An Empirical Analysis of the Relationship between Public Health Spending and Self-Assessed Health Status: An Ordered-Probit Model

By

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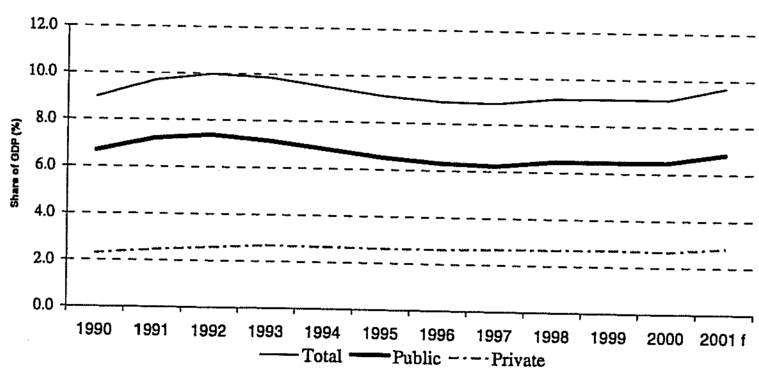
1. INTRODUCTION

There has been much heated debate surrounding the affordability of Canada's public health care system. Indeed, as Canadians are faced with difficulties in finding a family doctor, long waiting lists to see a specialist and long waiting periods for diagnostic tests, their confidence in the health care system is fading. Furthermore, governments are faced with rising health care expenditures that can only be sustained if other spending priorities continue to be crowded out and/or taxes raised. Canadians may be comfortable with these options, but only if it is perceived that they are getting better quality health care for their money. For the most part, though, the recent rapid growth in health care spending has simply reflected the higher costs of delivering the same services, and in some provinces, where certain services have been de-listed from the publicly-funded systems, even fewer services.

Figure 1
Total Health Spending as a Share of GDP
Canada

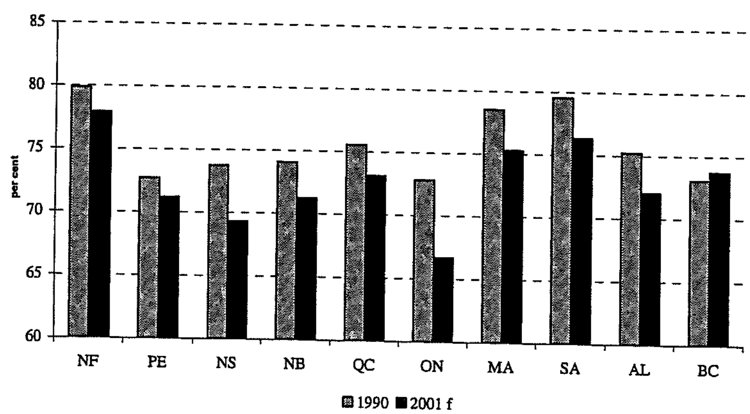


Source: Canadian Institute of Health Information, *National Health Expenditure Database, National Health Expenditure Trends 1975-2002.*

Looking at health care spending trends in more detail, total health care spending, which includes both public and private sectors, grew from 9.0 per cent of Gross Domestic Product (GDP) in 1990 to 9.7 per cent of GDP in 2001 (see Figure 1 above), while the share of public spending in total health care dropped by 3 percentage points, from 74 per cent to 71 per cent. This decline occurred between 1994 and 1997, a period of deficit reduction characterized by the consolidation of the EPF and CAP into the CHST, which resulted in a 33.5 per cent reduction in federal transfers, from $18.8 billion in 1994 to $12.5 billion in 1997.

A similar trend can be observed in most provinces. (See Figure 2.) Indeed, from 1990 to 2001, the share of public spending in total health care fell for all provinces except British Columbia, with the share of public spending lowest in Ontario at 66.7 per cent of total health spending and highest for Newfoundland at 77.9 per cent. British Columbia observed a 1 per cent increase in its public share of total health spending.

Figure 2
Public Sector Health Expenditure as a Proportion of Total Health Expenditure, 1990-2001



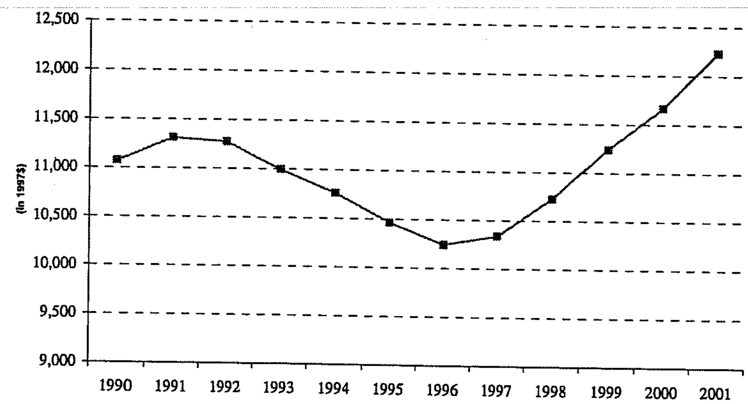
Source: Canadian Institute of Health Information, *National Health Expenditure Database, National Health Expenditure Trends 1975-2002.*

Overall real, per capita, age-adjusted[1] public health expenditures increased from $11,073 to $12,233 between 1990 and 2001. However, from 1993 to 1997, there was a substantial decrease in public health spending. (See Figure 3.) This coincides with the federal government's move towards a budgetary surplus through deficit and debt

[1] See Appendix 1 for the methodology related to age-adjusted health spending.

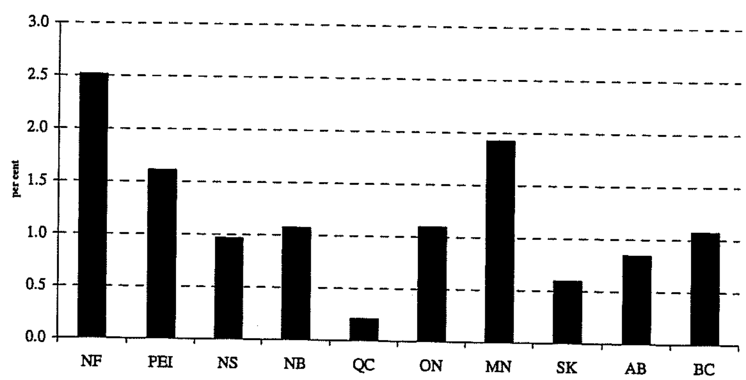
reduction. Indeed, in 1996, to fulfill its goal, the federal government consolidated the EPF block grant and the Canada Assistance Plan into the CHST. This resulted in a real, per capita, age-adjusted public health expenditure of $10,244--the lowest of the decade.

Figure 3
Public Health Expenditures, Real per Capita, Age-Adjusted, (1997 dollars)
1990-2001



Source: Canadian Institute of Health Information, *National Health Expenditure Database, NationalHealth Expenditure Trends 1975-2002.*

Figure 4
Real, Per Capita, Age-Adjusted Growth in
Total Provincial Government Health Spending
1990-2001

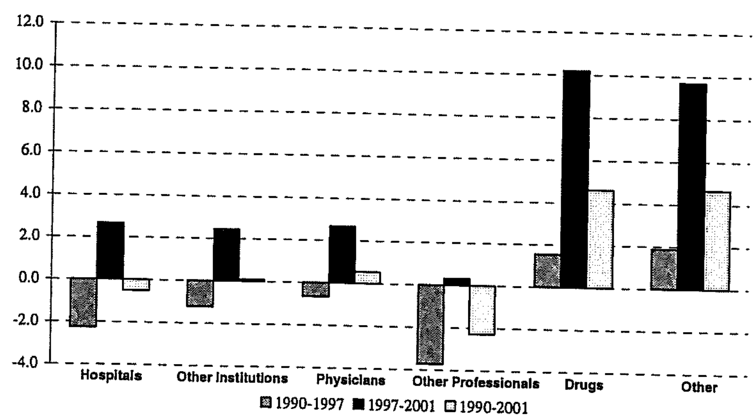


Source: Canadian Institute of Health Information, *National Health Expenditure Database, National Health Expenditure Trends 1975-2002.*

Furthermore, over the past decade, the average annual growth in provincial government health-care spending varied substantially across provinces. (See Figure 4.) In particular, Newfoundland experienced the greatest real, per capita, age-adjusted growth (2.5 per cent) in its provincial health expenditures, while Quebec experienced the smallest growth, with its total provincial health spending increasing by 0.2 per cent in real, per capita, age-adjusted terms.

The period between 1990 and 2001 was also characterized by important changes in the components of the health budget. Total public health spending covers a variety of categories, mainly spending on hospitals, other institutions, physicians, other professionals, drugs, and other health spending,[2] and the relative growth in public spending on these categories has varied considerably over the past decade. Over the entire period, real, per capita, age-adjusted growth rates in public health spending (or enrichment) on hospitals, other institutions, physicians and other professionals have been flat or negative, while in regards to drugs and other health spending, the real, per capita, age-adjusted growth rates have been positive and greater than 4 per cent. (See Figure 5.)

