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Economic fluctuations and mortality in Canada revisited

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Abstract

This paper uses panel data for Canada from 1976 to 2018, across 10 provinces, to reassess the relationship between mortality rates and economic fluctuations. The key contribution of our paper lies in examining the extent to which this relationship is driven by the employment rate (extensive margin) versus average hours worked (intensive margin). We find evidence of procyclical mortality for females at the aggregate level; aggregate male mortality remains largely unaffected by economic fluctuations. Our findings also reveal temporal heterogeneity, as the extensive margin becomes the driving force for female mortality rates during the more recent period (1990 onwards). These findings remain robust when accounting for personal income and pollution. Finally, we find some support for a procyclical relationship for individuals in the working age groups, while mortality exhibits a countercyclical pattern for children (age 0 to 14) and the elderly (age 65 and above).

KEYWORDS

average hours worked, Canada, extensive margin, intensive margin, mortality, recessions, unemployment

JEL CLASSIFICATION

E32, I12, R23

1 | INTRODUCTION

In this paper, we use panel data across 10 Canadian provinces for the 1976 to 2018 period to evaluate the impact of business cycles on mortality. We make use of alternate measures of the state of economic activity, specifically, unemployment rate, conditional hours worked, and employment rate, thereby differentiating between the impacts of the extensive and intensive margin of work. The unemployment rate captures the extensive margin indirectly, and allows us to evaluate our results against the existing literature where this measure is predominantly used. Conditional hours, defined as average hours worked in a reference week conditional on employment, are used to evaluate the impact of the intensive margin, as firms increase or decrease employee hours in response to changes in economic conditions, without necessarily hiring or firing workers (Zmitrowicz & Khan, 2014).[1] We go on to estimate a model with both conditional hours and the employment rate, where the latter measure reflects movements in and out of employment, and thus depicts the extensive margin.[2] Our paper contributes to the exiting literature by examining the role of the extensive vs. intensive margins.[3] In doing so, we are able to determine whether a focus on the unemployment rate alone, as is typical in the literature, misses important impacts of changes in economic activity (via changes in the labor market) on health.

We estimate a fixed-effects model for mortality that includes a time effect, a province level effect, and a province specific time trend to control for unobservables. The model is estimated at the aggregate, by gender, and across broad age groups as in Ruhm (2000). Estimation is first done using data from 1976 to 2018 with controls for the share of the population in seven different demographic groups (<1 year, 1 to 19, 45 to 54, 55 to 64, 65 to 74, 75 to 84, and older than 85 years). This model serves to illustrate how the relationship between the state of the economy (especially the unemployment rate) and mortality for Canada compares to evidence from other studies. Our preferred specification is one where both the extensive and intensive margins are captured simultaneously, hence we also estimate a model with employment rate and average hours worked for the 1976 to 2018 period, with the demographic controls. Subsequently, we focus only on our preferred specification and estimate the model using controls for personal income and pollution to explore the potential mechanism for the observed relationship; given the constraint of data availability this analysis is done using data from 1990 onwards. While personal income, as a control, has been used in much of the literature, different measures of pollution have only recently been explored in the health business cycle literature (see Heutel & Ruhm, 2016), however, neither control has been examined using Canadian data.

The relationship between macroeconomic conditions and health (via mortality rates) has been studied extensively in the literature. In a series of papers, Ruhm (2000, 2003, 2005, 2006) provided strong evidence of a procyclical relationship between business cycles and mortality

[1]Ohanian and Raffo (2012) show that the intensive margin (captured via average hours worked by those in employment) has become more important across the business cycles in capturing labor market conditions, especially since the Great Recession of 2008, for most OECD countries (including Canada).

[2]We also explore a composite measure, unconditional hours worked, which reflects average hours worked across those in the labor force (i.e., including the unemployed); this indicator can be viewed as capturing both the impact of unemployment and the hours worked by the employed.

[3]Our definitions of the extensive and intensive margin follow that of Blundell et al. (2013).

rates in the United States.[4] Using U.S. data from 1974 to 1990, Ruhm (2000) showed that a one percentage point (henceforth pp) increase in the unemployment rate yields a 0.5% decrease in the total mortality rate. A procyclical relationship was subsequently documented by Miller et al. (2009), Ionides et al. (2013) and Stevens et al. (2015) for the United States, and internationally by Neumayer (2004) for Germany, Tapia Granados (2005) for Spain, Tapia Granados (2008) for Japan, Tapia Granados and Ionides (2011) for Sweden, Buchmueller et al. (2007) for France, Gonzalez and Quast (2010, 2011) for Mexico, Lin (2009) for Asia-Pacific countries, and Ariizumi and Schirle (2012) for Canada, among others. In the case of Canada, Ariizumi and Schirle (2012) found that a one pp increase in unemployment decreased the total mortality rate by 0.53%, however, the relationship failed to remain significant once additional controls were added. In this paper, we build on existing literature and re-examine the relationship between economic fluctuations and mortality using Canadian panel data.

Ruhm (2000, 2003, 2005) proposed several channels that could give rise to procyclical mortality. First, rising hours worked during economic expansions increase the opportunity cost of time, making it costly for individuals to make time for medical appointments and engage in physical activities. Second, as working hours are extended during expansions, hazardous working conditions, job-related stress, and increased physical effort in manual jobs can lead to lower health and rising mortality. Third, during expansionary periods, risky activities such as drinking and driving can increase, thus contributing to external sources of death, for instance vehicle fatalities. In addition, migration to larger urban centers during an economic boom can contribute to higher mortality due to overcrowding, unfamiliarity with medical and road infrastructure by migrants, and exposure to diseases imported by migrants (Ruhm, 2000). Recently, Heutel and Ruhm (2016) have also explored the role of environmental risks, specifically the positive association between air pollution and economic activity, as the potential "source" of procyclical mortality, a factor we consider as well.

Despite the many studies documenting procyclical mortality, a countercyclical relationship has also been suggested by Gerdtham and Johannesson (2005) and Svensson (2007) for Sweden. Countercyclical mortality has been argued to be driven primarily by income and stress, where economic downturns cause hardships that adversely affect both physical and mental health (Brenner, 1973, 1979). First, as income drops, less can be spent on health-related expenditures or investments (Neumayer, 2004). Second, economic slowdowns contribute to higher stress that can negatively affect the health of those who experience job loss; they can also adversely impact the employed due to fear of job loss or stress associated with lower working hours. Third, in addition to the stress of job loss, being unemployed can adversely affect mental health as it can lower self-esteem and self-confidence and result in a loss of social networks as well as a sense of identity and purpose.[5] Moreover, social and psychological hardship can lead to self-medicating or unhealthy lifestyles—such as alcohol/drug consumption—to alleviate the hardship, thus exacerbating the above negative health effects.[6]

[4]Ogburn and Thomas (1922) and Thomas (1927) were the first to document a procyclical relationship between mortality and business cycles; the former using U.S. data and the latter data for the United Kingdom. This work was followed by that of Brenner (1973, 1975, 1979), who used U.S. time series data and showed that slowdowns in economic activity were accompanied by increases in mortality rates. The results were subject to vast criticism by Kasl (1979), Gravelle et al. (1981), and Wagstaff (1985), leading to much of Ruhm's work.

