Unemployment and Mortality in Canada

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1. Introduction

This paper explores the relationship between unemployment and mortality in Canada. This paper follows up on previous international research that has shown that unemployment affects mortality in both procyclical and countercyclical manner depending on the data used. There has been little investigation done on this topic in Canada when compared to international investigations, so the goal is to improve upon current Canadian research. The American study by Ruhm (2000) contributed to renewed interest in this area of research, and this paper is based on Ruhm's work, although it investigates the case of Canada.

Ruhm's paper improves on past research by using a different model that allows for analysis of panel data. Ruhm employs a fixed effect panel data model instead of a cross section or time series model. In this paper, the dependent variable, log of mortality used to proxy health status, was regressed against national and state level unemployment rates for all 50 states in the United States from 1972-1991, while controlling for education, personal income and population racial and demographic characteristics. The dependent variable was broken into ten different mortality categories for specific causes of death. The results demonstrated that in eight of the ten categories of mortality, state level unemployment was found to have a negative effect on mortality. The two categories of mortality that were found not to be procyclical were mortality due to cancer, on which unemployment had no effect, and mortality due to suicide which was found to be countercyclical. Ruhm also examines micro data and shows that obesity and smoking increase during economic up turns and these poor health behaviours suggest that the

macro level data is consistent with the micro level effects. Obviously, smoking and obesity contribute to mortality as those two behaviours are bad for health.

This paper will use Ruhm's model to investigate the unemployment and mortality relationship for Canada. An important control variable used in Rhum's analysis is the percentage of Blacks and Hispanics in the population, two groups that tend to have weaker health status than the overall population. For Canadian analysis, aboriginal Canadians are employed as the disadvantaged racial group instead of the Blacks and Hispanics since aboriginals are shown to have higher mortality than the rest of the Canadian population (Shah 1996).

In contrast to the results of Ruhm (2000), the analysis in this paper shows that unemployment has a positive effect on overall mortality in Canada. However, the results vary by age-groups and for different causes of mortality. In particular, unemployment has a positive and significant effect on mortality due to cardiovascular diseases, but has no significant effect on mortality due to cancer, as one would expect. This analysis also shows that mortality due to injuries and suicides were related negatively to unemployment. To further Canadian research, an additional control variable, real health spending per capita, designed to capture health resources available in each province, was included. This variable did not affect the unemployment mortality relationship previously reported. This shows that despite universal health care in Canada, this unemployment and mortality relationship still exists.

This paper is broken into different sections. First, British, American and Canadian literature pertaining to unemployment and mortality will be reviewed. Next the data and model will be discussed and the modifications to the basic model of Ruhm

(2000) for Canada. Results of Ruhm's specification, using Canadian data, and other regressions incorporating real health spending per capita are reported. Finally, policy options and future research questions are proposed.

2. Literature Review

Several questions regarding economic measures and health outcomes have been investigated by social scientists, health scientists and economists. Many different economic measures have been investigated to assess their effects on health including gross domestic product, health spending, family income, family wealth and business cycles (Wilkinson 1996). Internationally there have been many studies on the relationship between unemployment and mortality. This paper will examine the effect of unemployment on mortality in Canada.

A Canadian perspective is necessary since most of the research in this area has taken place outside of Canada. Many of the historical studies have examined the cases of Britain, which has a large public health care system called the National Health Service (NHS), and of the United States, which has a very large private delivery of health services (Brenner 1979, Ruhm 2000). The relationship between economic conditions and mortality in Canada may be different due to differences in health care systems and social programs.

This first part of this section will review the literature on the relationship between economic conditions and health for Britain and United States. The second part of the literature review will focus on Canadian specific research.

The seminal paper by Ogburn and Thomas *The Influence of the Business Cycle on Certain Social Conditions* was published in 1922. This paper was the first to examine with statistics the relationship between business cycles and mortality. The authors found a positive correlation, 0.57, between measures of the business cycle and mortality for the period of 1870 to 1920 in the United States. The authors investigated lags and found that the correlation decreased to 0.49 and 0.03 when the measure of the business cycle was lagged by one and two years, respectively. However, the authors emphasized that the relationship may not be causal. Ogburn and Thomas also examined the correlation in England, to see if the relationship held internationally, from 1870 to 1914 between general mortality and foreign trade, measure of the English business cycle, and found a correlation coefficient of only 0.02.