Figure 5
Provincial Government Spending by Use of Funds
Real Per Capita, Age-Adjusted Growth, %



Source: Canadian Institute of Health Information, *National Health Expenditure Database, National Health Expenditure Trends 1975-2002.*

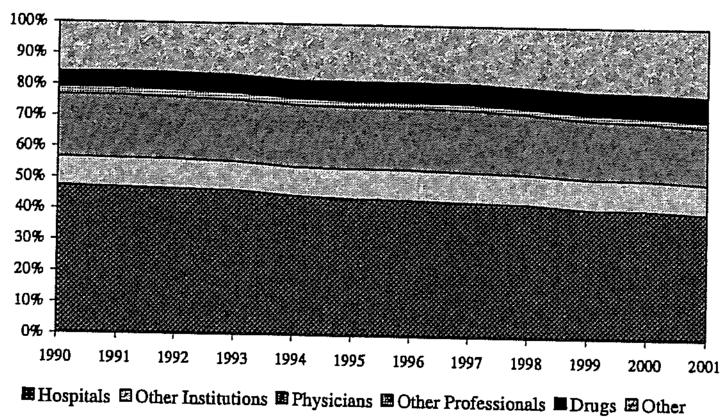
Also, between 1990 and 1997, a period characterized by deficit and debt reduction, public enrichment in hospitals, other institutions, physicians and other professionals was negative, ranging between -0.7 per cent for physicians to -3.8 per cent for other

[2] In this study, other health spending includes public spending on home care as well as capital expenditures.

professionals, while public enrichment in drug expenditure and other health expenditures was positive, with enrichment rates of 1.5 per cent and 1.9 per cent, respectively. On the other hand, between 1997 and 2001, real, per capita, age-adjusted growth rates in public health spending were positive for all categories, with public health spending on other professionals experiencing the smallest increase of 0.7 per cent in real, per capita, age-adjusted terms while public health spending on drugs experienced the largest increase (10.2 per cent).

As a result of these different growth rates, the composition of the health budget has changed in the past decade. (See Figure 6.) The share of hospital spending and physician spending in total provincial/territorial health care spending fell by 15 per cent and 8 per cent, respectively, while the share of spending on drugs and other health expenditures increased by 44 per cent and 36 per cent, respectively.

Figure 6
Composition of Provincial/Territorial Health Care Spending, Canada, 1990-2001



Source: Canadian Institute of Health Information, *National Health Expenditure Database, National Health Expenditure Trends 1975-2002.*

As governments have limited their transfers to the health care system in the face of rapidly rising costs, which has ultimately resulted in changes in the composition of the health budget, one can't help but wonder whether this has ultimately affected health outcomes for the Canadian population. The purpose of this paper is to address this issue. Using an ordered probit regression applied to cross-sectional data, this paper examines the relationship between health care expenditures and health outcomes while controlling for economic, socio-demographic and lifestyle factors that may have a significant influence on health.

The paper is structured as follows. The next section provides a brief description of the historical evolution of health care financing in Canada. Section 3 then looks at previous empirical work that studied the relationship between health outcomes and public health expenditures. Section 4 briefly describes the methodology for estimating an ordered probit model. The variables used in the estimation and their statistical characteristics are then described in Section 5. Next, Section 6 presents the estimation results, and the final section provides a summary and conclusions.

2. THE HISTORY OF CANADIAN HEALTH CARE FINANCING

Since 1867, health care in Canada has been a provincial responsibility. However, during the postwar period, the federal government started using its spending power in areas of provincial jurisdiction to build social programs, mainly because it had more solid sources of stable revenues, and as such, was in a better position to fund social programs. In 1957, the federal government began sharing some hospital care costs with the provinces. By 1961, all provinces had hospital insurance plans, with the federal government contributing about 50 per cent of the cost on average.[3] Furthermore, by 1971, all provinces had adopted a medicare scheme that included payments to doctors, with the federal government again sharing the cost through the Medical Care Act of 1966.

[3] Rosen, H. et al. (1999) Public *Finance in Canada* Toronto: McGraw-Hill Ryerson Limited, p.375

However, by the mid-1970s, problems emerged in the system. On the one hand, the federal government felt it couldn't control health care costs as the provincial governments made the relevant spending decisions.[4] On the other hand, the provinces complained that federal funding for hospital and medical care insurance distorted provincial health care priorities by only funding these two programs.[5] As such, these concerns led to the implementation of the Established Program Financing (EPF) in 1977. The EPF merged hospital insurance, medicare and post-secondary education into a block grant, which was delivered on an equal per capita basis.[6] In addition to the block grant, the federal government also transferred tax-points to the provinces. Indeed, the federal government agreed to give up 13.5 percentage points of personal income tax and 1 percentage point of its corporate income tax to the provinces and territories.

To further guarantee universal and accessible health care, the federal government passed the *Canada Health Act* (1984), which strengthened and clarified the federal conditions for health care financing. These conditions were: 1) Universality; 2) Accessibility; 3) Comprehensiveness; 4) Portability and 5) Public Administration. In 1996, in the context of an increasing emphasis on deficit reduction, the federal government announced the termination of EPF grants and the creation of a new block grant that supported health, post-secondary education and social services--the Canada Health and Social Transfer (CHST). This block grant, which retained the conditions of

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[4] Rocher, F. and Smith, M. "Federalism and Health Care: The Impact of Political-Institutional Dynamics on the Canadian Health Care System", (Romanow) Commission on the Future of Health Care in Canada, 2002

[5] *Ibid*

[6] Krelove, R., Stotsky, J. and Vehorn, C. (1997) "Canada", *Fiscal Federalism in Theory and in Practice,* IMF.

the *Canada Health Act*, was scheduled to decline from $18.5 billion in 1996 to $12.5 billion in 1998.

Although health care financing has undergone numerous changes in the postwar period, health care has remained a provincial responsibility, with the federal government playing a crucial role in maintaining the national standards of the *Canada Health Act* through its health care financing. As such, Canadians, irrespective of their income or province of residence, continue to enjoy access to a complete set of free medical services, including hospitalization and physicians.

3. LITERATURE REVIEW

This is not the first time an empirical analysis of the relationship between health care expenditures and health outcomes has been carried out. In fact, there exist numerous empirical studies in this area that have yielded conflicting results. The inconsistency of the results might be explained by the different variables inherent to each study. Indeed, there has been quite a range of proxies used to represent health outcomes. Popular measures used have been infant mortality rates, child mortality rates and life expectancy, although other measures such as self-assessed health status and potential years of life lost have also been used in the current literature. Each study is also unique in its choice of control variables, although these usually fall into four categories: lifestyle variables, social and demographic variables, economic variables and nutritional variables. Finally, the type of data used also seems to explain some of the differences in results. Indeed, international studies, which use heterogeneous data, tend to find that the relationship between health outcomes and health expenditures is statistically insignificant while national studies, which use more homogeneous data, tend to find a statistically significant relationship between health expenditures and health outcomes.

Recent studies of the relationship between health care expenditures and health outcomes within a country include those by Cutler and Richardson (1998), Crèmieux, Ouillette and Pilon (1999), Kee (2001), Rivera (2001), and Thornton (2002). Cutler and Richardson (1998) compare the changes in health capital with changes in medical expenditures in the United States and conclude that between 1970 and 1990, increases in health capital exceeded increases in medical spending. Cutler and Richardson define health capital as:

$$\text{(Health Capital)}_t = V\sum_{k=0}^{\infty}\frac{E_t[H_{t+k}]}{(1+r)^k}$$

where V is the value of a year in perfect health, H is quality of life in any year, and r is the real discount rate. Cutler and Richardson assume a year of life to be worth \$100,000 and the real discount rate to be about 3 per cent. H_{t+k} is defined as:

$$H_{t+k} = \text{Pr [Alive at } t+k\text{]} * (\sum_{d} \text{Pr [Condition } d \text{ at } t+k\text{]*[QALY for } d \text{ at } t+k\text{]})$$

where d is the range of conditions a person may have, and QALY is the quality of life for people with those conditions. To find a quality of life measure, Cutler and Richardson estimate the following model:

$$h_i^* = X_i\beta + \varepsilon_i$$

where h_i^* is an individual's self-reported health found in the American Health Interview Survey, X is a row vector of exogenous variables which include demographic variables and variables that reflect health conditions, β represents the coefficient vector and ε is an error term that is normally distributed. This model is estimated using an ordered probit regression and cross-sectional data for 1970 and 1990. As such, the β's provide a measure of the reduction in quality of health associated with each condition.

Cutler and Richardson conclude that medical expenditures over the 1970 to 1987 period were beneficial since the increase in health capital exceeded the increase in medical spending. More specifically, between 1970 and 1990, health capital increased by $95,000 for newborns and by $169,000 for the elderly, while expected medical costs increased by $19,000 for infants and by $34,000 for people aged 65.