[5]Durkheim (1897) first suggested that recessions are linked with higher suicide rates; subsequently, Brenner (1973, 1975), Dooley et al. (1989), and Ruhm (2000, 2015) have documented a countercyclical relationship between suicides and the business cycle.

[6]See Brenner and Mooney (1983) for a detailed discussion.

Some studies, while finding no evidence of a countercyclical relationship, have suggested that the procyclical relationship may be weakening in recent years to the point that recessions may no longer be good for one's health; for example, using U.S. data both Stevens et al. (2015) and Ruhm (2015) found that including data from the 1990s onwards tended to "diminish the estimated degree of cyclicality". Changes in the relationship between mortality and economic activity over time are further documented by Lam and Piérard (2017) for the United State, Lee and Kim (2017) for South Korea, and Brüning and Thuilliez (2019) for France. We touch on this issue, as we present findings for the whole sample and for a more recent time period.

Given the different mechanisms that can influence health over the business cycle, it is not surprising that empirical findings across studies differ, especially by age, gender, and the period under consideration. Both Miller et al. (2009) and Stevens et al. (2015) argue that procyclical mortality at the aggregate in the United States is driven by mortality rates of the elderly. Stevens et al. (2015) found that female mortality rates fell by 0.4% following a one pp rise in the unemployment rate, while that of males fell only by 0.25%. Neumayer (2004) found little difference between the impact of unemployment on mortality rates of males vs. females in Germany, while Gerdtham and Johannesson (2005) found female mortality and business cycles to be unrelated in Sweden. In the case of Canada specifically, Ariizumi and Schirle (2012) argued that those in their 30s are significantly affected by unemployment; their results did not differ by gender.

Our initial findings, spanning the 1976 to 2018 period, suggest female mortality to be procyclical, with a one pp rise in unemployment rate causing female mortality rates to fall by 0.22% (this is equivalent to 325 fewer deaths). Using measures to account of changes along the extensive vs. intensive margin, we find the intensive margin (average hours worked) to be positive and significant, while changes at the extensive margin (employment rate) do not have a significant impact on female health. We do not find any significant results for men over this period. Focusing on our preferred specification that includes both margins, we consider a smaller sample period (1990 to 2018), which allows us to consider additional controls, specifically personal income and pollution. Regardless of the controls used, female mortality rates continue to exhibit an aggregate response to economic fluctuations, while male mortality remains unaffected by either employment or average hours worked. Our findings also reveal temporal heterogeneity, since in the shorter (more recent) period it is the extensive margin that drives female mortality rates in all specifications. The role of personal income and pollution is examined, as potential mechanisms, and while both these variables have a positive association with mortality rates across gender, their inclusion does not change the significant relationship between state of the economy and female mortality.

Our age-specific analysis, using our preferred specification and data from 1990 onwards, suggests that the procyclical female mortality found at the aggregate due to the extensive margin's impact on health is driven by the working age population (25 to 64); however, the intensive margin is significant for the mortality of the 15 to 44 age group, with a rise in average hours being detrimental to their health. This demonstrates that evaluating both margins is essential in assessing the impact of macroeconomic conditions on mortality rates. Results for males indicate that those in 45 to 64 age group see their mortality rates rise when average hours fall, while mortality rates of males aged 0 to 14 and 65 to 74 fall as average hours fall; the mortality rates of the latter two age groups are impacted by both the extensive and intensive margin.

The paper is organized as follows. In Section 2, we discuss all data used in the analysis and the empirical specification that we estimate. Our findings and a discussion of our results, including potential mechanisms, are provided in Section 3. Section 4 concludes the paper.

2 | DATA AND METHODOLOGY

2.1 | Data

Our analysis uses annual data for 43 years, from 1976 to 2018, for 10 Canadian Provinces of Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario, Prince Edward Island, Quebec, and Saskatchewan.[7] Data is obtained from Statistics Canada and Environment Canada; data sources are provided in detail in Appendix A.

The mortality rate per 1000 individuals is used as a proxy for health; this is a measure of the mortality rate across all types of deaths. We use annual data on the province-specific number of deaths and population to calculate mortality rates; both variables are collected from July to June. For consistency, all control variables are also calculated on a July to June basis. In general mortality rates are relatively high for those less than 1 year old and rise again later in life. Mortality rates also differ by gender, with males having higher mortality rates than females across all age groups. To assess the impact of the macroeconomy, we obtain several indicators from the Labor Force Survey, all of which are seasonally adjusted and at monthly frequencies. Following the practice in the related literature, the unemployment rate at the province level is used, which in Canada is calculated for those aged 15 years and older. To capture the extensive vs. intensive margins, we use employment rate and conditional average hours worked, respectively. The latter refers to the average hours worked per week in a reference week for those that are employed, hence it gives average hours conditional on employment.[8] Finally, as a robustness check, we also use unconditional average hours worked, where we sum up the hours of employed and unemployed (which is zero) and then divide by the total labor force. Note that, these hours are necessarily lower than conditional average hours, and are affected by changes in conditional hours worked and fluctuations in the unemployment rate.

All our estimations control for the size of the populations that tend to have elevated mortality rates, including infants, 1–19, 45 to 54, 55 to 64, 65 to 74, 75 to 84, and 85 and older. These population controls are in line with those used in the literature; see Stevens et al. (2015), Miller et al. (2009), and Ruhm (2015).

To understand the different mechanisms for the observed relationship between the state of the economy and mortality we explore the role of personal income, and pollution. As in previous studies, we control for personal income to account for income effects. A permanent increase in income is associated with better health, however, the relationship between short-run changes in income and mortality rates is ambiguous (Neumayer, 2004).[9] A rise in transitory income due to expansions can lead to a rise in demand for "health-preserving investments," while

[7]The analysis is conducted at the provincial level due to the lack of availability of data on death rates for Canada at more disaggregated regional levels.

[8]The Labor Force Survey asks employees how many hours they worked in the reference week This information is then used to obtain total hours worked across the economy. Subsequently, average hours worked are obtained by dividing the total hours (in a reference week) by the number of employed. This measures the conditional average hours that, along with total hours and number of employed, are reported by Statistics Canada.

