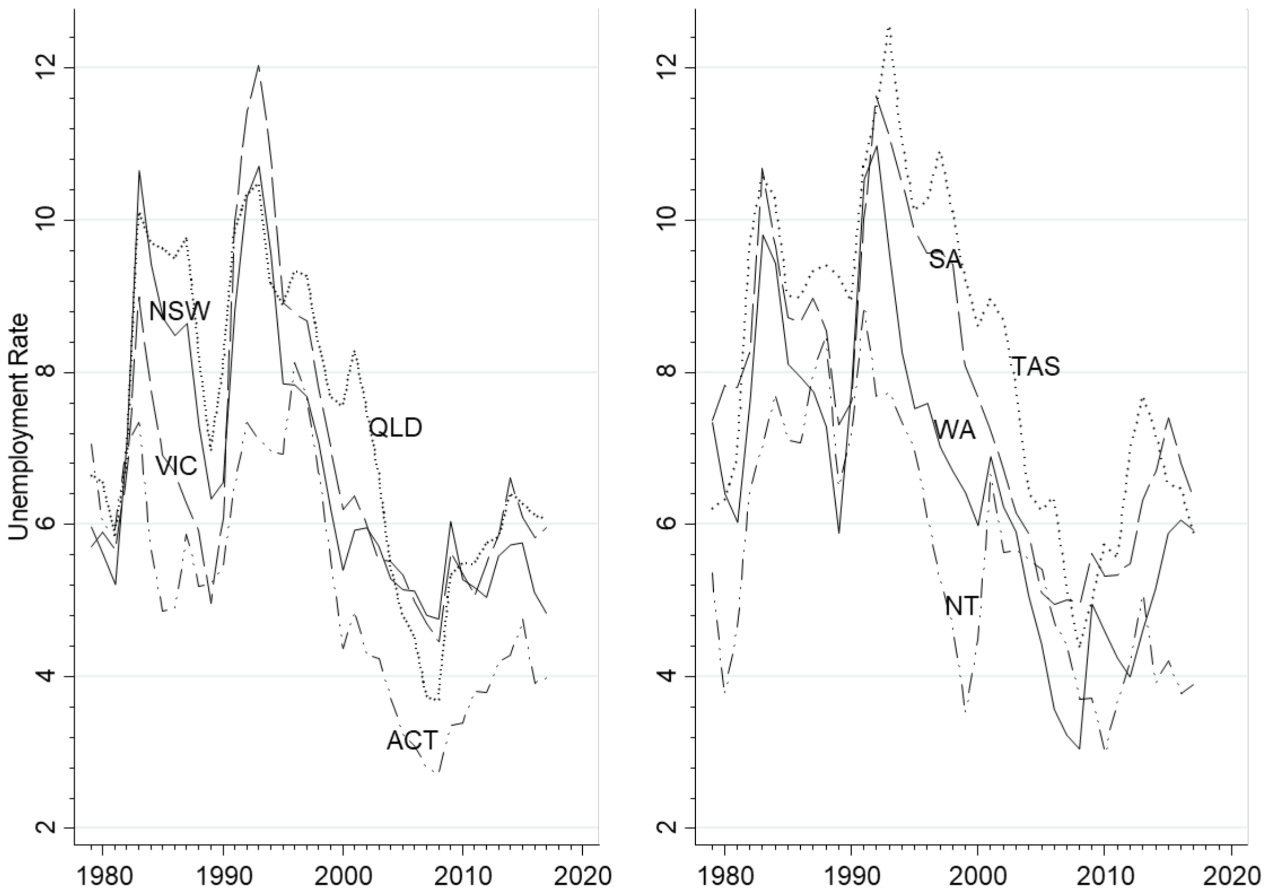
Note: Source – author's calculations using AIHW data. The regions between each of the 3 pairs of vertical lines indicate recessions of 1982-82, 1991-92, and the GFC of 2008-09. Recession dates sourced from https://www.rba.gov.au/education/resources/explainers/recession.html.