Crèmieux, Ouillette and Pilon (1999) take a different approach in evaluating the influence of medical expenditures on health. Indeed, rather than establishing how a change in medical expenditures influences the value of health in dollar terms, Crèmieux et al. examine the relationship between health care expenditures and health outcomes as measured by infant mortality and life expectancy from 1978 to 1992, based on province-specific Canadian data. They find that lower health care spending in Canada is associated with statistically significantly lower life expectancies and higher infant mortality. Their model is a single equation model with fixed provincial effects of the form:

$$Y_{it} = D_{it}\alpha + X_{it}\beta + \varepsilon_{it},$$

where Y is infant mortality or life expectancy at birth by sex for province i ($i = 1$ to 10) and time t (t = 1 to 15), and X is a row vector of exogenous variables which include: 1) health and economic variables (total private and public per capita health care spending, the provincial per capita number of civilian physicians, and per capita income); 2) social and demographic variables (average age of the population across provinces over time, provincial population density, number of bachelor's degrees per capita and poverty rate);

3) lifestyle variables (percentage of regular smokers, per capita consumption of alcohol) and 4) nutritional variables (spending on meat and spending on fat). D_{it} is a vector of dummy variables, only one of which is nonzero for each i, and α is the vector of coefficients of those dummies that are included to correct for potential systematic time invariant differences between provinces that are not captured by the included control variables.

This model is estimated using a Generalized Least Squares (GLS) method correcting for both autocorrelation and heteroskedasticity. Moreover, since previous researchers have suggested a logarithmic form for purely econometric reasons, Crèmieux and his co-authors look at both a linear model and a logarithmic model. Both yield similar results. Crèmieux et al. conclude that a strong relationship exists between health care spending and health outcomes across provinces. In particular, a 10 per cent reduction in health care spending is associated with 0.5 per cent higher infant mortality rates for males and 0.4 per cent higher infant mortality rates for females. As well, a 10 per cent reduction in health care spending lowers life expectancies by 6 months for men and 3 months for women. The inclusion of provincial fixed effects improves the explanatory power of their model, and supply side variables, such as health care spending or the number of available physicians, are highly significant determinants of health outcomes, even after controlling for age and other socio-economic factors.

Substantiating Crèmieux and his co-authors' results is another Canadian study undertaken by Kee. Kee (2001) studies the relationship between public health expenditures and health outcomes using Instrumental Variables (IV) estimation to examine the relationship between public health care spending and health from 1975 to

1996, based on province-specific Canadian data. She finds that public health care spending significantly influences health outcomes. Kee uses a simultaneous equations model of the form:

$$(1)\ H_{it} = X_{it}\beta + \varphi HE_{it} + v_{it}$$

$$(2)\ HE_{it} = Z_{it}\gamma + \delta H_{it} + u_{it}$$

where H_{it} represents the health of the population and is measured by gender specific infant mortality, age-standardized mortality rates for all age groups, and life expectancies at birth, in province i at time t. HE_{it} is the public health care spending variable, which is measured using both real per capita public health expenditures and real per capita provincial government health expenditures respectively. X_{it} is a row vector of exogenous variables in the health equation (1) and includes: 1) socio-demographic variables (poverty rates, number of graduates per 1,000 population, provincial fixed effects); 2) economic variables (real per capita provincial GDP) and 3) lifestyle variables (per capita alcohol consumption in liter and gender specific smoking rates). Z_{it} is a row vector of exogenous variable in the public health care spending equation (2) and includes the proportion of the population 65 and older and real per capita federal health transfers, as well as all the exogenous variables included in the health equation (1). Kee uses a simultaneous equations model as it is best suited to deal with the possibility that health and public health care spending are simultaneously determined. Indeed, she argues that while populations with lower (higher) health status would demand more (less) health care goods and services, it is also likely that greater (reduced) public health care spending would result in improved (worse) population health, which would ultimately reduce (increase) public health care spending.

This model is estimated using the instrumental variables (IV) procedure, which is implemented using the 2SLS estimator. Since IV estimation can only be applied under the assumption that there is simultaneity between public health care spending and health outcome, a Hausman test is performed to test this assumption. Regardless of which health outcome proxy is used, the simultaneity between public health care spending and health outcome is confirmed. As such, IV estimation using the 2SLS estimator is carried out with the instrument set containing the consumer price index for health goods and services and real per capita total federal transfers when health outcome is proxied by female and male infant mortality. When health outcome is measured by male age-standardized mortality rate and both male and female life expectancies at birth, the instrument set contains the proportion of population 65 and older and real per capita federal health transfers.

Kee finds that public health care spending has a statistically significant impact on the health of the population, regardless of the measure of health outcome used. When the consumer price index for health goods and services and real per capita total federal transfers are used as instruments, a 1 per cent decrease in public health care spending is correlated with a 2.22 per cent increase in the male infant mortality rate and a 2.14 per cent increase in the female infant mortality rate. When the proportion of the population 65 and older and real per capita federal health transfers are used as instruments, a 1 per cent decrease in public health care spending is correlated with a 1.19 per cent and a 1.09 per cent increase in the male and female age-standardized mortality rate, as well as a 0.29 per cent decrease in the male life expectancy at birth and a 0.18 per cent decrease in the female life expectancy at birth.

Rivera (2001) also finds the relationship between health expenditures and health outcomes to be statistically significant. In her study, she uses cross-sectional data from the 1993 Spanish National Health Survey (ENSE) to examine the impact of public health expenditures on self-assessed health status. Self-assessed health status appears in the ENSE on a scale of 1 to 5 where 1 corresponds to very good health, 2 to good, 3 to regular, 4 to poor and 5 to very poor. Furthermore, given that health depends on a number of factors, the author also includes a number of control variables. These are divided into four groups: biological, socio-economic, life style and medical resources. Within biological variables, age is considered, as is the sex of the individual. Socio-economic variables include education level (individuals with no studies, individuals with secondary school qualifications, and individuals with university qualifications), income level (upper, upper-middle, middle, lower-middle, lower), employment status (working or unemployed), marital status, and size of the municipal region (up to 50 000 inhabitants, more than 50 000 inhabitants). Life style variables include whether the individual smokes, whether he takes regular exercise either during the course of work or in leisure time, as well as the number of hours per day the interviewee sleeps. Finally, variables that reflect the level of medical resources include total health care spending per capita in 1993 and average per capita spending from 1986 to 1993. These statistics refer to 17 Spanish regions and are analysed in the form of a log-transformation of their values. The model is expressed as follows:

$$y_j^* = \beta' x_j + u_j$$

where y_j^* defines a latent continuous variable that corresponds to the individual's state of health j, while x_j is a row vector of exogenous variables, which include: 1) biological variables; 2) socio-economic variables; 3) life style variables and 4) medical resources. β represents the coefficient vector. This model is estimated using an Ordered Probit regression.

Rivera concludes that health spending significantly influences the probability of having a particular given state of health. Indeed, when health spending is relatively high, the individual will be more likely to value his health status as good. Rivera also finds that when the interviewee has a job, has university qualifications or exercises during leisure time, his or her health status tends to be valued as good or better. However, if the individual is characterized as being either female, divorced or separated, in the lower middle or lower class, or aged 65 or above, he or she is more likely to negatively assess his or her health status. As well, the interviewee is more likely to value his (her) health status as being poor if he (she) resides alone, has no educational qualifications, and to a lesser extent, if he (she) lives in a municipality with a population of more than 50,000 inhabitants.

Furthermore, to facilitate the interpretation of the coefficients, Rivera transforms the results so that, instead of simply presenting the coefficients, she evaluates the change in the probability when there is an infinitesimal change in each of the independent variables if and when the variable is continuous. If the independent variable is discrete, Rivera presents the discrete change associated with a one-unit change in the dummy variable. She finds that a marginal increase in health spending will increase the probability that individuals will tend to evaluate their state of health positively.

However, Thornton (2002) contradicts these findings. Indeed, in his study, which updates earlier research on the aggregate health production function for the US using data for the year 1990, he provides evidence that medical care expenditures do not significantly influence health outcomes. He estimates a log-log model of the form:

$$\ln D_i = \beta_0 + \beta_M \ln M_i + \beta_s \ln S_i + \beta_L \ln L_i + \beta_E \ln E_i + \beta_C C_i + \mu_i$$

where D_i is the age-adjusted death rate in state i, M_i is medical care expenditures, S_i is the vector of socioeconomic variables (education measured as the percent of the population 25 years of age or older with schooling beyond a high school degree, personal income per capita), L_i is the vector of lifestyle variables (cigarette consumption in packs sold per capita, alcohol consumption in gallons sold per capita, per cent of married households), E_i is the vector of environmental variables (urbanization, crime rate, manufacturing activity), C_i is the vector of control variables (race and gender variables[7]) and μ_i is an error term. Instrumental Variables (IV) estimation is implemented using the Two-Stage Least Squares (2SLS) estimator, with the instrument set containing education, cigarette consumption, alcohol consumption, urbanization, manufacturing, married households, crime, race, gender, unemployment rate, birth rate, percentage of population 65 years of age and older, percentage of population without health insurance, percentage of population below federal poverty level and Medicare recipients per capita. Thornton finds that changes in medical care expenditures do not have a significant effect on age-standardized mortality, with a 1 per cent increase in medical care use causing a 0.065 per

[7] Thornton does not specify which variables he uses to represent gender and race.

cent decrease in mortality. Thornton concludes that "the US is experiencing diminishing returns to medical care use and may well be operating in an environment of 'flat-of-the-curve' medicine, where additional resources devoted to medical care yield little if any improvement in mortality'.[8] However, Thornton also finds that states with higher levels of income, education and percent of married households have significantly lower death rates, while states with greater cigarette consumption and crime have significantly higher mortality.