[9]In our paper we examine the short-run impacts of economic activity, as is done in Ruhm (2000, 2005, 2006), and the other studies we cite. A separate body of literature examines the long-run impacts of economic activity, with a focus on growth, as increases in the standard of living are argued to improve health via improvements in nutrition, public health interventions, medical care, technology, and so forth; this includes the work of McKeown (1976), Preston (1975, 1976), Kunitz (1987), Szreter (1988), Cutler et al. (2006), Tapia Granados and Ionides (2008), and Janko et al. (2013), among many others.

simultaneously causing an increase in demand for health-damaging goods, such as "high-calorie foods" or drug use.[10] Including income as a control is expected to attenuate the impact of the state of the economy indicators; for example, a fall in personal income during economic slowdowns is likely to absorb some of the effects of macroeconomic fluctuations on mortality. In our analysis, we separate the personal income measure into the personal income of non-seniors (16 to 64 years) and seniors (65 and over). The personal income for the 16 to 64 age group is most likely to be impacted by changes in the labor market, therefore we expect that any observed income effect for this group will be driven by the transitory changes in the labor market. Income for seniors is largely composed of non-labor income, such as social security and pension benefits, hence changes in the income of this age group are more likely to reflect changes in the support available to the aging population.[11]

Finally, we control for air pollution, as it is possible that levels of pollution change over the business cycle. Specifically, a rise in pollution-inducing economic activity during expansionary periods is likely to adversely impact health (Heutel & Ruhm, 2016).[12] We use the following pollution measures in our analysis: Particulate Matter 2.5 (PM2.5) and Carbon Monoxide (CO).[13] In our analysis, we use PM2.5 as compared to PM10 that is used by Heutel and Ruhm (2016), as PM2.5 is smaller in size, and has been argued to be more hazardous; as such, it may better capture the impact of pollution on health (see Christidis et al., 2019).[14]

As pollution data are available from 1990 onwards, all our discussion of mechanisms is focused on the shorter period. For this shorter time period we are also able to use an additional demographic control, education, which has been used by others in the literature; see Ruhm (2000), Cutler et al. (2006), among others. We use the size of the population aged 25 to 54 with a university degree following Ariizumi and Schirle (2012). Summary statistics for all variables are provided in Appendix B, Tables B1 and B2.

2.2 | Empirical specification

A fixed-effect linear regression model is used to estimate the relationship between the state of the economy and mortality rates. The basic specification estimated is

[10]Health-preserving investments can include expenditures on mental health services, gym memberships, and other activities that reduce stress.

[11]Mortality rates may also be affected by resources devoted to health services at the societal level. Stevens et al. (2015) argued that the quality of healthcare facilities can be a potential mechanism to explain procyclical mortality for seniors. To capture access to health services, we used the number of physicians per 100,000 population as a proxy for health resources, however we did not find it to be significant. Given the potential endogeneity of this variable to economic activity, we do not include the number of physicians in our analysis; the results are available upon request.

[12]We check the correlation between unemployment and the two pollution measures for our sample and find that one pp increase in the unemployment rate leads to a 0.026 SD increase in PM2.5 and a 0.093 SD increase in CO.

[13]There is a considerable variation in pollution levels across different provinces of Canada. Alberta, British Columbia, Ontario, Quebec, and Saskatchewan have considerably higher levels of both pollutants, relative to the other five provinces. Most provinces have seen a decline in the emissions of PM2.5 over time, except for Alberta, Manitoba, and Saskatchewan, where PM2.5 emissions have increased in recent years. CO emissions have been declining across all provinces over time.

[14]In contrast to PM10 that includes particulate matter less than 10 μm in diameter, PM2.5 includes only fine particulate matter that is less than 2.5 μm in diameter. Carvalho et al. (2011) argue that particulate matter less than 3 μm is more likely to travel further into the respiratory system, where it can be deposited and lead to diffusion into the bloodstream (thus traveling into other parts of the body including the heart and the brain).

$$\log \mathrm{MR}_{jt} = \alpha_t + \beta \mathrm{SEA}_{jt} + \gamma X_{jt} + \psi_j + \varphi_j T + \epsilon_{jt}, \tag{1}$$

where subscript j indicates province and t indicates time. $\log \mathrm{MR}_{jt}$ is the natural log of the mortality rate in province j at time t; SEA_{jt} is the state of economic activity at the provincial level that is either captured by the unemployment rate, log of unconditional average hours worked in a referenced week, or it is a vector that contains employment (extensive margin) and conditional average hours worked in a referenced week (intensive margin) simultaneously. The latter interpretation reflects our preferred specification, as it is our objective to examine the role of the extensive and intensive margin on mortality in detail. X_{jt} is a vector that captures the different demographic controls (population shares of different age categories), share of population with university degree, log personal income, and the measures of air pollution. β and γ are parameter vectors to be estimated, associated with SEA_{jt} and X_{jt}, respectively. α_t is the time-specific fixed effect and ψ_j is the province specific fixed effect; both are used to control for omitted variables. The time-specific effect is used to control for factors that change over time yet are common across provinces, such as national health policies and health services, while province specific effect controls for differences across provinces that are common over time, such as differences in access to healthcare, and cultural differences. Following the literature, we incorporate province-specific time trends ($\varphi_j T$) to capture factors that vary over time within each province, such as changes in household structure, and medical coverage. Finally, ϵ_{jt} is zero-mean random error.

For ease of interpretation, the log mortality rate is used in the literature since it implies that in the estimation with the unemployment (or employment) rate, the estimated parameter shows the percentage change in the mortality rate given a one pp change in the unemployment (employment) rate. When the model is estimated using the log of average hours worked, the estimated parameter is the elasticity; it shows the percentage change in the mortality rate given a percentage change in either conditional or unconditional average hours worked. If recessions are good for health, then we expect the estimated coefficient associated with the unemployment rate to be negative and the estimated coefficient associated with employment and log average hours to be positive; during recessions unemployment rates rise and employment rates fall as do average hours, and vice versa in the boom periods.

3 | EMPIRICAL RESULTS AND DISCUSSION

In Section 3.1 we present and discuss our results at the aggregate for both total mortality and mortality by gender that utilizes data from 1976 to 2018. We present results for three separate specifications of the economic indicator and also discuss heterogeneity over time. In Section 3.2, we take our preferred specification that allows us to determine the role across the intensive vs. the extensive margin, and we assess the mechanisms that might drive the results. We focus specifically on the role of personal income and pollution, using data from 1990 to 2018. Section 3.3 presents a discussion of our findings from an age- and gender-specific analysis conducted using employment and conditional hours worked.

3.1 | Aggregate and gender-specific analysis

Table 1 shows results from estimating Equation (1) using three alternate economic activity indicators with the use of demographic controls; results are provided for men and women together

TABLE 1 Effect of economic indicators on log mortality rates, 1976 to 2018.