Figure 2: Age-adjusted mortality rates by state, 1979, 1998 and 2017



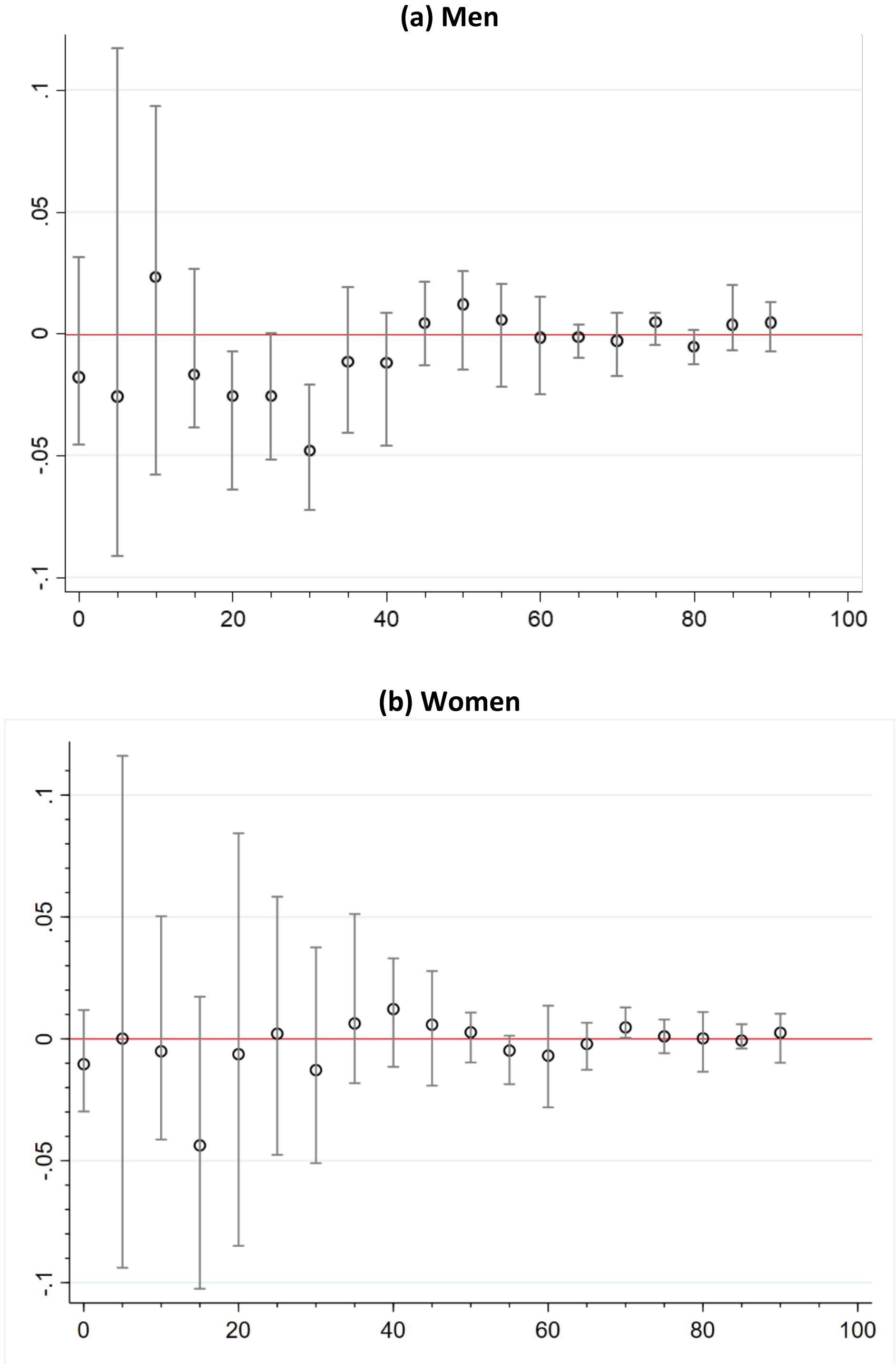
Source: Authors' tabulations based on AIHW data and ABS (2020a) population data. Estimates reflect the 1998 age structure in each state.