There are also numerous cross-country investigations that study the relationship between health expenditures and health outcomes. These include studies by Filmer and Pritchett (1999), Baldacci et al. (2002), Wolf (1986), Wolfe and Gabay (1987) and Or (2000). Filmer and Pritchett (1999) use cross-sectional data to examine the impact of both public spending on health and non-health factors in determining child (under 5) and infant mortality in 1990 and they find that the relationship between health outcomes and health expenditures is statistically insignificant. Their analysis covers forty-five countries, which they classify into five groups: East Asia and the Pacific; Latin America and the Caribbean; the Middle East and North Africa; South Asia; and Sub-Saharan Africa. They specify and estimate the following multivariate regression:

$$\ln(M_i) = \beta_1 \ln(GDP_i / N_i) + \beta_2 \ln(H_i / GDP_i) + \beta_3 X_i + \varepsilon_i$$

where M is child mortality (or infant mortality), GDP/N is per capita income, H/GDP is public health spending as a share of GDP, and X represents a variety of socio-economic

[8] Thornton, J. "Estimating a health production function for the US: some new evidence" *Applied Economics*, 2002, p. 61

variables, which include: educational status; a Gini coefficient that captures income inequality; a dummy variable equal to one if the predominant religion is Islam; a measure of ethno-linguistic diversity; percentage of urbanization; location in a tropical climate; and percentage of the population with access to safe water, a measure found in the World Bank's Social Indicators of Development database.

Their model is estimated using several estimation methods. The first is OLS. The second, a median regression, is used to ensure that the results were not merely driven by a few 'outlying' countries, as it is much less sensitive to influential observations. The two countries with the largest impact on the parameter vector are also dropped to further insure the robustness of their results. The third method of estimation, IV estimation, is used to deal with both reverse causality and measurement errors. Reverse causality is problematic in their study since countries with higher under-5 mortality for which increased public spending may have had a significant impact on reducing under-5 mortality may still observe a small or even negative regression coefficient. Measurement error is another serious problem with health care spending since the accounting systems that track public health care spending are not consistent across countries. IV estimation using a Two-Stage Least Squares (2SLS) estimator is carried out with the instrument set containing the average public sector health spending as a share of GDP, the average public health spending as a share of GDP of a country's geographic neighbours, and the average military spending as a share of GDP of a country's geographic neighbours.

Moreover, to address the econometric problem of reverse causality between income and health, given that better health status might cause higher average income, the authors use whether or not the country's main export is oil and years since 1776 that the country has been independent as instruments for income. However, their overall results are largely unaffected, suggesting that the impact of better health on income does not affect the estimation of the cross-national impact of income on health.

In general, Filmer and his co-author find that the impact of public spending on health in reducing child and infant mortality is typically both numerically small and statistically insignificant at conventional levels. GDP per capita is found to be a highly significant determinant of child mortality, with an elasticity of around –0.6. Furthermore, years of female schooling was also found to have a significant impact on child and infant mortality. In fact, every year of female schooling was associated with a 10 per cent reduction in mortality. The probability that two citizens speak a different native language also has a significant positive impact on mortality.

Baldacci, Guin Siu and de Mello's findings support Filmer and Pritchett's conclusion. In their study, Baldacci et al. (2002) use panel data from a sample of 94 developing and transition countries to analyse the effects of public spending on social indicators for the period between 1985-98 and they find that in general, the relationship between health care spending and health status is statistically insignificant. They specify and estimate 3 different models. The first is the conventional cross-sectional model. This model takes the form:

$$y_i = \alpha + \beta GDP_i + \gamma S_i + \delta X_i + u_i \qquad (1)$$

where y denotes the social indicator (child mortality rates and infant mortality rates), GDP is defined in real per capita terms, S denotes public spending (health care as a percentage of GDP), X is a vector of control variables (total fertility rate, intrasectoral allocation of public spending, urbanization, pupil-teacher ratio (as a proxy for the input mix of government spending)) and u is a random error term, where i identifies the countries in the sample. Baldacci and his co-authors also prefer the logarithmic transformation of the variables as it proves to be the best specification, yielding the highest model fit.

This model is estimated using the means of the variables for the period between 1996-98, and several methods are used. These include ordinary least squares (OLS), weighted least squares (WLS), two-stage least squares (TSLS), and weighted two-stage least squares (WTSLS) to take into account the possibility of endogeneity and heteroskedasticity in the data.

Baldacci et al. find that spending on health care is usually negatively associated with mortality rates, although not always at statistically significant levels, and per capita income is a more important determinant of health indicators than government spending. Furthermore, a higher fertility rate increases both infant and child mortality rates, and the urbanization rate is weakly correlated with infant mortality rates. As well, Baldacci et al. do not find the intrasectoral allocation of spending and the pupil-teacher ratio to be correlated with mortality rates at classical levels of significance.

The second model re-estimates equation (1) using a time dimension in order to address some econometric problems inherent in the cross-sectional approach. In this model, the dataset includes the same 94 countries for a 14-year period (1985-1998). The dependent, explanatory and control variables are the same as in their cross-sectional regression to facilitate comparisons. They also use a linear double-log panel specification as it provides ready elasticity estimates that are comparable to the cross-sectional results. This time equation (1) is estimated by fixed effects (FE), random effects (RE), generalized least squares (GLS), feasible generalized least squares (FGLS), and the generalized method of moments (GMM).

Baldacci and his co-authors find that GDP per capita is not always significant across regressions. They also find that the government spending and intrasectoral allocation variables, as well as the control variables, are in general not statistically significant and the signs of the coefficients are not consistent across regressions. To improve these results, Baldacci et al. added some regional dummies to control for geographical differences. They also added a time trend, lagged variables, instrumental variables and several other control variables, but all these only improved the parameter estimates marginally. However, the inclusion of the lagged dependent variable produced statistically significant and correctly signed coefficients of the spending and per capita income variables, suggesting a more complex dynamic relationship between government spending and social indicators.

Baldacci and his co-authors also construct a latent variable (or covariance structure) model. They argue that in general, the outcome of social spending is generally unobservable, and as such, the covariance structure model best reflects this feature. Indeed, instead of regressing observable social indicators on government spending and control variables, the covariance structure model treats these indicators as determinants of an unobservable, latent variable.

The covariance structure model used by Baldacci et al. is a Multiple Indicators Multiple Causes model (MIMIC). Baldacci et al. estimate two such models. The first uses child and infant mortality rates as proxies of population health status, while the second model uses immunization rates and access to sanitation as the determinants of the latent variable. Their control variables include per capita income, illiteracy rates and total fertility rates. In both cases, Baldacci et al. find that the influence of public spending on health is "correctly signed but not statistically significant at classical levels".[9] As well, per capita income was found to have a statistically significant negative impact on mortality rates, while it had a statistically significant positive impact on both immunization rates and access to sanitation. Baldacci et al. also found that illiteracy had a significant positive impact on mortality; however it was found to be an insignificant determinant of health status when immunization rates and access to sanitation were used as proxies for health status. Finally, Baldacci et al. find that fertility is statistically significant in both models and negatively related to health.

Baldacci et al. then use a more general covariance structure model that estimates the determinants of both health and education status simultaneously. They find that public spending on education is positively associated with the corresponding latent factor while health spending does not seem to affect health status significantly.

However, Wolfe's (1986) study is unable to lend support to the conclusion reached by Baldacci et al. Indeed, in her study, using a deductive analytical approach, Wolfe analyses the relationship between health status and health expenditures after taking into account changes in lifestyle that have an impact on health. Her methodology consists of looking at health status (infant mortality rates, life expectancies at birth and at age 60), lifestyle variables (tobacco consumption, liver cirrhosis mortality rates by sex as a proxy for troublesome consumption of alcohol, number of persons injured in road accidents per

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[9] Baldacci E., Guin-Siu M. T., and de Mello L. (2002) *More on the Effectiveness of Public Spending on Health Care and Education: A Covariance Structure Model,* Working Paper 02/90, Fiscal Affairs Department, IMF, p. 20

million, percentage of the labour force in risky industries, percentage of the labour force in safe industries) and total health care spending (total health care spending as a percentage of GNP) across six OECD countries (Germany, France, the Netherlands, Sweden, U.K., and U.S.A.) for the period between 1950 and 1980. Wolfe also adjusts health expenditures for population increases and deflates nominal health expenditures by the GDP deflator for 1960 to 1981 in order to obtain a measure of the real rate of expenditure increases. Having analysed each variable across time, Wolfe then compares their patterns and finds that regardless of the measure of health status used, an increase in aggregate medical expenditures results in an improvement in health status. She concludes that:

> if we assume that, in aggregate, life-style changes are exogenous-are independent of changes in medical expenditures-then a decision to increase medical expenditures is expected to lead to some improvement in health status.[10]

Wolfe and Gabay (1987) take this study one step farther. In their analysis, Wolfe and Gabay use the same underlying model found in the Wolfe (1986) study, but expand it to include 22 countries with observations for three points in time--1960, 1970 and 1980.