	(1) All	(2) Male	(3) Female	(4) All	(5) Male	(6) Female	(7) All	(8) Male	(9) Female
Unemployment rate	−0.0004	0.0014	−0.0022**						
	(0.0004)	(0.0010)	(0.0008)						
Log average hours (unconditional)				0.0529	−0.0630	0.1655***			
				(0.0409)	(0.0691)	(0.0447)			
Employment rate							−0.0007	−0.0031	0.0017
							(0.0013)	(0.0022)	(0.0012)
Log average hours (conditional)							0.1571	0.0839	0.2308*
							(0.1112)	(0.1324)	(0.1242)
N	430	430	430	430	430	430	430	430	430
R^2	0.922	0.920	0.970	0.922	0.919	0.970	0.923	0.921	0.970

Note: Standard errors in (.) parentheses are clustered over provinces. The standard errors reported are robust to disturbances being heteroscedastic and autocorrelated. The table reports the weighted estimates, where the weight is the province-specific population averaged over 43 years. All specifications include time fixed effects, province specific time trends, and demographic controls (share of the province residents who fall in one of the following seven age categories: <1, 1–19, 45 to 54, 55 to 64, 65 to 74, 75 to 84, and 85 and older).
*$p < .10$; **$p < .05$; ***$p < .01$.

and separately.[15] Results in columns (1) to (3) indicate that estimates for unemployment are insignificant for the whole population and for males, however, the impact is statistically significant for females. Specifically, a one pp rise in unemployment rate decreases female mortality rates by 0.22% (this is equivalent to almost 325 fewer deaths in 2018). Thus, across the whole sample period, female mortality appears to be procyclical, as found by Neumayer (2004) for Germany, and Stevens et al. (2015) for the United States.[16] The lack of a statistically significant relationship at the aggregate is also consistent with the findings of Ariizumi and Schirle (2012); authors do not report findings by gender.

Estimates reported in columns (4) to (6) show that unconditional hours have a significant positive impact only on female mortality, with an estimate of 0.1655. This suggests that a 1% increase in log average (unconditional) hours worked leads to almost a 0.17% increase in the mortality rate for females; for 2018 this would mean almost 250 additional deaths over the year for an additional 30 min worked per week on average.[17] The results for our preferred specification are in columns (7) to (9), where both the extensive and intensive margins are captured.[18] Note that the coefficient on conditional average hours worked represents the incremental effect of the intensive margin of employment, over and above the effect of the extensive margin (employed vs. not employed). The findings for males continue to be insignificant, however this is not the case for females. Across our whole sample changes along the intensive margin (hours) have a significant positive impact on female mortality; a 1% rise in average hours worked, for a given level of employment, leads to a 0.23% rise in female mortality rates.[19] Now that we see the importance of the extensive vs the intensive margin, we explore to what extent these impacts hold over time. Consequently, we conduct our analysis using data from 1990 to 2018. This has the additional benefit of allowing us to control for education level, along with the population demographics already considered.

Table 2, columns (1) to (3) report findings for the more recent time period with the same controls considered thus far, and columns (4) to (6) provide results when controlling for the percent of the population 25 to 54 with a college degree, since an education control is commonly utilized in the literature, including in the work by Ariizumi and Schirle (2012). First, we continue to find employment and conditional average hours to have no significant impact on male mortality. Second, we find female mortality to be significantly impacted by economic conditions, however the results change over time, as it is employment rate that has a positive

[15]In all our analysis we report robust standard errors (based on the Huber/White estimator) which are clustered at the province level. However, we have few clusters, to correct for this we also implemented the bootstrap correction outlined in Cameron et al. (2008). The 95% confidence intervals from the wild-bootstrap approach are not very different from those we get with the robust standard errors; we do not report bootstrap confidence intervals, however, these are available on request.

[16]Stevens et al. (2015) find mortality to be procyclical across both genders, however Ruhm (2015) finds that the relationship is present only between 1976 and 1995, but not from 1996 to 2010.

[17]Average (unconditional) weekly hours in a reference week are 31.5 h for 2018, hence a 1% increase implies an additional 30 min of work a week on average.

[18]We do not provide estimated coefficients for all other control variables in the main paper. One set of estimates, for our preferred specification with the employment rate and conditional hours worked, are provided in Appendix B, Table B3, for reference. Detailed estimates for all other specifications are available on request.

[19]Unconditional hours worked are strongly positively correlated with conditional hours worked and strongly negatively correlated with unemployment. Further, the gap between conditional and unconditional average hours widens as the unemployment rate rises. Given this relationship between the two different measures of hours worked and unemployment, we would expect the estimate on the conditional hours to be bigger in magnitude relative to the unconditional hours worked, as the latter will incorporate the negative impact of unemployment as well.

TABLE 2 Effect of economic indicators on log mortality rates, 1990 to 2018.

	(1)	(2)	(3)	(4)	(5)	(6)
	All	**Male**	**Female**	**All**	**Male**	**Female**
Employment rate	0.0008	−0.0020	0.0039***	0.0015	−0.0013	0.0045***
	(0.0024)	(0.0038)	(0.0012)	(0.0018)	(0.0031)	(0.0010)
Log average hours (conditional)	0.2134*	0.2205	0.2023	0.2015	0.2072	0.1918
	(0.1080)	(0.1459)	(0.1131)	(0.1263)	(0.1648)	(0.1230)
University degree (25 to 54) %				0.0075**	0.0084**	0.0066*
				(0.0027)	(0.0027)	(0.0030)
N	290	290	290	290	290	290
R^2	0.898	0.882	0.934	0.906	0.892	0.937

Note: See notes to Table 1. Standard errors in (.) parentheses are clustered over provinces.
$^*p < .10$; $^{**}p < .05$; $^{***}p < .01$.

significant impact on mortality, while mortality is not affected by changes in hours; a one pp rise in employment yields a 0.39% increase in female mortality. Hence, our results suggests that there is some heterogeneity over time.[20] Third, the findings in columns (2) and (3) continue to hold when we control for educational attainment. A one pp point increase in employment leads to a 0.45% fall in female mortality, as reported in column (6), which is approximately 660 fewer female deaths for 2018. Hence, whether we control for education or not, it is the extensive margin that is driving the impact of changes in the business cycle over female mortality.

In summary, the results so far suggest that recessions are good for female health, while fluctuations in employment or average conditional hours do not impact male health. In the next section we explore the mechanisms that drive the results.