Figure 3: Unemployment Rates across the States and Territories of Australia (1979-2017)



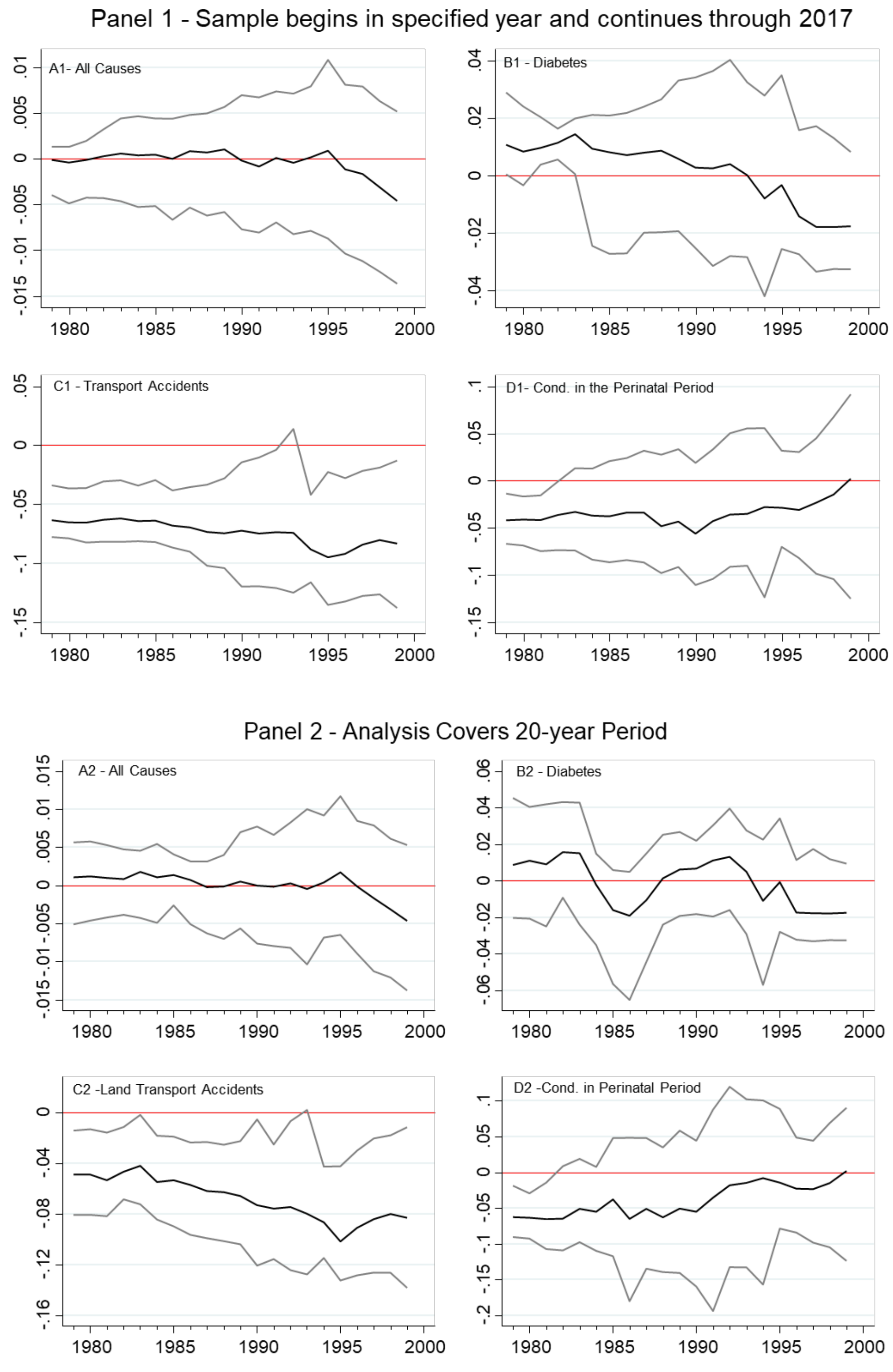
Source: ABS Labour Force Statistics (ABS, 2020b)

Figure 4: Semi-Elasticity of Mortality by Age with Respect to Unemployment



Notes: Log-linear models estimated separately by sex and for each 5-yr age group. Controls include state and year fixed effects, state trends, and demographic and education variables. Bars give 95 percent confidence intervals. Wild bootstrap cluster standard errors are used, clustered by state.