Between 1922 and 1979 there was research undertaken in the medical community showing that health was influenced by many different factors. The next paper that contributed to understanding the relationship between unemployment and mortality was published in 1979 by Brenner. Brenner concludes that economic instability and unemployment lead to mortality. The proposed mechanism is that unemployment causes stress and downward social mobility. Brenner investigated the cases of Britain and Wales from 1936 to 1976, with the NHS being implemented in 1948. Brenner considered mortality at all ages and mortality rates per five-year age-groups. The independent variables in Brenner's model included the economic growth trend, the annual deviation of the growth rate from the trend, government welfare expenditures as a percentage of total government revenue and unemployment rates. Brenner's analysis suggests that increased unemployment is related to increase mortality or mortality is procyclical with

unemployment rates for Britain for his time period of analysis. Brenner also found that the R-squared, for total mortality was high, .97 and when different age group mortalities were used the R-squared varied from .64 to .98. The F-statistic for joint test of significance also rejected the null hypothesis that the variables were jointly all zero. Brenner concludes that the long run decline in mortality is due to economic growth, but the short run variation in mortality is due to the unemployment cycles.

Brenner (1979) used the fact that medical and social scientists were starting to realize that health and health conditions were also explained by economic factors. These various articles and books are beyond the scope of this review since the literature for each specific health condition is extensive on it own. Brenner's 1979 paper then lead to a large discussion of this area of literature in the 1980's with critics of the models, selection of time period and measurement of economic conditions. The next few papers will discuss the 1980's research that resulted from Brenner's article.

One of the first critic of Brenner's 1979 work was Gravelle, Hutchison and Stern (1981). The authors examine four separate issues with Brenner's study: robustness of results with respect to sample periods; consistency and reliability of data; specification errors and results compared to other studies. The authors cite microeconomics studies and cross sectional studies that illustrate mortality and unemployment cannot be as simply explained as Brenner states and other factors maybe influencing mortality as well. The other three concerns are with respect to the data Brenner used. The first concern was that mortality was for England and Wales and economic statistics were only for England. The authors felt that some of the variables may cause multicolinearity in the model and the model might suffer from endogeneity bias. The authors also felt that the length of

time series might be capturing other effects and compared two parts of the sample with a chow test for structural stability and found that the model was different for both time periods. The authors then estimate a model with British data and demonstrate that Brenner's model is not robust and that there is potential for misspecification; however, the authors note that Brenner pioneered this area of investigation and more work is needed.

Then Brenner and Mooney (1983) examined the multidisplinary evidence that relates unemployment and health in the context of economic change, and suggested three ways that economic change affects health. First, a down turn in the economy may cause a change in financial resources. Insufficient level of financial resources may lead to the inability to purchase goods that affect health such as food and housing. Second, the loss of job may cause psychosocial stress and reduce the benefits of social relationships. Third, the stress might cause a change in health behaviours such as smoking, drinking, eating and others that affect health outcomes. The authors suggest that there is enough evidence to consider a research agenda at the macroeconomic and microeconomic levels to examine unemployment, health and mortality relationship more thoroughly.

The literature continued with Gravelle (1983), who argued that the failure of research to find a robust and clear conclusion is due to the lack of quality data and inadequate modeling techniques. More and better collected data would be required for properly examining the relationship. Gravelle suggests that cross sectional data be collected and used, but also recognize that there is a considerable expense and difficulty in collecting data like this. Modeling techniques need to consider other variables that

also affect mortality such as behaviours and correct for potential multicollinearity among variables such as unemployment and income.

Forbes and McGregor (1984) differed from other papers since it looked at only one country being Scotland and continued the idea of disaggregating mortality for different age groups. The reason for using only Scotland was that previous studies used variables from one region and assumed that they represented unemployment in another region. Brenner (1979) used British unemployment and mortality for all of the United Kingdom. This was the first study that attempted to improve the data by selecting a country that had unemployment data and mortality for the same geographical region. The reason for the different age groups was to test to see if evidence of differing bouts of unemployment affects mortality of different ages. Another improvement consisted in using only post war years given that the world wide depression and World War II would affect mortality. The model also included other variables that may affect health such as real health spending per capita, long run trend of real GDP per capita and other measures of economic change. Findings suggest that unemployment is more significant predictor of mortality in the 40 to 64 years old age group and that duration of unemployment, short duration measure less than 26 weeks of unemployment and long duration of unemployment being greater than 26 weeks, does matter for estimates with significant results differing according to duration of unemployment. The authors find again little support for Brenner's hypothesis that long run economic growth reduces mortality.

McAvinchey (1985) examined five European countries for unemployment and mortality, distinguishing between male and female mortality within each country. The author's innovation was to test whether rising income accounts for the overall decrease in

mortality with unemployment explaining variations. The author, using time series data, selected the lags and degree of polynomial using econometric techniques rather than arbitrarily selecting the degree of polynomial and lag of unemployment, first study to have done this. The author finds that unemployment is significant in nine of the ten models, but the direction of effect on mortality occurs in both ways. The authors also discussed that the time series data and not having cross sectional data impacts the study, but the author does recognize that collecting better data may help explain the relationship.