3.2 | Mechanisms: Personal income and pollution

Here, we explore the role of personal income and pollution, in our preferred specification for the 1990 to 2018 period. As previously discussed, expansions in economic activity and the resulting rises in personal income can impact mortality rates via the income effect. With a rise in income, consumers can on one hand engage in health preserving investments thus improving mortality rates, but on the other hand increase consumption of lower quality foods (or high calorie foods) that may contribute to worsening health.[21] Similarly, improvements in economic activity as reflected by higher employment rates and average hours worked, have an adverse impact on health as documented in the literature. In Table 3 we report our results accounting

[20]Results over 1990 to 2018 for the other two specifications are provided in the Appendix, Table B4. The results are qualitatively the same, but the magnitudes are greater (0.33 for unemployment rate impact on female mortality and 0.21 for unconditional hours).

[21]Ettner (1997) used data from the 1988 National Health Interview Survey to investigate the relationship between income and health. He found that higher income improves physical and mental health, but also increases alcohol consumption.

TABLE 3 Effect of economic indicators on log mortality rates, 1990 to 2018, mechanisms.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	All	**Male**	**Female**	**All**	**Male**	**Female**	**All**	**Male**	**Female**
Employment rate	0.0008	−0.0017	0.0037**	0.0022	−0.0005	0.0050***	0.0017	−0.0008	0.0045**
	(0.0019)	(0.0031)	(0.0012)	(0.0021)	(0.0034)	(0.0012)	(0.0020)	(0.0033)	(0.0014)
Log average hours (conditional)	0.2003	0.2258	0.1830	0.0973	0.1089	0.0841	0.1230	0.1433	0.1098
	(0.1122)	(0.1355)	(0.1249)	(0.1171)	(0.1581)	(0.1271)	(0.1045)	(0.1355)	(0.1171)
Log personal income 16 to 64, all	0.0083	−0.0075	0.0147				−0.0159	−0.0237	−0.0155
	(0.0342)	(0.0577)	(0.0268)				(0.0276)	(0.0478)	(0.0338)
Log personal income 65+, all	0.0542**	0.0536*	0.0574***				0.0588**	0.0561*	0.0636***
	(0.0183)	(0.0288)	(0.0136)				(0.0194)	(0.0286)	(0.0153)
PM2.5 (×10,000 Metric tons)				0.0021*	0.0020*	0.0022	0.0022*	0.0021*	0.0022*
				(0.0011)	(0.0011)	(0.0012)	(0.0011)	(0.0011)	(0.0012)
CO (×10,000 Metric tons)				−0.0000	−0.0001	0.0000	0.0000	−0.0000	0.0001
				(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
N	290	290	290	290	290	290	290	290	290
R^2	0.908	0.894	0.938	0.910	0.895	0.939	0.912	0.897	0.940

Note: Standard errors in (.) parentheses are clustered over provinces. The standard errors reported are robust to disturbances being heteroscedastic and autocorrelated. The table reports the weighted estimates, where the weight is the province-specific population averaged over 43 years. All specifications include time fixed effects, province specific time trends, demographic controls (share of the province residents who fall in one of the following seven age categories: <1, 1–19, 45 to 54, 55 to 64, 65 to 74, 75 to 84, and 85 and older), and % of 25 to 54 population with university degree.

**p* < .10; ***p* < .05; ****p* < .01.

for these mechanisms. First, we control for personal income in columns (1) to (3), followed by controlling for pollution alone in (4) to (6), and finally considering both mechanism in columns (7) to (9).

Our findings indicate that personal income is an important channel for male and female mortality, with the rise in income leading to higher mortality rates across gender. Men and women, both experience rising mortality rates as personal income rises, although it is the personal income of the 65+ population that is significant, while the income of the working age population is found to have an insignificant impact. Similar adverse effect of personal income on health are found in Ruhm (2000). The income effect is robust to the inclusion of pollution. Looking at pollution, our findings indicate that PM2.5 is an important driver of health for males and females; an increase in PM2.5 worsens male and female health, for a given level of income.

Most notably, our findings in terms of the impact of the extensive vs. intensive margin on health, continue to hold both for males and females. Once we account for both personal income and pollution, the impact of employment and average (conditional) hours on female mortality is consistent with our results in Section 3.1, in fact our results become more pronounced, with the estimated coefficient on employment rate increasing from 0.0037 to 0.0045. Hence, our findings continue to indicate that recessions are good for female health. Nevertheless, despite our results suggesting that male health is not impacted by changes in macroeconomic conditions, it may be the case that across certain age groups male mortality rates are being impacted, however, not sufficiently to be present at aggregate. Moreover, it is possible that while certain age groups experience adverse health effects across the business cycle, the opposite is the case for different age groups. Similar differences by age are of course possible for females. It is therefore essential that an age specific analysis be conducted before concluding which margin, if any, plays an important role for male versus female heath.

3.3 | Age specific analysis

The age specific findings for males and females, using data from 1990 to 2018, are reported in Table 4; six broad age groups are considered. In all estimations, we control for demographics, % of 25–55 year-olds with a university degree, personal income, and pollution. First, we look at the populations that are engaged directly in the labor market (age groups 15 to 24, 25 to 44, and 45 to 64). For working-aged men, we find no significant relationship between the changes at the extensive margin and the mortality rates. We find conditional average hours worked to have a significant negative impact on mortality rates of men aged 45 to 64. Specifically, a 1% rise in average hours worked causes male mortality rates for this age group to fall by 0.474%; this is equivalent to 140 fewer deaths in 2018.

For women of working age, we find that both the extensive and the intensive margins are important. At the extensive margin, our findings suggest that a slowdown in the economy is good for their health. Specifically, for women aged 25 to 44 and 45 to 64, a fall in the employment rate by one pp leads to a fall in the mortality rate by 1.31% and 1.12% respectively. However, at the intensive margin, an increase in hours worked is good for their health. In particular, a rise in conditional average hours worked, controlling for the employment rate, leads to a fall in the mortality rate of 2.70% and 1.55% for the 15 to 24 and 25 to 44 age groups respectively.

Next, we look at the estimates for the elderly. Across all our specifications, the estimates on the indicators of state of the economy are insignificant for both females and males ages 75 and

TABLE 4 Effect of economic indicators on age-specific log mortality rates, 1990 to 2018.