Figure 5: Stability of the coefficient over time (1979–2017)



Notes: In Panel 1, each figure shows the coefficient from a series of rolling regressions where the sample begins in the specified year and continues through 2017. That is, the first point plotted in black is the estimated coefficient using a sample from 1979-2017, and the last is the estimated coefficient using 1999-2017. Panel 2 shows the coefficient from rolling regressions each using a 20-year sample window. The paler grey lines provide 95% confidence intervals. The coefficients are estimated using our preferred specification and confidence interval is constructed using wild-bootstrapped clustered standard errors.

Tables

Table 1: The Effect of the Unemployment Rate on Mortality by Age Group

		All Ages (1)	0-24 years (2)	25-64 years (3)	65+ years (4)
Men & Women	Coefficient	-0.0002	-0.0180**	-0.0002	0.0002
	p-value[(a)]	(0.840)	(0.031)	(0.965)	(0.848)
	Confidence Interval[(b)]	[-.0040, .0014]	[-.0246, -.0038]	[-.0111, .0091]	[-.0031, .0021]
Men	Coefficient	-0.0009	-0.0194*	-0.0006	-0.000619
	p-value[(a)]	(0.493)	(0.053)	(0.907)	(0.689)
	Confidence Interval[(b)]	[-.0063, .0029]	[-.0282, .0005]	[-.0170, .0125]	[-.0036, .0040]
Women	Coefficient	0.0008	-0.0149*	0.0012	0.0013
	p-value[(a)]	(0.535)	(0.040)	(0.678)	(0.274)
	Confidence Interval[(b)]	[-.0055, .0028]	[-.0350, -.0011]	[-.0059, .0073]	[-.0034, .0028]

Notes: *p<0.1, **p<0.05, ***p<0.001. Linear probability model regressions. The dependent variable is the age-adjusted log death rate for the age group and sex indicated. Parameters are the estimated mortality semi-elasticity with respect to the state-year unemployment rate. Each cell is a separate regression. Controls include state and year fixed effects, state-specific trends, demographic and education controls.
(a) We report wild bootstrap cluster p-values in parentheses and (b) wild bootstrap cluster 95 percent confidence intervals in square brackets, generated using boottest command in Stata 16 (Roodman et al. 2019) for standard errors clustered at the state level (8 clusters).