The research conducted in the 1980's shows that unemployment affects mortality along with demonstrating that this can differ based on regions, time series analyzed and other factors. Mc Avinchy (1985) shows that there are differences between male and females. Forbes and McGregor (1988) show differences among age groups and specification of data for regions. Some of these factors have not been investigated for Canada. The studies in the 1980's also made use of only time series data or cross sectional data. Subsequent research has used panel data.

The next major advancement came in 2000 when Christopher Ruhm, using panel data, published *Are Recessions Good for Your Health?* This paper made use of more data that had become available and a better understanding of the multifactor influences on health, including mortality and other health conditions. Ruhm (2000) used new data for the 50 US states and estimated a fixed effects model. He used data for overall mortality and mortality in specific age groups, including 20 to 44 years olds, 45 to 64 years old and greater than 65 years old. In addition, Ruhm was able to get mortality data for ten specific health conditions: heart disease, cancer, flu/pneumonia, liver disease, vehicle accidents, other accidents, suicides, homicides, infant mortality and neonatal mortality.

Eight of the ten variables were negatively related to unemployment in the United States. Unemployment had no effect on mortality due to cancer and this was used as a control to test to ensure that the model was not misspecified as cancer should only be affected by biological variables. Only one cause of mortality, suicide, was found to be related positively to unemployment. Ruhm's analysis controlled for income, percentage of blacks and Hispanics residing in each state, national unemployment and population under age five and over age sixty five. The results were also robust to the inclusion of lagged unemployment by two and four time periods. The conclusion of this paper is that it appears that recessions are good for you health. Interestingly the smallest effect of unemployment on mortality is for 45 to 64 years of age and sixty five plus years of age. At 65 in the United States people are entitled to Social Security and Medicare, similar to Canadian Pension Plan and Canadian Medicare, and Ruhm did not correct for this. Government health spending will likely impact mortality and it may be important to control for this. Rhum also controlled for national and local economic conditions by including national and state level unemployment rates.

Laporte (2004) recently revisited Brenner's hypothesis attempting to correct Brenner's model and examine short and long run mortality trends. Laporte applies an error correction method to allow for non-stationarity of data and also examines whether fluctuations, percent changes, in the regressors along with the actual value of the regressors explain mortality. This is done to examine the shock effect on mortality while controlling for the level of the variables, which have been researched extensively before. Laporte estimated three models. The first model examined the short run effects on mortality of the percentage of the labour force unemployed, controlling for lagged real

GDP per capita and lagged total health spending. The second model examined long run effects of unemployment on mortality. Percentage change in unemployment was significant along with lagged values of real per capita health spending, real per capita GDP and unemployment rate. Also, the third model looked at positive and negative shocks in unemployment to see if there is a different effect on mortality if the shock is positive or negative along with other regressors. This model demonstrates that an increase unemployment rate decreases mortality in Canada while controlling for GDP shocks, negative unemployment rate shocks, percentage unemployed, real GDP per capita and real health spending per capital were all significant as well. This paper supports the conclusion that an increase in unemployment has a positive effect on health.

Overall, the international evidence is mixed and uses a wide variety of variables and different measures of mortality. This section will review the Canadian evidence related to unemployment and mortality. The first Canadian study was done by Statistics Canada (Adams, 1981) investigating unemployment and mortality in Canada and this study was motivated by Brenner's work. The Canadian study was based on annual data from 1950 to 1977 with mortality compiled by causes and age groups. The model used lagged unemployment rates and duration of unemployment and mortality was detrended. The author clearly shows that there is a relationship between mortality and unemployment and duration of unemployment in Canada, though the direction varies with causes of death. This study however included only unemployment as regressor.

The next Canadian study used cross sectional data of the 1978-1979 Canadian Health Survey and discussed the differences between the employed and the unemployed self reported health measures and physician reported health measures (D'Arcy and

Siddique 1983). The authors note that employment was negatively and significantly related to reports of these health measures. However, the analysis did not include a time trend or gender differences. The importance of this study is that these measures are morbidity factors and this study demonstrates in cross sectional form a significant relationship. These two studies demonstrate that there might exist a relationship over time and within Canada between unemployment and mortality.