Their underlying model is a simultaneous equations model, which is appropriate given Wolfe and Gabay's assumption that lifestyle choices influence both health status and medical expenditures. Furthermore, their analysis involves the use of more statistical techniques. Indeed, Wolfe and Gabay construct a latent variable (or covariance structure) model as it is best suited to incorporates the fact that health status and lifestyle are generally unobservable. Their health status indicators include the infant mortality rate,

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[10] Wolfe, B. "Health Status and Medical Expenditures: Is there a Link?", *Social Science and Medicine* 25, No. 8, p. 998

the prenatal mortality rate, life expectancy at birth for males and females, life expectancy at age 60 for males and females and real medical expenditures. Their control variables include lifestyle variables (tobacco consumption, liver cirrhosis, mortality rates by sex, number of persons injured in road accidents per million, percentage of the labour force in risky industries, percentage of the labour force in safe industries, butter consumption), demographic variables (percent of population 65 and over) as well as real medical expenditures. These variables are measured in terms of rates of changes between 1960 and 1970 and between 1970 and 1980.

Wolfe and Gabay conclude that medical expenditures have a statistically significant impact on health status, regardless of the proxy used. They also find that a negative change in lifestyle results in an increase in medical expenditures and a decrease in health outcome.

Or's study supports these results. In her study, Or (2000) uses panel data for 21 OECD countries to first measure the relationship between health status and a non-monetary measure of health care supply and second, to test whether the institutional set up of a health system has any impact on health performance. Her study covers the period between 1970 and 1995 and uses a wide range of mortality measures to proxy health status. These are: perinatal and infant mortality; potential years of life lost (PYLL) by all causes and separately for cancer and heart disease; and life expectancy at birth and at age 65. Or (2000) estimates a linear model of the form:

$$H_{it} = D_{it}\alpha + X_{it}\beta + \varepsilon_{it}$$

where H is a measure of health status and X is a vector of independent variables. These independent variables can be classified into four different groups: the level of medical care inputs (the number of active physicians per 1000 population), medical care institutions (share of public expenditure in total health expenditures and a number of dummy variables reflecting the structure of the health care system), determinants potentially open to public health intervention (per capita consumption of alcoholic beverages (15 and over) and per capita consumption of tobacco (15 and over)) and background variables (GDP per capita, share of white-collar workers in total work force to represent occupational status, NOx emissions per capita to represent air pollution). The subscripts i and t refer to country and time, respectively. β is the vector of coefficients while D_{it} is a vector of country-specific dummy variables. Both β and α are constant over time.

For each measure, apart from perinatal and infant mortality, the model was estimated for men and women separately. The model was estimated using a feasible generalized least squares method to correct for cross-section heteroscedasticity and for autocorrelation specific to each country. The robustness of the results was tested using fixed-effect OLS estimations and to avoid the dummy variable trap, the equations were estimated with one of the variables in each group of dummy variables omitted.

Or finds that the impact of health care is highly significant regardless of the measure used. A 10 per cent increase in doctors is associated with (1) a reduction in premature mortality of almost 4 per cent for women and about 3 per cent for men; (2) a 1 per cent increase in life expectancy at 65 (i.e. 1.8 months for men and 2.4 months for women); (3) a 6 per cent decrease in perinatal mortality and a 6.5 per cent decrease in infant mortality; and (4) a reduction in premature mortality by heart diseases of 6 per cent for men and 6.5 per cent for women. However, Or's findings also suggest that the characteristics of medical care systems are less important than variations in the number of doctors in affecting mortality. Indeed, although Or's results confirm that the higher the public share of health expenditure the lower are perinatal, infant and premature mortality, the estimates of the individual effects of the various institutional variables were highly sensitive to different measures of health status and different estimation methods. A fee-for-service arrangement in the hospital sector was found to have a (weakly) positive significant impact on premature mortality, while "capitation" was significantly negatively related to female premature mortality. On the other hand, countries with primary physicians reimbursed by a salary and acting as gatekeepers for secondary care appeared to perform better in terms of perinatal mortality, although this was not confirmed for infant mortality. For all other health status proxies, the coefficients of the various institutional variables were found to be insignificant.

Turning to the non-medical factors, economic growth (GDP per capita) was highly significantly correlated with all health indicators. The share of total white-collar workers was also found to have a significant coefficient in all cases, although the effects tended to be different depending on the health status indicator. The share of total white-collar workers was negatively related to premature mortality and perinatal and infant mortality, with a 10 per cent increase in the share of white-collar workers implying a 6 per cent reduction in perinatal mortality and more than a 7 per cent decline in infant mortality. On the other hand, a statistically significant positive relationship was found between the share of total white-collar workers and life expectancy at age 65, PYLL caused by heart diseases and PYLL caused by cancer. Or also concluded that the coefficient of tobacco consumption was significant in all cases with tobacco consumption positively related to premature mortality, perinatal mortality, infant mortality, PYLL due to heart disease and PYLL due to cancer, and negatively related to life expectancy at age 65. Alcohol consumption was also positively related to premature mortality, perinatal mortality, infant mortality, and PYLL caused by cancer in men, although it was also found to be statistically insignificant with respect to PYLL due to heart disease (both sexes) and PYLL due to cancer in women. Air pollution (as measured by NOx per capita, kg) was found to be significant and positively related to premature mortality, infant mortality, PYLL due to heart diseases, and PYLL due to cancer; however it was found to be insignificant with respect to perinatal mortality and life expectancy at 65.

All in all, recent empirical studies reveal either no impact of medical expenditures on health outcomes or a positive impact depending on the determinants of health outcomes as well as on the type of data used. In general, the different results inherent in cross-country studies can be explained in part by the heterogeneity of the data. However, conflicting results are also inherent to national studies, despite the fact that more homogenous data are used. This can be mainly attributed to the different proxies used to represent health outcomes. While Crèmieux, Ouillette and Pilon (1998) use infant mortality and life expectancy as their determinant of health outcomes, Kee (2001) uses infant mortality as well as age-standardized mortality rates and life expectancy at birth, while Thornton (2002) uses age-standardized mortality rates. However, these variables are not sensitive to health status. Rivera on the other hand, uses 'self-assessed health status' as a proxy of health outcome, "in order to group and reflect, not just the problems which originate in the health care system itself but also the problems which individuals perceive themselves.[11]" There are several advantages to using self-assessed health status as a measure of health outcome. First, this measure is sensitive to improvements in quality of life. Second, self-assessed health status has been shown to be strongly correlated with health and well-being (Okun *et al.*, 1984). Furthermore, self-assessed health constitutes a good predictor of mortality, and in fact, Mossey and Shapiro (1982) found that subjective ratings of poor health were more highly correlated with mortality than physician ratings. As such, this study uses self-assessed health status as a measure of health outcome. Moreover, by using both homogenous Canadian data and self-assessed health status, this study hopes to yield a more precise estimate of the relationship between public health care expenditures and health outcomes.

4. THE ORDERED PROBIT MODEL

In this study, the relationship between self-assessed health status and public health expenditures is estimated using an ordered probit model. This model was chosen as it was the most appropriate given the ordinal nature of our dependent variable. Indeed, health status responses are coded 0,1,2,3, and 4 where 0 represents the lowest level of health and 4 the highest, and since these responses are both discrete and ranked, they are considered ordinal. The model is expressed as follows:

$$y_j^* = \beta' x_j + u_j$$

where y_j^* defines the latent continuous variable that corresponds to individual j's state of health, while x_j is a row vector of exogenous variables which include: 1) economic

[11] Rivera, B. (2001) "The effects of public health spending on self-assessed health status: an ordered probit model." *Applied Economics* 33, p. 1313

variables; 2) socio-demographic variables; 3) life style variables and 4) public health expenditures. β represents the coefficient vector and u_j is an error term that is normally distributed. y_j^* is unobserved but what is observed is:[12]

$$y_j = 0 \text{ if } y_j^* \leq 0$$
$$= 1 \text{ if } 0 < y_j^* \leq \mu_1,$$
$$= 2 \text{ if } \mu_1 < y_j^* \leq \mu 2,$$
$$\bullet$$
$$\bullet$$
$$= J{+}1 \text{ if } \mu_{j\text{-}1} \leq y_j^*$$

where J represents the number of alternatives and the μ_i represent the cut-off points between successive alternatives. The probability of observing y_j may be expressed as:

$$\Pr(y_j = i) = \Pr(\mu_{i-1} < \beta_j' x_j + u_j \leq \mu_i)$$
$$= F(\mu_i - \beta_j' x_j) - F(\mu_{i-1} - \beta_j' x_j)$$

where F(•) is the standard normal cumulative distribution function.