Table 2: Cause-specific Mortality Estimates

	Coefficient estimate	p-value[(a)]	Confidence Interval[(b)]	Number of additional deaths
Panel A-Pooled: Men & Women				
All Causes	-0.0002	0.840	[-.0040, .0014]	-32.6
Cerebrovascular disease	-0.0042	-0.677	[-.0225, .0086]	-43.4
Chronic lower respiratory diseases	-0.0009	0.880	[-.0134, .0142]	-7.7
Cirrhosis and other diseases of liver	-0.0080	0.670	[-.0409, .0540]	-15.3
Dementia, including Alzheimer disease	-0.0041	0.724	[-.0417, .0192]	-57.4
Diabetes	0.0108*	0.051	[-.0001, .0281]	53.0
Disease of the heart	-0.0018	0.533	[-.0130, .0040]	-54.8
Disease of the urinary system	0.0188	0.559	[-.0452, .0708]	67.7
Influenza and pneumonia	-0.0180	0.757	[-.0966, .0564]	-77.5
Intentional self-harm (suicide)[(a)]	-0.0209	0.338	[-.0613, .0173]	-65.9
Malignant neoplasms	0.0027	0.387	[-.0076, .0066]	123.9
Non-transport accidents	0.0147	0.679	[-.0307, .0590]	82.1
Transport accidents	-0.0634**	0.011	[-.0778, -.0364]	-88.2
Conditions in the perinatal period	-0.0169	0.3560	[-.0387, .0090]	-9.6
Homicide, legal intervention	-0.0280	0.6262	[-.1067, .0781]	-5.4
Malnutrition and nutritional anaemias	0.0075	0.778	[-.0405, .1124]	1.2
Panel B: Men				
All Causes	-0.0009	0.493	[-.0063, .0029]	-75.6
Cerebrovascular disease	-0.0017	0.839	[-.0238, .0208]	-7.5
Chronic lower respiratory diseases	0.0007	0.913	[-.0156, .0187]	3.1
Cirrhosis and other diseases of liver	-0.0083	0.742	[-.0527, .0569]	-10.7
Dementia, including Alzheimer disease	-0.0200	0.210	[-.0710, .0141]	-99.7
Diabetes	0.0167	0.153	[-.0151, .0420]	43.9
Disease of the heart	-0.0001	0.982	[-.0124, .0056]	-1.6
Disease of the urinary system	0.0282	0.270	[-.0210, .0754]	45.5
Influenza and pneumonia	-0.0156	0.857	[-.0971, .0602]	-30.3
Intentional self-harm (suicide)[(a)]	-0.0188	0.413	[-.0586, .0205]	-44.8
Malignant neoplasms	0.0015	0.686	[-.0106, .0074]	38.8
Non-transport accidents	0.0160	0.660	[-.0417, .0635]	48.3
Transport accidents	-0.0708***	0.004	[-.0866, -.0450]	-73.3
Conditions in the perinatal period	0.0038	0.881	[-.0354, .0744]	1.2
Homicide, legal intervention	-0.0449	0.543	[-.1567, .0952]	-6.3
Malnutrition and nutritional anaemias	0.0218	0.634	[-.1006, .1324]	1.2

Panel C: Women

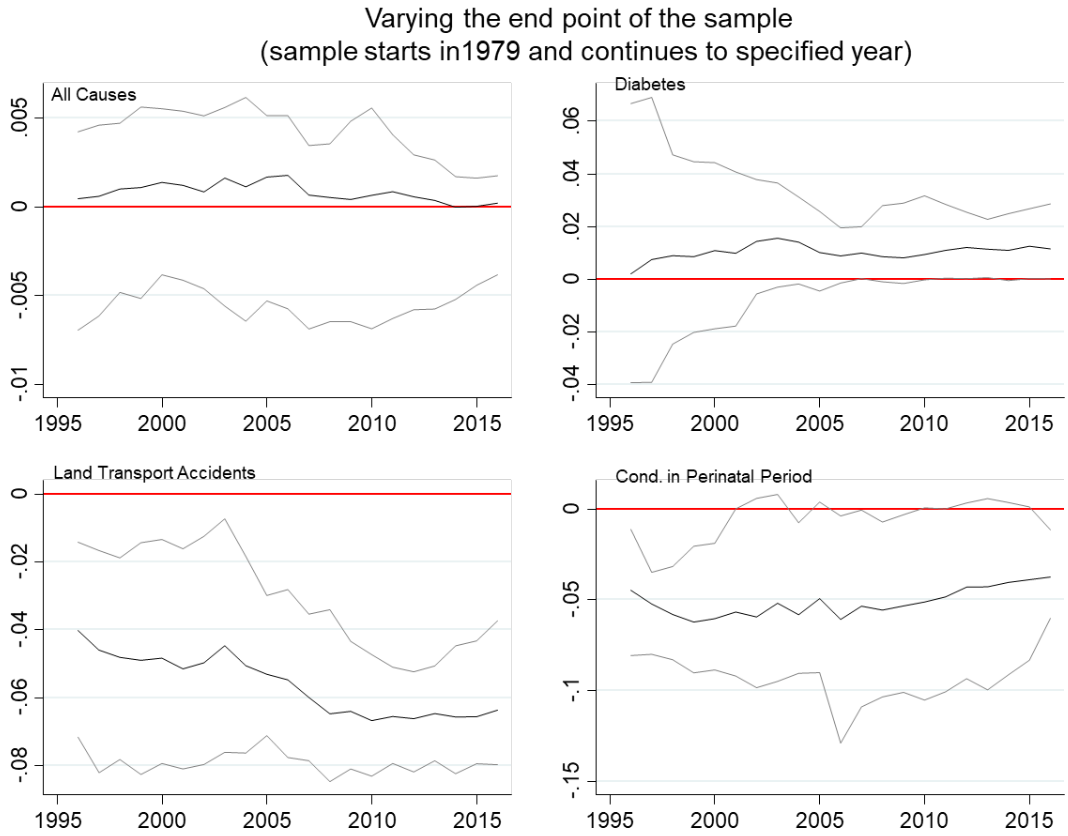
All Causes	0.0008	0.535	[-.0055, .0028]	63.2
Cerebrovascular disease	-0.0038	0.759	[-.0286, .0096]	-22.6
Chronic lower respiratory diseases	-0.0026	0.763	[-.0274, .0213]	-10.8
Cirrhosis and other diseases of liver	-0.0134	0.630	[-.0513, .0642]	-8.4
Dementia, including Alzheimer disease	0.0157	0.271	[-.0169, .0481]	141.4
Diabetes	0.0049	0.436	[-.0059, .0232]	11.2
Disease of the heart	-0.0034	0.296	[-.0152, .0027]	-49.8
Disease of the urinary system	0.0134	0.710	[-.0643, .0822]	26.6
Influenza and pneumonia	-0.0192	0.633	[-.0962, .0698]	-45.4
Intentional self-harm (suicide)[(a)]	-0.0295	0.174	[-.0903, .0104]	-22.7
Malignant neoplasms	0.0050	0.213	[-.0068, .0099]	100.0
Non-transport accidents	0.0125	0.602	[-.0324, .0594]	32.1
Transport accidents	-0.0408*	0.068	[-.0625, .0059]	-14.5
Conditions in the perinatal period	-0.0416**	0.011	[-.0662, -.0137]	-10.4
Homicide, legal intervention	0.0077	0.875	[-.0923, .1181]	0.4
Malnutrition and nutritional anaemias	0.0188	0.749	[-.1328, .2374]	1.9