The most up to date research in Canada has been done by Beddard et al. (1999) and Laporte and Ferguson (2003). These papers both make use of all provincial data and expand on the number of regressors to explain mortality. The first paper uses standardized mortality rates across provinces, a relative measure of deaths between provinces, but this paper uses many independent variables of interest. The goal of this paper was to examine the impact of health care funding, but socioeconomic variables were included for the cross sectional data. The variables that were also included were male unemployment rate, percentage of aboriginal population, proportion of families with low income - under 20 000 – and percentage of high school graduates which were shown to be jointly significant. Among provincial data, unemployment rate had a positive and significant effect at the 1% level for Nova Scotia, Ontario and Manitoba when explaining standardized mortality rate for people under 75. Also, when the dependent variable is standardized mortality rate for ages less than 65, unemployment had a positive and significant effect at the 5% level for Nova Scotia and 1% level for Ontario. Aboriginal percentage of population was positively correlated to standardize mortality rates for people less than 75 years of age at the 1% level of significance for Manitoba and at the 5% significance level for Newfoundland, Ontario, Saskatchewan and Alberta. The

percentage of aboriginal population was also positively related to age standardized mortality rates for age less than 65, at the 1% significance level for Ontario and Alberta and at the 5% significance level for Saskatchewan. Overall, this paper demonstrates with cross sectional data that unemployment, when combine with other variables, can help explain mortality, and supports the inclusion of percentage of aboriginal population as an important regressor. This study also supports the idea that unemployment affects mortality positively in Canada, counter to Ruhm's observations that mortality and state level unemployment are negatively related.

The most recent paper to include unemployment and panel data is a paper about income inequality and mortality in Canada by Laporte and Ferguson (2003). The goal of this paper was to examine the effect of income inequality, measured by Gini coefficient, on mortality. The effect was found to vary significantly across provinces, while controlling for other factors. The authors included a time trend and found that it was significant. The authors also found that unemployment and health spending had a significant effect on mortality.

The Canadian evidence points to the fact that unemployment maybe related to mortality. The Canadian studies have shown that other factors matter such as percentage of aboriginal population (D'Arcy 1986), unemployment rate (Adams 1981), health spending (Laporte 2004) and income (Laporte and Ferguson 2003). However, the Canadian studies have only used either time series data (Adams 1981) or cross sectional data to examine the relationship (D'Arcy and Sidique 1983). The paper by Ruhm (2000) showed that panel data may be an appropriate technique for the purpose of examining this relationship and this has not been done for Canada. Hence, this paper will use Ruhm's

approach to take a new look at the Canadian evidence while taking into account Canadian differences.

The next section discusses the data used in the paper. The third section discusses the model and the estimation method used in this paper to evaluate the unemployment and mortality relationship for Canada. The fourth section presents the results of the paper and discusses them. The fifth section concludes the paper with policy options and future research.

4. Data

The data was retrieved from the CANSIM database maintained by Statistics Canada. The model consists of yearly provincial level data from 1991 to 1999. The first data discussed are the dependent variables. The dependent variables are similar to those in Ruhm (2000). Three different types of mortality measures are used: mortality rates, measured as deaths per 100 000 of population, by age groups including infant mortality (deaths per 1000 live births), potential years of life lost due to suicide and unintentional injuries and mortality rates for specific causes of death. The mortality data was limited in time length as International Classification of Disease 9 (ICD 9) was used until 1999, but there after the World Health Organization switch to International Classification of Disease 10 (ICD 10). The equivalency between the two systems of classification has yet to be done. In Table 1, descriptive statistics for the dependent variables are shown.

Table 1 – Descriptive Statistics for dependent variables

Variable	Mean	Std Dev
Mortality per 100 000 population		
Mortality for all older than 15 years (D15PB)	940.010	113.690
Mortality for 25 to 44 years old, both sexes (D2544B)	112.000	12.471
Mortality for 45 to 64 years old, both sexes (D4564B)	564.920	55.330
Mortality for 65 years and older, both sexes (D65PB)	4735.500	361.350
Per 1000 live births		
Infant mortality per 1000 live births (BIRTH)	6.181	1.332
Potential Years of Life Lost per 100 000 population		
Due to unintentional injuries, both sexes (CBINJ)	872.430	201.680
Due to unintentional injuries, both sexes,(CBSUI)	434.980	129.390
Mortality per 100 000 population		
Both sexes deaths from colorectal cancer (BCR)	18.583	3.020
Both sexes deaths from lung cancer (BL)	50.627	7.298
Both sexes deaths from acute myocardial(BAMI)	73.591	13.759
Both sexes deaths from all cereberovascular (BCE)	79.578	5.622
Both sexes deaths from all strokes (BALL)	43.678	5.165

The regressors were retrieved from government databases. The two variables that were not retrieved from CANSIM were aboriginal population and real health spending per capita. Per capita income, provincial and national unemployment rates were all retrieved from CANSIM. The education variables were aggregated into the three categories from data retrieved in CANSIM. Population percentage was calculated from population data in the CANSIM database by calculating the percentage of the population in the two age groups, less than five years old and older than sixty five years old. Real Health Spending was retrieved from the Canadian Institute of Health Information website. Percentage of aboriginals was retrieved from the Census surveys. The percentage of aboriginal was calculated by assuming that population growth between the three observations was equal and then divided by the provincial population of that year. Table 2 has the descriptive statistics of the data.