However, without a fair amount of extra calculation, it is quite unclear how the coefficients in the ordered probit model should be interpreted since the probability of choosing the option y_j=0 is influenced by both the estimated coefficients of the explanatory variables and the values of the explanatory variables.

Given the ambiguity associated with the coefficients, it may be helpful to consider the marginal effects of the exogenous variables. The marginal effects of changes in the

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[12] Greene, W. (2000) *Econometric Analysis,* 4th Edition, New Jersey: Prentice Hall, Inc., p. 876

exogenous variables on the probability of observing y_j, assuming that the exogenous variables are continuous, may be expressed as:

$$\frac{\partial \Pr\lfloor y_j = 0\rfloor}{\partial x_{jk}} = -f(\beta' x_j)\beta_k,$$

$$\frac{\partial \Pr\lfloor y_j = 1\rfloor}{\partial x_{jk}} = \lfloor f(-\beta' x_j) - f(\mu_1 - \beta' x_j)\rfloor\beta_k,$$

$$\frac{\partial \Pr\lfloor y_j = 2\rfloor}{\partial x_{jk}} = \lfloor f(\mu_1 - \beta' x_j) - f(\mu_2 - \beta' x_j)\rfloor\beta_k,$$

$$\frac{\partial \Pr\lfloor y_j = 3\rfloor}{\partial x_{jk}} = \lfloor f(\mu_2 - \beta' x_j) - f(\mu_3 - \beta' x_j)\rfloor\beta_k,$$

$$\frac{\partial \Pr\lfloor y_j = 4\rfloor}{\partial x_{jk}} = f(\mu_3 - \beta' x_j)\beta_k,$$

where f(•) is the standard normal probability density function and x_{jk} is a vector of exogenous variables, where j identifies the individual and k identifies the exogenous variable with respect to which the derivative is being taken. Furthermore, the marginal effects sum to zero, which follows from the requirement that the probabilities of y_j being in the J+1 categories must add to 1.[13] When the exogenous variables are discrete, the discrete change in the probability of observing y_j is evaluated at the mean of the independent variables. For dummy variables, this is expressed as:

$$\frac{\partial \Pr(y_j = i)}{\partial x_{jk}} = [\Pr(y_j = i \mid x_{jk} = 1) - \Pr(y_j = i \mid x_{jk} = 0)]$$

[13] As such, LIMDEP only prints out 4 sets of marginal effects. The marginal effect of the 5th category is just –1 times the sum of the marginal effects for the other categories.

Therefore, rather than simply evaluating the coefficients of the explanatory variables, this study will also evaluate the change in the probability of observing y_j when there is an infinitesimal change in each of the independent variable.

5. DESCRIPTIVE STATISTICS

In measuring per capita public health expenditures by province, this study uses data from the Canadian Institute of Health Information (CIHI) as it provides detailed estimates of public health expenditures by age, sex and provinces for 1996. Furthermore, in order to isolate the relationship between health care spending and health outcomes, this study also controls for economic, socio-demographic and lifestyle factors as these factors also play an important role in determining health outcomes (Tremblay *et al.*, 2002). As such, this study uses data from the National Population Health Survey (NPHS) conducted in 1996, to account for these factors. The survey is a cross-sectional study that includes 81,795 observations. Table 1 defines the variables that are used in this analysis, while Table 2 lists the descriptive characteristics of those variables.

Table 1: ***Definition of Independent Variables***

Variable	Definition
HEALTH	Self-assessed health status on a scale of 1 to 5 (1 = worst, 5 = best)
URBAN	= 1 if the interviewee resides in an urban area
UPINC	= 1 if the interviewee falls into one of the two social classes: high or upper-middle
LOWINC	= 1 if the interviewee falls into one of the two social classes: lower middle or lower
AGE2	= 1 if the interviewee is 65 or over
FEMALE	= 1 if the interviewee is female
MARRIED	= 1 if the interviewee is married or common-law married
DISE	= 1 if the interviewee is divorced or separated
BASED	= 1 if the interviewee has graduated from secondary school
UNED	= 1 if the interviewee has a Bachelor, Master or Doctorate degree
WORKEX	= 1 if the interviewee's work involves physical activity
WORK	= 1 if the interviewee works
POSH	= 1 if the interviewee did something to improve his/her health
OVERWT	= 1 if the interviewee is overweight
DIF	= 1 if the interviewee has been worried or unhappy due to death in the family
PHYACT	= 1 if the interviewee is physically active
SMOKE	= 1 if the interviewee is a daily smoker or a former daily smoker
ALCOHOL	= 1 if the interviewee is a regular drinker or a former regular drinker
HEXP	Per capita public health expenditure by age, sex and province in 1996

Table 2: ***Descriptive Statistics***

Variable	Mean	Standard Deviation	Minimum	Maximum
HEALTH	*3.7820*	*1.0119*	*1*	*5*
URBAN	*0.5994E-01*	*0.23738*	*0*	*1*
UPINC	*0.4125*	*0.4923*	*0*	*1*
LOWINC	*0.1358*	*0.3426*	*0*	*1*
AGE2	*0.1634*	*0.3697*	*0*	*1*
FEMALE	*0.5291*	*0.4992*	*0*	*1*
MARRIED	*0.4883*	*0.4999*	*0*	*1*
DISE	*0.1600*	*0.3666*	*0*	*1*
BASED	*0.1533*	*0.3603*	*0*	*1*
UNED	*0.1216*	*0.3268*	*0*	*1*
WORKEX	*0.3577E-01*	*0.1857*	*0*	*1*
WORK	*0.4981*	*0.500*	*0*	*1*
POSH	*0.3384*	*0.4732*	*0*	*1*
OVERWT	*0.3404*	*0.4738*	*0*	*1*
DIF	*0.6541E-02*	*0.8061E-01*	*0*	*1*
PHYACT	*0.1758*	*0.3806*	*0*	*1*
SMOKE	*0.4085*	*0.4916*	*0*	*1*
ALCOHOL	*0.5936*	*0.4912*	*0*	*1*
HEXP	*2925.8*	*4777.4*	*417.90*	*25812*

5.1 Health Outcome

The variable used as a proxy of health outcome is self-assessed health status. This variable appears in the NPHS on a scale of 1 to 5, where 1 corresponds to excellent health, 2 to very good, 3 to good, 4 to fair and 5 to poor[14]. This scale has been reversed so that 5 represents excellent health and 1 represents poor health since this seems more logical and is consistent with the methodology used by Rivera (2001). In our sample, 27 per cent of the respondents rated their health as excellent, 37 per cent rated their health as very good, 25 per cent rated their health as good, 8 per cent rated their health as fair and only about 3 per cent indicated a health status of poor.

5.2 Economic Variables

The income class of an individual is likely to affect the way he (she) evaluates his

[14] Some individuals chose not to specify their health status, and as such, they are excluded from the sample. However, some individuals did not provide an answer to the questions used to generate the lifestyle variables and the variables related to income, marital status, educational attainment, and employment status. These individuals were included in the sample and their responses were given a value of 9.

(her) health. In particular, individuals in higher income classes can afford better nutrition, better housing and better sanitation relative to those in lower income classes.

Furthermore, individuals in higher income classes are also able to pay for health care not covered by social insurance in Canada. Empirical evidence also substantiates the assumption that a positive relationship exists between income and health outcomes. For example, Pritchett and Summers (1996), using IV and fixed effects estimation on cross-country, time-series data, find that wealthier is causally healthier when health outcomes are proxied by infant and child mortality as well as life expectancy. Ettner's study supports these findings. In her study, Ettner (1996) studies the relationship between income and health in the United States, using a variety of health proxies, mainly self assessed health status, work and functional limitations, bed days, average daily consumption of alcohol, and scales of depressive symptoms and alcoholic behaviour. She uses data from the 1987 National Survey of Families and Households, the 1986-87 panels of the Survey of Income and Program Participation, and the 1988 National Health Interview Survey, which were merged with Bureau of Labor Statistics data on state unemployment rates. Ettner's model is estimated using the instrumental variables (IV) procedure, which is implemented using the 2SLS estimator, with the instrument set containing the unemployment rate, work experience, parental education, as well as spousal education and experience and the education of the spouse's parents. Ettner finds that an increase in income significantly improves mental and physical health although it also increases the prevalence of alcohol consumption.

Given the existence of empirical studies that support the hypothesis that income positively impacts health, this study includes both UPINC and LOWINC as variables that reflect both high and upper-middle income classes and lower and lower-middle income classes, respectively. As can be observed from Table 2, 41.3 per cent of the respondents in our sample belong to the high or upper-middle income classes while 13.6 per cent belong to the lower or lower-middle income classes.