Notes: *p<0.1, **p<0.05, ***p<0.001. Linear probability model regressions. The dependent variable is the age-adjusted log death rate for the sex and cause of death indicated. Parameters are the estimated mortality semi-elasticity with respect to the state-year unemployment rate. Each cell is a separate regression. Controls include state and year fixed effects, state-specific trends, demographic and education controls.
(a) We report wild bootstrap cluster p-values in parentheses and (b) wild bootstrap cluster 95 percent confidence intervals in square brackets, generated using boottest command in Stata 16 (Roodman et al. 2019) for standard errors clustered at the state level (8 clusters).

Online Appendix - Supplementary Materials

Figures

Figure A1: Stability of the coefficient over time



Notes: This figure is analogous to Panel 1 of Figure 5 in the main text, except here each figure shows the coefficient from a series of rolling regressions where the sample begins in 1979 but the end point of the sample varies. That is, the first point plotted in black is the estimated coefficient using a sample from 1979-1999, and the last is the estimated coefficient using a sample from 1979-2017. The dashed lines provide 95% confidence intervals. The coefficients are estimated using our preferred specification and confidence interval is constructed using wild-bootstrapped clustered standard errors.

Table A1: Causes of Death Counts, 2017

	Men & Women	Men	Women	Ratio of Male to Female death counts
All Causes	162,979	83,980	78,999	1.1
Cerebrovascular disease	10,345	4,386	5,959	0.7
Chronic lower respiratory diseases	8,504	4,368	4,136	1.1
Cirrhosis and other diseases of liver	1,912	1,286	626	2.1
Dementia, including Alzheimer disease	13,992	4,985	9,007	0.6
Diabetes	4,910	2,627	2,283	1.2
Disease of the heart	30,420	15,772	14,648	1.1
Disease of the urinary system	3,602	1,615	1,987	0.8
Influenza and pneumonia	4,305	1,941	2,364	0.8
Intentional self-harm (suicide)[(a)]	3,151	2,381	770	3.1
Malignant neoplasms	45,881	25,880	20,001	1.3
Non-transport accidents	5,583	3,018	2,565	1.2
Transport accidents	1,391	1,036	355	2.9
Conditions in the perinatal period	571	322	249	1.3
Homicide, legal intervention	192	141	51	2.8
Malnutrition and nutritional anaemias	155	54	101	0.5