	(1)	(2)	(3)	(4)	(5)	(6)
Male	**0 to 14**	**15 to 24**	**25 to 44**	**45 to 64**	**65 to 74**	**75 over**
Employment rate	−0.0195*	0.0156	0.0103	0.0042	−0.0082**	−0.0028
	(0.0104)	(0.0113)	(0.0120)	(0.0049)	(0.0033)	(0.0027)
Log average hours (conditional)	1.4876**	−0.7934	−0.0275	−0.4744**	0.3523*	0.2687
	(0.5883)	(0.8317)	(0.4621)	(0.1909)	(0.1863)	(0.1739)
Log personal income 16 to 64, all	0.0649	0.5419*	−0.1064	0.1361	0.1817**	−0.0778
	(0.3830)	(0.2743)	(0.2296)	(0.0999)	(0.0588)	(0.0623)
Log personal income 65+, all	−0.2421	0.1443	0.1029	0.1004*	0.0841*	0.0637*
	(0.2631)	(0.1903)	(0.0693)	(0.0470)	(0.0447)	(0.0319)
PM2.5 (×10,000 Metric tons)	0.0032	0.0155***	0.0049	0.0027	0.0009	0.0026**
	(0.0048)	(0.0042)	(0.0045)	(0.0016)	(0.0011)	(0.0010)
CO (×10,000 Metric tons)	−0.0011	−0.0005	0.0005	−0.0007***	−0.0002	0.0002
	(0.0006)	(0.0012)	(0.0008)	(0.0001)	(0.0002)	(0.0002)
N	288	290	290	290	290	290
R^2	0.871	0.906	0.932	0.983	0.993	0.964
Female	**0 to 14**	**15 to 24**	**25 to 44**	**45 to 64**	**65 to 74**	**75 over**
Employment rate	−0.0293	0.0099	0.0131**	0.0112***	−0.0045*	0.0022
	(0.0215)	(0.0251)	(0.0041)	(0.0026)	(0.0022)	(0.0013)
Log average hours (conditional)	1.5337	−2.6985**	−1.5458***	−0.0678	0.4040	0.2114
	(1.9449)	(0.9170)	(0.4130)	(0.3105)	(0.3265)	(0.1378)
Log personal income 16 to 64, all	0.0633	0.8295	0.1499	−0.1285	0.2509*	0.0455
	(0.5825)	(0.5137)	(0.1967)	(0.0992)	(0.1142)	(0.0518)
Log personal income 65+, all	0.5752**	−0.2326*	0.0824	0.0958*	0.1771***	0.0593
	(0.2071)	(0.1200)	(0.0798)	(0.0456)	(0.0261)	(0.0430)
PM2.5 (×10,000 Metric tons)	−0.0006	0.0037	0.0080**	0.0036	0.0009	−0.0001
	(0.0101)	(0.0080)	(0.0029)	(0.0021)	(0.0012)	(0.0010)
CO (×10,000 Metric tons)	−0.0007	−0.0025	−0.0011*	−0.0003	0.0006**	0.0000
	(0.0010)	(0.0016)	(0.0005)	(0.0003)	(0.0002)	(0.0001)
N	288	286	290	290	290	290
R^2	0.735	0.641	0.876	0.948	0.982	0.960

Note: See notes to Table 3. Standard errors in (.) parentheses are clustered over provinces.
**p* < .10; ***p* < .05; ****p* < .01.

over. Furthermore, in the case of females over 75, pollution and income do not affect mortality. However, mortality rates of males ages 75 and over are impacted by PM2.5 levels, with an estimate that is around 0.003. We also find that an increase in the personal income of the elderly causes mortality rates of males 75 and over to rise. For the 65 to 74 senior population, business cycle fluctuations matter both for male and female health, with recessionary periods being detrimental to health, while expansionary periods improve health. A one pp rise in employment leads to a fall in mortality rates of 0.82% for males and 0.45% for females respectively, which implies about 270 and 115 less deaths respectively (using 2018 data). However, estimates on average hours indicate that senior male mortality is positively impacted by conditional average hours. Thus, while an improvement in employment rates reduces the mortality for elderly males, the rise in average hours worked worsens senior male health once we control for employment. This effect is not found for senior females, where only changes along the extensive margin are statistically significant.

Finally, we look over the findings for the 0 to 14 age group. This age group includes infant mortality rates, which tend to be high due to the high death rates in the first 24 hours of life. Mortality rates for those 1 to 14 also tend to be the lowest among all age groups.[22] We find employment and conditional average hours worked to be significant for male mortality rates, while for females both are insignificant. For males, a rise in employment by one pp leads to a fall in mortality rates of 1.95%; as the number of deaths in this age group tends to be low this means about 12 additional deaths each year. Furthermore, when employment is controlled for, a rise in conditional average hours by 1% leads to a fall of 1.5% in male mortality rate. Interestingly, our findings for the 0 to 14 and 65 to 74 male age groups are qualitatively similar, in terms of the extensive and intensive margins.

3.4 | Discussion

In summary, our results at the aggregate and those by gender suggest that female mortality is impacted by fluctuations in economic activity, irrespective of the measure used as a proxy for economic activity. Findings from our analysis using data from 1976 to 2018 versus 1990 to 2018 reveal heterogeneity over time, specifically in terms of the impact of the extensive vs. intensive margin. This finding is important as it demonstrates that not only can there be changes over time in the estimates, as was documented by Ruhm (2015) for the United States, but the channel via which individuals' health is impacted can also differ dramatically. In our case, the intensive margin initially drives changes in female mortality, however, this is no longer true when more recent data is considered. Instead, we find changes in the extensive margin to have a significant impact on female mortality. This suggest that the role of both margins should be examined to provide a clearer answer to whether economic activity impacts health.

Our next set of findings imply that the importance of personal income and pollution changes cannot be overlooked when examining the relationship between economic fluctuations and mortality. Specifically, our results suggests that at aggregate male health is adversely impacted by the rise in income and pollution levels, which are more likely to happen during expansions. This contrasts with findings for females, where in addition to the positive impact of personal income and pollution, rise in employment also yield higher mortality rates. Thus, there are clearly differences in the transmission channels of changes in macroeconomic conditions on health across gender.

[22]Note that the number of deaths ages 1 to 14 in Canada was 346 in total with a total mortality rate of 11.6 per one hundred thousand (stats Canada; 2018). We do a robustness check, where infant (below the age of 1) mortality rate and mortality rates for 1 to 14 are considered separately. Results do not change qualitatively to those presented for the combined age group, 0 to 14. Results are available on request.

Our age-specific results provide additional insights, particularly when examining the role of the extensive and intensive margin. For men, while at the aggregate there is no relationship between the extensive or intensive margins and mortality rates, the age-specific analysis suggests that recessions are bad for the health of working age men (45 to 64); this impact is seen along the intensive margin, where lower average hours worked cause mortality rates to rise. Results for seniors (age 65 to 74) and children (0 to 14) differ across margins; while a rise in economic activity via higher employment leads to improvement in mortality rates, indicating that recessions are bad for male health, changes along the intensive margin suggest that recessions are good for these age groups. In the case of working age females (25 to 64), the employment rate is found to be positively correlated with mortality rates, suggesting that recessions are good for female health. The fact that mortality rates of senior females, ages 65 to 74, worsen during periods of falling employment, while that of the working age population improves, implies that our aggregate results, while somewhat muted, are driven by those of the working age. Changes in hours worked negatively impact the health of females, however only those 15 to 44; the elderly working age population is not impacted. Our results suggest that it is possible that even if the movements of individuals in and out of employment have no impact on the mortality rate, especially when considering age-specific mortality, changes in macroeconomic conditions can adversely affect the employed via a change in average hours worked. Consequently, an evaluation of both the extensive and intensive margin is needed.