Table 2 – Descriptive Statistics of Regressors

NAME	MEAN	ST. DEV
Per capita Income	67377	83804
Real Health Spending	2496	249.930
Aboriginal population	66671	54604
Percentage of population five and under	7.999	0.791
Percentage of population 65 and older	12.307	1.400
Percentage of Population with less then highschool education	27.487	4.618
Percentage of Population with highschool completed and some post secondary	21.299	3.223
Percentage of population with post secondary completed	28.364	3.713
Unemployment Rate Provincial	11.029	3.846
Unemployment Rate National	8.711	1.098

The first independent variable of concern is the measure of economic cycle. Ruhm (2000) measures the cycles using changes in unemployment at both state and national levels in the United States. Following Ruhm, provincial and national unemployment rates will be used. In principle, many other measures such as employment ratios and growth in GDP could also be used, although there is a strong correlation between change in GDP and the unemployment rate in Canada, known as Okun's law (Sogner and Stiassny, 2002). The question to ask is why not use GDP instead of unemployment rate? Unemployment rate is better than GDP as it may capture better the effect of the business cycle on the economic unit, the family. Gross domestic product change would capture all the effects, but this variable might be at such a macroeconomic level it would miss the influence on the individual family. So, change in unemployment might best represent the effects on the individual family unit.

The next economic variable of interest is income per capita. The effect of income on health and mortality has been studied a lot. Income affects health through the ability of people to purchase necessities that improve health. Research in Canada, a small subset

of world wide research on this topic, supports the inclusion of this explanatory variable (Thomas and Hrudey 1997). Frohlich et al (2006) considers that income is one of the three reasons for health disparities in Canada. To measure income in Canada, provincial personal income per capita was retrieved from CANSIM.

Ruhm (2000) included the percentage of African Americans and Hispanics as regressor. However, in Canada, race is not recorded on death certificates and this means no one knows if these groups are disadvantaged compared to the rest of the Canadian population (Thomas and Hrudey 1997). However, it is known that aboriginal Canadians are at significant disadvantage and this group is used as an independent variable (Aboriginal Peoples Survey 2001). This significant health disadvantage of the aboriginal is also one of the reasons that health disparities exist in the overall Canadian population according to Frohlich et al. (2006). Inequity in health and health determinants for aboriginals when compared to the Canadian population is demonstrated extensively by Adelson (2005) and higher rates of aboriginal mortality than the Canadian average is documented by MacMillan et al. (1996). To construct a measure for aboriginals similar to Ruhm's percentage of African Americans and Hispanics, the 1986, 1991, 1996 and 2001 Census were used. From the Censuses the number of aboriginals - Métis, First Nations and Inuit – was determined by provinces with the numbers for years between each census years calculated by taking the difference between each survey and dividing by the number of time periods, assuming that population growth took place equally between each five year census. The yearly measure for each provinces aboriginal population was then divided by the provinces total population.

Another regressor is education which has been shown to reduce mortality (Lleras-Muney 2005). This study used mandatory school laws that varied across states in the United States while controlling for other factors and demonstrated that more education is protective against mortality. Canadian evidence also supports that more education is protective of health and mortality (Thomas and Hrudey 1997). To construct variables to control for education, the percentages of the labour force that hold certain amounts of education were used. These percentages were aggregated into three categories: less than high school, high school and some post secondary, and completion of post secondary. These were then expressed as percentage of each provinces populations.

The last two variables controlled for were health spending by province, which was retrieved from the Canadian Institute of Health Information, and the proportions of provincial population younger than five years of age and older than sixty five years of age. The information retrieved was health spending per capita which was then adjusted to real health spending. This variable would measure the resources available for use. The age variable was calculated by determining the population in those two age groups and then dividing by the overall Canadian population, again this data was retrieved from CANSIM.

5. Model

Following Ruhm (2000), a fixed effects model is used for the Canadian data. The main regression specification (Model 1) is

$$DV_{it} = \beta_0 + \beta_1 TREND_{it} + \beta_2 PROUN_{it} + \beta_3 ABOR_{it} + \beta_4 EDLHS_{it} + \beta_5 EDHSPS_{it} + \beta_6 EDCOM_{it} + \beta_7 AGE5_{it} + \beta_8 AGE65_{it} + \phi_i + \varepsilon_{it}$$

where i is the province and t is the year.