Source: AIHW data and author calculations

Table A2: The Effect of the Unemployment Rate on Mortality by 5-year Age Groups

	Pooled: Men & Women				Men				Women			
			Confidence Interval(b)				Confidence Interval(b)				Confidence Interval(b)	
Age groups	Coefficient estimate	p-value(a)	*lower bound*	*upper bound*	Coefficient estimate	p-value(a)	*lower bound*	*upper bound*	Coefficient estimate	p-value(a)	*lower bound*	*upper bound*
0-4	-0.0140	0.1787	-0.0273	0.0061	-0.0177	0.3975	-0.0452	0.0315	-0.0104	0.1478	-0.0298	0.0118
5-9	-0.0336	0.4659	-0.1148	0.0845	-0.0257	0.5447	-0.0913	0.1171	0.0001	0.9983	-0.0939	0.1161
10-14	0.0148	0.3261	-0.0195	0.0599	0.0233	0.5033	-0.0578	0.0933	-0.0051	0.7540	-0.0413	0.0503
15-19	**-0.0276***	0.0582	-0.0502	0.0009	-0.0165	0.2543	-0.0385	0.0267	-0.0437	0.1443	-0.1025	0.0173
20-24	-0.0230	0.1240	-0.0715	0.0056	**-0.0254*****	0.0042	-0.0640	-0.0071	-0.0063	0.8228	-0.0849	0.0843
25-29	-0.0173	0.2673	-0.0429	0.0110	**-0.0256***	0.0527	-0.0516	0.0003	0.0021	0.9145	-0.0476	0.0583
30-34	**-0.0365****	0.0355	-0.0657	-0.0025	**-0.0479****	0.0124	-0.0720	-0.0210	-0.0128	0.5975	-0.0510	0.0375
35-39	-0.0037	0.7078	-0.0227	0.0246	-0.0113	0.5052	-0.0408	0.0191	0.0063	0.5882	-0.0182	0.0512
40-44	-0.0022	0.8159	-0.0340	0.0218	-0.0120	0.3392	-0.0459	0.0086	0.0122	0.4107	-0.0115	0.0330
45-49	0.0065	0.3447	-0.0101	0.0201	0.0045	0.5101	-0.0131	0.0212	0.0058	0.5751	-0.0192	0.0278
50-54	0.0085	0.3222	-0.0111	0.0200	0.0122	0.3003	-0.0148	0.0257	0.0027	0.5025	-0.0097	0.0108
55-59	0.0010	0.8391	-0.0211	0.0104	0.0057	0.4574	-0.0219	0.0203	-0.0048	0.1427	-0.0186	0.0013
60-64	-0.0019	0.5915	-0.0167	0.0053	-0.0016	0.8234	-0.0247	0.0152	-0.0069	0.4332	-0.0281	0.0136
65-69	-0.0017	0.1782	-0.0054	0.0015	-0.0013	0.5489	-0.0100	0.0039	-0.0021	0.6268	-0.0127	0.0066
70-74	-0.0008	0.9296	-0.0117	0.0076	-0.0028	0.8812	-0.0172	0.0085	0.0047	**0.0444**	0.0004	0.0129
75-79	0.0023	0.2506	-0.0043	0.0064	0.0048	0.1917	-0.0047	0.0085	0.0010	0.7008	-0.0059	0.0079
80-84	-0.0033	0.3586	-0.0139	0.0064	-0.0053	0.1325	-0.0125	0.0018	0.0002	0.9614	-0.0135	0.0110
85-89	0.0001	0.9704	-0.0067	0.0099	0.0037	0.4113	-0.0066	0.0199	-0.0007	0.7277	-0.0040	0.0060
90 plus	0.0036	0.4116	-0.0067	0.0109	0.0046	0.4045	-0.0070	0.0132	0.0025	0.4876	-0.0098	0.0103