Our findings of a countercyclical mortality observed for working age adults, via the intensive margin, could be driven by higher stress associated with fears of job loss, and the potential of loss of social networks, status, self-worth, and so forth. The rise in stress can exacerbate poor physical health and worsen mental health leading to a higher mortality rate. Charles and DeCicca (2008) point to the so-called "stress hypothesis" that specifically refers to worsening health and weight gain incurred by males during periods of rising unemployment. Poor nutrition and greater alcohol consumption may be used as a coping mechanism to deal with stress, and can contribute to liver disease, heart disease, and diabetes.[23] Moreover, males may experience additional stress and deteriorating physical and mental health in times of recession due to societal expectations, as "men are more often expected to be active in the labor market than women," Van Hedel et al. (2015). These stresses resulting from job loss or a loss in hours worked could potentially give rise to suicide. Ruhm (2000, 2003, 2015) consistently finds suicides to rise during contractionary periods in the United States. Since male suicide rates in Canada tend to be highest for the working age group closest to retirement, suicide could also be a contributing factor to countercyclical mortality for males 45 to 64.[24]

We find some indications of countercyclical mortality for males ages 0 to 14 and for male and female seniors ages 65 to 74. The rise in mortality among children as the average hours worked increase may be a result of lower supervision (or inadequate supervision) as the economy expands, thus leading to a rise in accident-related deaths.[25] However, fluctuations in employment have the opposite effect on health. A micro level analysis would likely shed light on why the rise in employment improves health outcomes for males 0 to 14, however it should

[23]Liver disease is the fourth leading cause of death for males ages 45–64, while it is sixth for females, while the mortality rates of younger males (20s and 30s) are largely driven by motor vehicle crashes and other external sources of death. Statistics Canada Table: 13-10-0394-01 (2000s).

[24]Suicide rates for males ages 64 to 75 have been lowest among the population 15 and older; Canadian Vital Statistics—Death Database, Statistics Canada (2000–2020).

[25]According to Statistics Canada the leading cause of death for this young age group are accidents, followed by cancers, malformations, and self-harm, with male deaths in the late 2000s being approximately 1.5 to 2 times larger than female.

be noted that the number of deaths here is relatively small given the low mortality rates for this age group. In contrast, the mortality rates for the elderly are high, as they experience worsening physical health over time, with cancer, heart disease, respiratory disease, and diabetes leading to most deaths. For this group, as economic conditions worsen, these illnesses can be exacerbated due to stress. Although the mechanism is unclear, Ruhm (2015) found cancer to be countercyclical in recent years in the United States, which can be a possible source of the rise in the mortality rate during recessions for the elderly in Canada.

Procyclical mortality is found in working age females in the 25 to 65 age group, specifically via the extensive margin. This is likely due to different mechanisms influencing the relationship in the aggregate, with health-improving impacts—due to changes in opportunity costs, less exposure to work-related accidents, and transport accidents—dominating health-deteriorating impacts from job loss. It should be noted that this age group also includes the majority of first-time mothers in Canada, those 25 to 44. Motherhood could be contributing to why the relationship between macroeconomic conditions and mortality for those 25 to 44, differs across the extensive vs. intensive margin, and it is worth investigating further in the future.

Following Heutel and Ruhm (2016), we examine the role of air pollution in our analysis as a potential mechanism via which economic activity impacts health. In contrast to their results, we do not find that including pollution in our estimation reduces the impact of fluctuations in the employment rate on the mortality rate as our estimate remains largely unchanged, especially when both person income and pollution are controlled for simultaneously. Furthermore, higher PM2.5 levels are associated with higher mortality rates for males, particularly those 75 and over who are likely more sensitive to pollutants.

4 | CONCLUSION

In this paper, we use panel data for Canada to re-evaluate the relationship between mortality and economic fluctuations (captured via changes in the labor market). The key contribution of our paper is in exploring alternative measures of economic activity, unemployment rate, employment rate, and hours worked, and assessing the differential impact of extensive vs. intensive margin on health. We also explore if the relationship has changed over time, and if it varies across gender and different age groups.

Across different specifications we find that at the aggregate recessions are good for female health, however, heterogeneity is found over time, with the intensive margin driving the results across the whole sample, and the extensive margin being important for female health in the recent time period (1990 onwards). Our estimate, where both personal income and pollution are controlled for, suggests that a one pp increase in the unemployment rate leads to a 0.47% fall in mortality rate. We find no relationship between male mortality rates and economic fluctuations at the aggregate. While the procyclical impact on female health seems to be primarily driven by women aged 25 to 64, there is evidence to suggest that mortality rates among women aged 15 to 44 actually decrease in response to higher average hours worked. This suggests that there may be opposing effects at play within the 25 to 44 age group. The impact of economic conditions on male mortality varies significantly by age group. Among males of working age, only those between the ages of 45 and 64 are affected by economic changes, specifically by fluctuations in average working hours. In this case, mortality rates move in the opposite direction of economic cycles, increasing during economic downturns and decreasing during economic upturns. For younger and older males, the relationship between mortality and economic conditions is more straightforward. Both groups experience higher mortality rates when average working hours increase, but lower mortality rates when employment rates rise. Overall, our results suggest that by examining both the extensive and intensive margins, we gain important insights into the impact of macroeconomic fluctuations on health, that a focus on the unemployment rate alone may miss.

Our findings can guide policy makers in several ways. First, our results suggest that falling unemployment rates are associated with rising mortality rates for females. This is further documented for females in the 25 to 64 age group. Policy campaigns to raise awareness of deteriorating health during expansionary periods for women ages 25 to 44 as employment rates fall should be pursued. Second, we propose that recessions can be a time of increase in stress for some working age female and male workers that stem from the intensive margin. Hence, despite these workers remaining employed, public services targeted toward employed workers with decreasing hours during recessions should not be overlooked. It should be noted that this impact of decrease in hours worked cannot be explained by income effect alone, as we see this effect even after controlling for income. Finally, our findings suggest that policy efforts to lower exposure to PM2.5 pollutants would be beneficial for health across both genders.