$ABOR_{it}$ = Percentage of Aboriginals

RHS_{it} = Real Health Spending per capita

$EDLHS_{it}$ = Percentage of population with less than highschool education.

$EDHSPS_{it}$ = Percentage of population with highschool and some post secondary education.

$EDCOM_{it}$ = Percentage of population with completed undergraduate post secondary education.

$NATUN_t$ = National Unemployment Rate.

$PROUN_{it}$ = Provincial Unemployment Rate.

$PERCAP_{it}$ = Per capita income

$TREND_{it}$ = Province-specific time trend.

$AGE5_{it}$ = Proportion of population less than age five

$AGE65_{it}$ = Proportion of population greater than age 65.

Model 1 is Ruhm's specification with provincial unemployment and with province-specific time trend included, since Laporte and Fegusson (2003) demonstrates the significance of the time trend. Four other models, presented in Table 3 below, were also considered to test the robustness of the provincial time trend and provincial unemployment.

Table 3 - Regressions under consideration.

Model 2 $DV_{it} = \beta_0 + \beta_1 TREND_{it} + \beta_2 PROUN_{it} + \beta_3 PERCAP_{it} + \beta_4 ABOR_{it} + \beta_5 EDLHS_{it} + \beta_6 EDHSPS_{it} + \beta_7 EDCOM_{it} + \beta_8 AGE5_{it} + \beta_9 AGE65_{it} + \phi_i + \varepsilon_{it}$
Model 3 $DV_{it} = \beta_0 + \beta_1 TREND_{it} + \beta_2 PROUN_{it} + \beta_3 RHS_{it} + \beta_4 ABOR_{it} + \beta_5 EDLHS_{it} + \beta_6 EDHSPS_{it} + \beta_7 EDCOM_{it} + + \beta_8 AGE5_{it} + \beta_9 AGE65_{it} + \phi_i + \varepsilon_{it}$
Model 4 $DV_{it} = \beta_0 + \beta_1 TREND_{it} + \beta_2 PROUN_{it} + \beta_3 NATUN_t + \beta_4 ABOR_{it} + \beta_5 EDLHS_{it} + \beta_6 EDHSPS_{it} + \beta_7 EDCOM_{it} + + \beta_8 AGE5_{it} + \beta_9 AGE65_{it} + \phi_i + \varepsilon_{it}$
Model 5 $DV_{it} = \beta_0 + \beta_1 TREND_{it} + \beta_2 PROUN_{it} + \beta_3 NATUN_t + \beta_4 PERCAP_{it} + \beta_5 RHS_{it} + \beta_6 ABOR_{it} + \beta_7 EDLHS_{it} + \beta_8 EDHSPS_{it} + \beta_9 EDCOM_{it} + \beta_{10} AGE5_{it} + \beta_{11} AGE65_{it} + \phi_i + \varepsilon_{it}$

According to Greene (2003), the fixed effects would represent some unobserved variables that may be correlated to the other regressors. This fixed effect model would seem appropriate given that social programs, including health care programs, that differ in characteristics among provinces would likely affect health and may be difficult to measure directly. Accounting for the decentralized delivery of programs may be important given that provinces can offer slightly different programs in their jurisdictions based on local preferences.

The model was estimated using the generalized least squares estimation technique, correcting for heteroskedasticity using a heteroscedasticity consistent covariance matrix. Residuals were used to calculate the heteroscedasticity consistent covariance matrix. In Canada, it would be expected to observed heteroscedasticity

among provinces due to both different population characteristics and local provision of social programs. Models 2 to 4 each include one of three additional economic regressors: personal income, national unemployment and real health spending. Model 5 includes all of the economic variables. All models also control for education, racial variables and demographics.

For Canada, the racial variable was changed from percentage of population of Hispanics and Blacks to percentage of provincial population that is aboriginal. Unemployment was the same except that national meant the overall Canadian rate and local unemployment, provincial level. The next section will present the result of this work.

6. Results

This section presents the results for provincial unemployment effect on overall mortality in Canada, mortality for different age-groups followed by mortality due to specific conditions. The results for overall Canadian mortality are presented in Table 4. Provincial unemployment is found to have a positive and significant effect on mortality in Canada. The province-specific time trend variable is also positive and significant. These results are robust when additional economic regressors are added. These additional regressors shown in table 4 are not significant when added to the main model specification of provincial unemployment and provincial time trend.