Notes: *p<0.1, **p<0.05, ***p<0.001. Linear probability model regressions. The dependent variable is the age-adjusted log death rate for the sex and age group indicated. Parameters are the estimated mortality semi-elasticity with respect to the state-year unemployment rate. Each cell is a separate regression. Controls include state and year fixed effects, state-specific trends, demographic and education controls. (a) We report wild bootstrap cluster p-values in parentheses and (b) wild bootstrap cluster 95 percent confidence intervals in square brackets, generated using boottest command in Stata 16 (Roodman et al. 2019) for standard errors clustered at the state level (8 clusters).

Table A3: Cause-specific Death Rates by Age Group

	Estimated Coefficient on unemployment rate			Additional deaths from 1 p.p. increase in unemployment rate		
	Age Group			Age Group		
	0-24	**25-64**	**65+**	**0-24**	**25-64**	**65+**
Cerebrovascular disease	0.0107	0.0088*	-0.0051	0.1	6.4	-49.2
Chronic lower respiratory diseases	0.0033	0.0031	-0.0011	0.0	2.6	-8.5
Cirrhosis and other diseases of liver	†	0.0020	-0.0239	†	2.0	-21.6
Diabetes	†	0.0073	0.0106	†	4.7	45.2
Disease of the heart	-0.0279	-0.0042	-0.0024	-1.6	-13.7	-63.6
Disease of the urinary system	†	-0.0018	0.0202	†	-0.4	68.6
Influenza and pneumonia	-0.130*	-0.0069	-0.0168	-3.5	-2.0	-67.0
Intentional self-harm (suicide)	‡	-0.0230	-0.0452*	‡	-51.6	22.4
Malignant neoplasms	-0.0073	0.0068	0.0022	-1.4	68.1	79.1
Non-transport accidents	0.0381**	0.0055	0.0241	6.2	8.9	91.3
Transport Accidents	-0.0549**	-0.0737***	-0.0560*	-16.9	-54.2	-19.5

Notes: Dependent variable is log age-adjusted death rate for a given cause as listed in each row. Each column shows results for a different age group, indicated at the column head. Each cell is a separate regression, and each parameter is the estimated mortality semi-elasticity with respect to the state-year unemployment rate. Note that for brevity, only the coefficient estimates are reported. Full results are available on request from the authors. Significance is assessed using the wild bootstrap cluster p-values. * p<0.1 **p<0.05 ***p<0.01
(†) For this particular age x cause group there were fewer than 10 deaths per year.
(‡) Data for deaths among Age 0-14 years for this cause of death is not reported.

Table A4: Poisson Estimates of Cause-specific Mortality

	Coefficient	Cluster-robust Standard Error
All Causes	-0.00002	0.00121
Cerebrovascular disease	-0.0022	0.0049
Chronic lower respiratory diseases	0.0012	0.0045
Cirrhosis and other diseases of liver	-0.0067	0.0140
Dementia, including Alzheimer disease	-0.0115	0.0106
Diabetes	0.0118	0.0053
Disease of the heart	-0.0007	0.0022
Disease of the urinary system	0.0145	0.0212
Influenza and pneumonia	-0.0228	0.0279
Intentional self-harm (suicide)[a]	-0.0169	0.0146
Malignant neoplasms	0.0037	0.0017
Non-transport accidents	0.0160	0.0142
Transport accidents	-0.0585	0.0095
Conditions in the perinatal period	-0.0231	0.0088
Homicide, legal intervention	-0.0188	0.0318
Malnutrition and nutritional anaemias	0.0079	0.0206

Notes: *p<0.1, **p<0.05, ***p<0.001. Poisson regressions. The dependent variable is the age-adjusted death rate for the sex and cause of death indicated. Parameters are the estimated mortality semi-elasticity with respect to the state-year unemployment rate. Each cell is a separate regression. Controls include state and year fixed effects, state-specific trends, demographic and education controls. We report cluster robust standard errors, clustered at the state level (8 clusters).