Table 3: ***Percentage of Sample in each Health Category by Income Level, 1996***

Health Status	Income Level	
	Upper Income Quintile	Lower Income Quintile
Excellent	35.4	19.9
Very Good	40.7	28.1
Good	19.5	28.1
Fair	3.7	15.8
Poor	0.8	8.1

Table 3 shows the respondents' health status by income level. Across income groups, respondents were more likely to evaluate their health positively the higher their income level. In particular, 35.4 per cent of the respondents in the upper income quintile evaluated their health as excellent, while 19.9 per cent of the respondents in the lower income quintile evaluated their health as such. Moreover, 8.1 per cent of the interviewees in the lower income quintile rated their health as poor, compared to 0.8 per cent of the interviewees in the upper income quintile.

One would also expect involuntary unemployment to have a negative impact on psychological well-being. Therefore, this study takes this factor into account by including a variable (WORK), which reflects whether or not the respondent is presently working. Within our sample, 49.8 per cent of respondents are currently working.

Table 4 provides a look at the health ratings of working individuals and unemployed individuals. As expected, working individuals have a better health status than unemployed individuals. In particular, among individuals who are working, 4.7 per cent rate their health as fair and 0.67 per cent rate their health as poor, while among those who are unemployed, 11.1 per cent rate their health as fair and 4.5 per cent rate their health as poor.

Table 4: ***Percentage of Sample in each Health Category by Working Status, 1996***

Health Status	Working Status	
	Working	Unemployed
Excellent	27.8	26.3
Very Good	42.4	31.8
Good	24.4	26.3
Fair	4.7	11.1
Poor	0.67	4.5

5.3 Social and Demographic Variables

Demographic variables in this study include both age and sex as these affect health outcomes. Age is represented by a dummy variable (AGE2) that equals 1 if the respondent is 65 or above and 0 if he (she) is younger than 65. Within our sample, 16.3 per cent of the 81,795 interviewees were 65 years of age or older. (See Table 2.) Furthermore, the sex of the interviewee is also denoted by a dummy variable (FEMALE). The sample used in this study is characterized as being more than half (53 per cent) female.

Table 5 shows the respondents' health status profile by age and sex. Across age groups, health status was most likely to be evaluated as good (poor) the younger (older) the respondent. Indeed, 28.6 per cent of the interviewees between the ages of 15 to 44 rated their health as excellent, while 9.7 per cent of those over 80 indicated such a health status. Furthermore, 8.2 per cent of those over 80 rated their health as poor, while 1.2 per cent of the respondents between the ages of 15 to 44 rated their health as such.

Table 5: ***Percentage of Sample in each Health Category by Age and Sex, 1996***

	Age Category					Sex	
Health Status	**15 to 44**	**45 to 64**	**65 to 74**	**75 to 79**	**≥80**	**Female**	**Male**
Excellent	28.6	20.3	12.9	10.1	9.7	26.2	28.0
Very Good	42.0	36.4	30.4	28.9	26.4	37.1	37.1
Good	23.2	28.9	35.6	34.8	35.0	25.5	25.2
Fair	5.0	10.3	16.0	19.6	20.7	8.5	7.2
Poor	1.2	4.2	5.2	6.6	8.2	2.6	2.5

Interestingly, there seems to be very little variation in the way females and males rate their health. Indeed, 26.2 per cent of female respondents evaluated their health as excellent, which is only 1.8 percentage points higher than the proportion of males that rated their health as excellent. Similarly, although a greater percentage of females evaluated their health as fair or poor, the difference between the percentage of males that evaluated their health as fair or poor was negligible.

The educational attainment of an individual also plays an important role in his (her) health outcome. In general, individuals with a higher level of education are more aware of potential health risks and remedies.[15] This study uses educational attainment as found in the National Population Health Survey and classifies education level into two groups: individuals with a secondary diploma and individuals with a Bachelor, Master or Doctorate degree. In our sample, 15.3 percent of the respondents have a secondary diploma and 12.2 per cent have a Bachelor, Master or Doctorate degree.

[15] Crémieux, Peirre-Yves, Pierre Ouellette, and Caroline Pilon (1999) "Health Care Spending as Determinants of Health Outcomes." *Health Economics* 8, p. 631.

The marital status of the interviewees is also considered in this study. Indeed, it has been hypothesized that married individuals receive better home care and place a higher value on health relative to other market goods and risky activities than unmarried persons. Furthermore, married individuals also avoid the negative health affects associated with divorce and death of a spouse. As such, two dummy variables are included that reflect marital status. The first is MARRIED, which equals 1 if the interviewee is married or in a common-law relationship, and 0 otherwise. Within our sample, 48.8 per cent of the respondents are married. Furthermore, among the married individuals, 29.1 per cent rated their health as excellent, while 2.6 per cent rated their health as poor. (See Table 6.)

The second dummy variable that reflects marital status is DISE, which equals 1 if the interviewee is divorced or separated, and 0 otherwise. In particular, 16 per cent of the interviewees in our sample are either divorced or separated. Among the divorced or separated interviewees, 16.4 per cent rated their health as excellent, while 5.5 per cent rated their health as poor. Therefore, married couples are more likely to rate their health as excellent and less likely to rate their health as poor compared to divorced or separated individuals.

Table 6: ***Percentage of Sample in each Health Category by Marital Status, 1996***

Health Status	Marital Status	
	Married	**Divorced or Separated**
Excellent	23.6	16.4
Very Good	38.9	32.3
Good	26.9	31.0
Fair	7.9	14.8
Poor	2.6	5.5

Furthermore, this study includes a dummy variable DIF to reflect the negative impact the loss of a loved one has on health. However, out of the 81,795 respondents, only 535 have been worried or unhappy due to a death in the family and therefore, the final specification does not include this variable.

The relative density of the region is also thought to affect health outcomes since denser regions are often characterized as having higher levels of pollution and greater numbers of accidents, both of which negatively affect health. This study uses the dummy variable URBAN to reflect the relative density of the regions in which the interviewees reside. However, given that only 6.0 per cent of the respondents in our sample reside in an urban area and that the data were unavailable for over 90 per cent of the respondents, our final specification excludes regional density as a determinant of health outcomes.

5.4 Lifestyle Variables

It is well recognized that an individual's lifestyle choices influences his (her) health outcome. In particular, alcohol and tobacco consumption negatively affect health since they increase the risk of heart disease and damage the lungs and liver, among other things. As such, the variables used to control for alcohol and tobacco consumption are whether the individual smokes or has ever smoked and whether the individual is a regular drinker (consumed more than 12 drinks a week) or has ever been a regular drinker.

Within our survey sample, 40.9 per cent of respondents were either current smokers or past smokers, while 59.4 per cent drank regularly or used to drink regularly.

It is also well recognized that diet and physical activity are determinants of health. Indeed, individuals that consume high fat diets tend to be overweight and have high cholesterol levels as well as high blood pressure, all of which make the individual more susceptible to cardiovascular disease. Therefore, to account for the fact that being overweight negatively affects health, the dummy variable OVERWT is used. 34 per cent of the respondents in our sample rated themselves as overweight

Physical activity is also known to have a positive impact on health. As such, the variables WORKEX and PHYACT are used to embody the level of physical activity of the respondent. Within our sample, 17.6 per cent of the interviewees were physically active, while 3.6 per cent worked in physically demanding jobs.

It is also intrinsic to the nature of an individual to set out a goal in order to improve his (her) quality of life. Hence, POSH is included as it reflects the interviewee's willingness to actively improve his (her) health. Among the 81,795 respondents, 33.8 per cent did something positive to improve their health.

Table 7: ***Percentage of Sample in each Health Category by Lifestyle Choices, 1996***

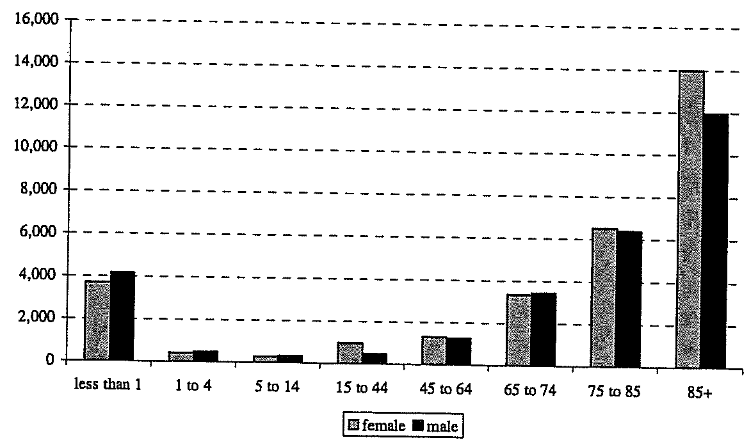
	Smoking status		Overweight		Physical Activity		Alcohol Consumption	
Health Status	**Daily Smoker**	**Non Smoker**	**Overweight**	**Not Overweight**	**Frequent Exerciser**	**Infrequent Exerciser**	**Regular drinker**	**Non-drinker**
Excellent	19.0	27.1	17.0	27.1	32.8	19.0	24.0	27.1
Very Good	37.2	37.1	39.1	37.1	40.7	37.0	39.2	37.1
Good	29.7	25.4	30.9	25.4	20.8	29.8	26.2	25.4
Fair	10.4	7.9	10.1	7.9	4.9	10.5	8.0	7.9
Poor	3.6	2.6	3.0	2.6	0.9	3.6	2.6	2.6

Table 7 above provides a look at the self-assessed health reported by the respondents according to a series of lifestyle factors. As might be expected, reporting of fair or poor health is greater among daily smokers, regular drinkers, overweight individuals, and infrequent exercisers. Moreover, reporting of excellent health is greatest among respondents who are physically active. In fact, infrequent exercisers were 4 times as likely as frequent exercisers to report poor health.