The reasons for the positive relationship can be explained in a couple of different ways. Unemployment maybe related to due financial hardship and effects on the social network and demographic changes. The positive relationship between provincial unemployment and mortality is different than what Ruhm (2000) found; however, this is

consistent with Brenner's (1979) analysis which showed a positive relationship. The explanation given was that unemployment results in stress due to financial hardship and withdrawal from social networks. The positive value of the time trend can likely be explained by the ageing demographics in the Canadian society which tends to increase in death rate for Canada.

The next investigation examines four age categories where one might expect a different relationship between unemployment and mortality. For the different age groups only the first model was used since adding the additional variables to the first model was to ensure model robustness, this was demonstrated for aggregate mortality, and for this reason there was no need to run all models for all the different age groups.

Table 4 – Mortality per 100 000 population in Canada

Dependent Variable: Mortality per 100 000 population	Model 1	Model 2	Model 3	Model 4	Model 5
National Unemployment p value				1.042 0.805	0.220 0.965
Provincial Unemployment p value	4.347 0.002	4.732 0.001	4.796 0.002	4.137 0.014	5.356 0.005
Trend P value	11.041 0.000	11.822 0.000	11.482 0.000	11.341 0.000	12.087 0.000
Percapita Income p-value		0.306E-04 0.477			-0.208E-05 0.963
Real Health spending p value			0.268E-01 0.111		0.317E-01 0.106

The different age groups are presented since the characteristics of each age group may vary: infant mortality, 25 to 44 years old, 45 to 64 years old and age 65 and older. The characteristics that may differ among groups that make them more or less susceptible to unemployment effect and time trend effect are varied. For infant mortality one might

hypothesize unemployment having little negative effect on mortality as there are many support programs for mothers and the availability of medical care before, during and after birth. One might expect that young adults between 25 to 44 years old would be very significantly affected by unemployment, as these individuals are starting their career and their employment may not be as secure as for more experienced workers. As a result, they may be the first group to experience unemployment during economic downturns. For 45 to 64 years old, one would expect that unemployment would have a smaller negative effect on mortality since these people have job tenure and would not be the first to be laid off during economic downturns. Lastly seniors aged 65 and older that are retired may not be affected by unemployment. In any case, all age-groups may also be affected by the mechanisms that can potentially make mortality procyclical, as emphasized by Ruhm (2000).

The results, reported in table 5, clearly show that different age groups are affected differently. Provincial unemployment appears to be significant only for older age groups; however, the economy being strong throughout the late 1990's might have mitigated the effect on the two middle age groups. The time trend clearly shows that better medical technology and demographics are influencing mortality with magnitude and direction of the effect dependent on the age groups.

For infant mortality, unemployment is insignificant at the 5% significance level, and this may be explained by the parental leave programs in Canada and the variety of programs available for expectant mothers to help them before, during and shortly after birth. The trend is significant, at the 5% level, and slightly positive. The slight upward

trend could be just slight fluctuations as Canada has a low infant mortality rate, so the slight increase maybe due to fluctuations around the mean.

For the 25 to 44 and 45 to 64 years old groups, the estimated effect of unemployment is negative, as in Ruhm (2000), although it is not significant. Thus, it appears that neither of the procyclical effects emphasized by Rhum (2000) or the countercyclical effects emphasized by Brenner (1979) and others are clearly dominating for these age-groups in Canada. The lack of a positive effect of unemployment on mortality in Canada may also be partly explained by the following. High labour mobility among these age-groups may mitigate the negative effects on mortality by allowing these workers not to be unemployed as long. A Canadian example is demonstrated by maritimers moving west to find work. Another potential explanation is that more young adults are moving back home (boomerang generation) due to life circumstances and that parents are providing economic support to their offsprings longer than in the past. For age 45 to 64, any positive effect of unemployment on mortality may be mitigated by the fact that these people have precautionary savings and with experience are able to find work faster. Precautionary savings may take the form of equity in a house that can be borrowed against, RRSP and other family savings. These precautionary savings would mitigate the loss of employment. Also, the Canadian social safety net may influence this group and provide protection. Again for this age group provincial mortality is trending down and the same explanation of better medical interventions apply especially since biological processes would be more evident in this group.

The time trend is significant and negative for both of these age groups. One reason could be that despite the small likelihood of dying in this age group, better

medical technology and advances decreased the mortality rate when bouts of illness do strike.

For seniors, age 65 years old and older, it is evident that the trend variable is significant and positive with the aging demographics likely explaining this. Provincial unemployment is positive and significant and this is a surprising result since one would suspect that unemployment would not affect seniors very much. These people would also qualify for various government support programs such as old age security, Canadian Pension Plan and some type of retirement savings. The provincial rates maybe showing an effect since the seniors who are working are doing so to earn money for necessities and when laid off this significantly affects there standard of living.

Table 5 – Mortality for different age groups (Model 1).