Finally, our research suggests several possible directions for future research as more data becomes available, such as the specific role of stress both for the unemployed and the employed (as their hours adjust) for health, the importance of consumption of alcohol and drug use as economic conditions change and their impact on mortality rates, and the mechanisms that may be impacting the health of females of child-bearing age over the business cycle.

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APPENDIX A

Mortality Rate – per 1000 population (annual data is provided on a July to June basis).

1976–1977 data: Canada. Vital Statistics, Volume III, Deaths. Statistics Canada, Vital Statistics Section. Ottawa, Issues 1976–1977.
1978–1982 data: Canada. Vital Statistics, Volume I, Births and Deaths. Statistics Canada, Vital Statistics and Disease Registries Section. Ottawa, Issues 1978–1982.
1982–1986 data: Canada. Vital Statistics, Volume I, Births and Deaths. Statistics Canada, Vital Statistics and Disease Registries Section. Ottawa, Issues 1982–1986.
1987–1990 data: Canada. Health Reports, Supplement, Deaths. Canadian Centre for Health Information. Ottawa, Issues 1987–1990.
1991–2018 data: Statistics Canada Table: 17-10-0006-01.

Population (annual, July 1st estimates): Provincial population data are obtained from Statistics Canada Table: 17-10-0005-01.

Personal Income for 15 to 64 and 65 and over are obtained from Statistics Canada Table: 11-10-0239-01.

Pollution data is obtained from Canada's Air Pollutant Emissions Inventory (APEI). The APEI is an annual report of air pollutant emissions across Canada published by Environment and Climate Change Canada. The report details the release of air pollutants from all known sources since 1990.

All data below are obtained at monthly frequencies; an annual average is obtained on a July to June basis. All data are at the provincial level.

Unemployment rate data is obtained from Statistics Canada (from Labor Force Survey estimates) Table: 14-10-0287-03.

Average hours worked (AHW) in reference week: total hours worked in a reference week are obtained from Statistics Canada Table: 14-10-0032-01. To obtain the conditional average hours worked in a reference week, AHW is divided by the total number employed (Table: 14-10-0032-01). For the unconditional average hours worked in a reference week, AHW is divided by the total number in the labor force (Table: 14-10-0032-01).

Percent of 24–54 population with University Degree (1990–2017) data by province is obtained from Statistics Canada (from Labor Force Survey estimates) Table: 14-10-0032-01.

APPENDIX B

TABLE B1 Mortality rates by age and gender, Canada, 1976 to 2018.

	All		Male		Female	
Age	Mean	SD	Mean	SD	Mean	SD
All	7.60	1.03	8.18	1.08	7.03	1.16
0 to 14	0.30	0.14	0.34	0.17	0.25	0.13
15 to 24	0.75	0.26	1.09	0.41	0.39	0.14
25 to 44	1.14	0.21	1.51	0.31	0.77	0.14
45 to 64	6.10	1.58	7.80	2.32	4.44	0.92
65 to 74	22.14	4.82	28.93	7.34	16.19	2.93
Over 75	69.75	6.28	83.32	9.15	60.78	6.99

Note: Mortality rate is the number of deaths divided by the size of the population, reported per 1000 people.

TABLE B2 Summary statistics of selected variables.

	Mean	SD	Date range
Unemployment rate	9.42	3.65	1976–2018
Average weekly hours (conditional)	34.75	1.26	1976–2018
Average weekly hours (unconditional)	31.48	1.81	1976–2018
Employment rate	56.38	5.68	1976–2018
Share of residents in age categories			
Infant (<1 year)	1.27	0.26	1976–2018
1 to 19	26.44	4.73	1976–2018
45 to 54	12.55	2.64	1976–2018
55 to 64	10.23	2.44	1976–2018
65 to 74	7.26	1.48	1976–2018
75 to 84	4.08	0.93	1976–2018
85 and older	1.22	0.65	1976–2018
Log personal income 16 to 64, all	10.53	0.19	1976–2018
Log personal income 65+, all	10.28	0.22	1976–2018
University degree (25 to 54) %	20.02	5.87	1990–2018
PM2.5 (×10,000 Metric tons)	14.37	16.12	1990–2018
CO (×10,000 Metric tons)	81.41	85.38	1990–2018

TABLE B3 Effect of employment rate and log average conditional hours worked on log mortality rates 1976–2018, with demographic controls.

	(1) All	(2) Male	(3) Female
Employment rate	−0.0007	−0.0031	0.0017
	(0.0013)	(0.0022)	(0.0012)
Log average hours (conditional)	0.1571	0.0839	0.2308*
	(0.1112)	(0.1324)	(0.1242)
Infant population%	−0.0348	−0.0750*	−0.0003
	(0.0261)	(0.0370)	(0.0263)
1% to 19%	−0.0177***	−0.0176***	−0.0164***
	(0.0021)	(0.0026)	(0.0019)
45% to 54%	0.0106**	0.0117**	0.0123**
	(0.0047)	(0.0051)	(0.0047)
55% to 64%	0.0191**	0.0174**	0.0217**
	(0.0063)	(0.0054)	(0.0077)
65% to 74%	0.0288**	0.0232	0.0359***
	(0.0117)	(0.0147)	(0.0089)
75% to 84%	0.0381*	0.0314	0.0474**
	(0.0169)	(0.0199)	(0.0158)
85% and older %	0.0677*	0.0509	0.0886***
	(0.0327)	(0.0384)	(0.0234)
N	430	430	430
R^2	0.923	0.921	0.970

Note: Standard errors in (.) parentheses are clustered over provinces. The standard errors reported are robust to disturbances being heteroscedastic and autocorrelated. The table reports the weighted estimates, where the weight is the province-specific population averaged over 43 years. All specifications include time fixed effects and province specific time trends.
*$p < .10$; **$p < .05$; ***$p < .01$.

TABLE B4 Effect of economic indicators on log mortality rates, 1990 to 2018.

	(1) All	(2) Male	(3) Female	(4) All	(5) Male	(6) Female
Unemployment rate	−0.0002	0.0028	−0.0033*			
	(0.0019)	(0.0026)	(0.0016)			
Log average hours (unconditional)				0.1016	0.0012	0.2078**
				(0.0887)	(0.1245)	(0.0841)
N	290	290	290	290	290	290
R^2	0.896	0.882	0.933	0.897	0.880	0.933

Note: Standard errors in (.) parentheses are clustered over provinces. The standard errors reported are robust to disturbances being heteroscedastic and autocorrelated. The table reports the weighted estimates, where the weight is the province-specific population averaged over 43 years. All specifications include time fixed effects, province specific time trends, and demographic controls (share of the province residents who fall in one of the following seven age categories: <1, 1–19, 45 to 54, 55 to 64, 65 to 74, 75 to 84, and 85 and older).
*$p < .10$; **$p < .05$; ***$p < .01$.