Dependent Variable	Deaths per 1000 live Birth's	Mortality for both sexes age 25 to 44 per 100 000 population	Mortality for both sexes age 45 to 64 per 100 000 population	Mortality for both sexes age 65 and older per 100 000 population
Provincial Unemployment p value	0.670E-01 0.184	-0.985E-01 0.854	-1.143 0.395	37.354 0.000
Trend P value	0.208 0.000	-2.040 0.002	-12.971 0.000	79.098 0.000

Mortality of Specific Conditions

Seven different mortality categories are examined: potential years of life lost due to injuries and suicides, mortality due to two types of cancer and mortality due to three types of cardiovascular disease. The results reported in table 6 show that provincial unemployment has a negative and significant effect, at level of significance of 5%, potential years of life lost due to injuries and suicide. A potential explanation is that the jobs lost in the 1990's are blue collar jobs with physical labour required and higher injury rates. The replacement for these jobs would be the growth in the service sector and these

jobs would likely be less accident prone with a decreased injury rate. The negative effect of unemployment on suicide is puzzling. It could indicate that the stress associated with work and work-related pressures during economic booms are more important than the stress associated with unemployment. However, this would suggest that job stress exceeds the benefit of the income received by being employed. The trend variable was not significant in either model and this would suggest that stress is one of the factors of employment and that working can be dangerous, supporting Ruhm's (2000) conclusions.

Table 6 – Potential Years of Life (PYY) lost due to injuries and suicide.

Dependent Variable	PYL Injuries	PYL Suicide
Provincial Unemployment p value	-18.351 0.013	-22.355 0.000
Trend P value	1.279 0.874	1.631 0.793

Also, in this section, five specific causes of mortality are examined with results reported in table 7. The five causes investigated for both sexes are colorectal cancer (CR), lung cancer (L), acute myocardial infarction (heart attacks-AMI), cerebrovascular disease (CE) and all causes of strokes (ALL).

Ruhm (2000) used mortality from cancer as an indicator to verify that unemployment should not affect a disease process that is thought to be biological only. The results for colorectal cancer and lung cancer indicate that provincial unemployment rates do not affect cancer and do not contradict Ruhm's results. If unemployment causes stress and stress is factor affecting mortality, then there should be a positive relationship between provincial unemployment and mortality for the diseases of the cardiovascular system: acute myocardial infarction, cerebrovascular disease and all causes of strokes. The theory is supported by the results as in all three cases provincial level unemployment

is significant and positively related to mortality by the three cardiovascular system conditions.

The trend variable is also important to examine as all five trend variables are significant at the 5% level. For the two causes of cancer the trend shows a decrease in mortality for both colorectal and lung cancer. This could be explained by the improving medical technology and treatments available for cancer. There is also a negative trend for AMI and this could be due to greater public awareness and newer treatments available. The increasing trend for cerebrovascular disease and all strokes suggests that obesity epidemic is affecting this and the availability of treatment has not kept up with the increase in the obesity epidemic.

Table 7 – Mortality for five specific causes of death per 100 000 population

Dependent Variable	Both Sexes Colorectal Cancer mortality per 100 000 population	Both Sexes Lung Cancer mortality per 100 000 population	Both Sexes AMI mortality per 100 000 population	Both Sexes CE mortality per 100 000 population	Both Sexes ALL mortality per 100 000 population
Provincial Unemployment p value	-0.429E-01 0.705	-0.305 0.200	0.660 0.009	1.458 0.000	1.292 0.000
Trend P value	-0.331 0.019	-1.124 0.000	-2.952 0.000	0.754 0.001	0.635 0.003

7 . **Conclusion**

This research demonstrates that unemployment tends to increase mortality in Canada. This relationship was shown to be robust to the inclusion of other variables, including national unemployment, per capita income and real health spending. Province-specific time trend variables were also found to be significant and robust, supporting the idea that demographic changes are affecting mortality as well. However, provincial

unemployment does not affect mortality in the 25 to 44 years old and the 45 to 65 years old groups.

There are at least two potential areas for future research. First, it may be interesting to conduct a gender based analysis, which would further extend Ruhm's paper. Such an analysis could be conducted for Canada as gender statistics on mortality are available.

Finally the use of microeconomic data should be explored such as the Canadian Health Survey and other Canadian databases that include microeconomic data. This could potentially be very insightful for the 24 to 45 years old age group and the 45 to 64 years old age group. In both of these age groups, unemployment appears to have no effect; however, there might be other reasons that are not evident at the macroeconomic level. International research has moved to the microeconomic level to capture more regressors with the hope of generating a clearer understanding of the relationship between unemployment and mortality.

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