5.5 Health Care Expenditure

Since the focus of our study is the relationship between public health care expenditures and health outcomes, the variable used here to reflect public health care expenditures is public per capita health care spending in 1996. These data are made available by CIHI, which provides detailed estimates of public health expenditures by age, by sex and by province.

Figure 7
Per Capita Public Health Expenditures
By CIHI Age Categories, 1996

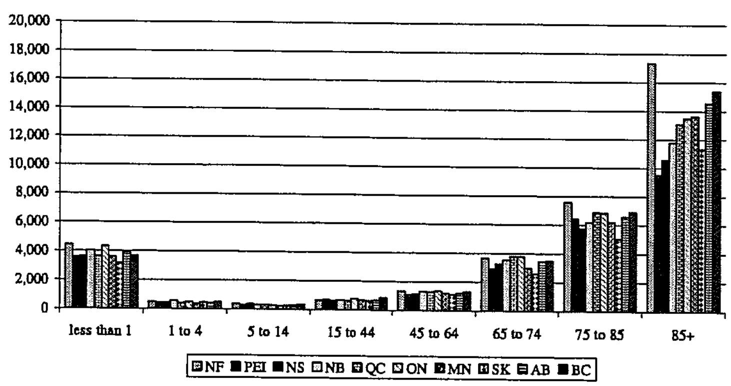


Source: Canadian Institute of Health Information, *National Health Expenditure Database, National Health Expenditure Trends 1975-2002.*

Figure 7 provides a look at per capita public health expenditures for each province across eight CIHI age groups for both females and males. Not surprisingly, public health expenditures are highest among those aged 85 and above, with public health care spending on females exceeding public health care spending on males by $2,018 per capita. In fact, with the exception of the 75 to 84 age group, public health spending on females 15 years of age or older tends to exceed health spending on males. On the other hand, for the portion of the population aged 15 or less, public health spending on females is lower than for males. Furthermore, public health expenditures are lowest amongst those aged 5 to 14, with per capita health spending on males exceeding per capita health spending on females by about $42.

Figure 8 shows per capita public health spending by age and by province. It is interesting to note that Newfoundland has the highest per capita health expenditures among those aged 85 and above, and compared to all other provinces, it spends the least on those between the ages of 15 and 44. This largely follows from the fact that relative to all other provinces, the population of Newfoundland is, on average, older. Prince Edward Island, on the other hand, has the lowest per capita health expenditures among those aged 85 and above, while Manitoba has the lowest per capita health expenditures among those between the ages of 5 to 14, the age category that commands the least public health spending.

Figure 8
Per Capita Provincial Health Spending
By CIHI Age Categories, 1996



Source: Canadian Institute of Health Information, *National Health Expenditure Database, National Health Expenditure Trends 1975-2002.*

6. RESULTS

Although public health care expenditures have increased between 1990 and 2001, it is not clear whether these increases have resulted in better quality of health care and thus better health outcomes, or whether these increases are simply a result of the increased demand for health care services by the ageing population and/or improvements in technology, which have increased the range of available services (some of which are costly) as well as generated new drugs, resulting in a growth in drugs as a share of total health spending. As such, the econometric results presented in Tables 8 and 9 can help shed light on the benefits of public health spending for the population as a whole. It is important to note that the Log Likelihood Function (LLF) did not converge using the initial specification of the health expenditure variable. However, the LLF did converge when health expenditures were assigned to individuals based on their age and sex, rather than based on their age, sex and province, as was initially done. Thus, it is this latter set of results that is reported henceforth.

Overall, the log likelihood ratio test statistic of 12,073.82 with 16 degrees of freedom greatly exceeds the critical value of 26.30 for a level of significance of 0.05, suggesting that some of the variation in health can be explained by the independent variables included in our model. These results will be discussed in more detail in this section. The first sub-section will discuss the effects of public health care spending on self-assessed health status, focusing on marginal effects. Section 6.2 will describe the effects of income and employment on health. This will be followed by a discussion of the effects of socio-demographic and lifestyle variables on health in Section 6.3.

Table 8: *Estimation Results using an Ordered Probit Regression*[16]

Variable	Coefficient	T-ratio
Constant	2.440	98.284 **
UPINC	0.163	19.049 **
LOWINC	-0.243	-21.643 **
AGE2	-0.427	-32.650 **
FEMALE	0.397E-01	2.096 *
MARRIED	-0.228	-24.119 **
DISE	-0.307	-23.975 **
BASED	0.346E-01	3.201 **
UNED	0.204	16.226 **
WORKEX	-0.280E-01	-1.266
WORK	0.177	19.253 **
POSH	-0.119	-14.364 **
OVERWT	-0.284	-33.545 **
PHYACT	0.238	25.631 **
SMOKE	-0.276	-33.470 **
ALCOHOL	-0.655E-01	-7.847 **
HEXP	-0.168E-06	-0.149
Number of Observations	81,795	
Level of Significance	0.05	
Log Likelihood Ratio Test Statistic	12,073.82 (26.296)	

* significant at 5 per cent level; ** significant at the 1 per cent level..

Table 9: *Marginal Effects*

Variable	Marginal Effect*			
	HEALTH=POOR	HEALTH=FAIR	HEALTH=GOOD	HEALTH=VERY GOOD
Constant	-0.1000	-0.2805	-0.5218	0.1235
UPINC	-0.0067	-0.0188	-0.0349	0.0083
LOWINC	0.0100	0.0279	0.0520	-0.0123
AGE2	0.0175	0.0491	0.0912	-0.0216
FEMALE	-0.0016	-0.0046	-0.0085	0.0020
MARRIED	0.0094	0.0263	0.0489	-0.0116
DISE	0.0126	0.0352	0.0656	-0.0155
BASED	-0.0014	-0.0040	-0.0074	0.0018
UNED	-0.0084	-0.0235	-0.0437	0.0103
WORKEX	0.0011	0.0032	0.0060	-0.0014
WORK	-0.0073	-0.0204	-0.0380	0.0090
POSH	0.0049	0.0137	0.0255	-0.0060
OVERWT	0.0116	0.0327	0.0608	-0.0144
PHYACT	-0.0098	-0.0274	-0.0509	0.0120
SMOKE	0.0113	0.0318	0.0591	-0.0140
ALCOHOL	0.0027	0.0075	0.0140	-0.0033
HEXP	0.0000	0.0000	0.0000	0.0000

*Limdep computes the marginal effects at the sample means of the independent variables.

6.1 The Effect of Public Health Expenditures on Health Status

The effect of health care spending on population health is found to be statistically insignificant at a 5 per cent level of significance and an unexpected sign is observed. Indeed, the absolute value of the t-test statistic of health expenditures is 0.149, much

[16] Estimates were obtained using LIMDEP 7.0.

smaller than the critical value of 1.96, which suggests that overall health expenditures have no impact on health status. The marginal effects of health expenditures also reflect this assertion since there are no marginal variations in the probabilities with respect to the effects of health spending on self-assessed health status. This result contradicts the finding by Rivera (2001), but is analogous with the findings by Filmer and Pritchett (1999), Thornton (2002) and Baldacci et al. (2002). Filmer and Pritchett (1999) believe that public health spending had a weak effect on reducing mortality rates because of the high cost effectiveness of health services. In fact, they put forth three criteria that must be met for public spending to improve health cheaply. The first is that public spending must create effective health services. The second is that the existence of those new public services has to change the total amount of effective health services consumed by the population. The third is that the additional services consumed have to be cost-effective in improving health. If any one of these conditions is not met, Filmer and Pritchett state that health services are not delivered efficiently, which would explain why increasing public health expenditures would have no significant impact on reducing mortality rates.

Thornton (2002), on the other hand, finds that lifestyle factors and socioeconomic status have a substantially larger marginal impact on death rates than medical care use and as such, he concludes that better health outcomes can be achieved through policies that strengthen the education system, foster income growth, reduce overall crime and promote social stability. Baldacci et al. (2002) support Thornton's conclusion. They suggest that removing unfavorable social conditions, such as high illiteracy rates and/or sizable income and gender disparities in the access to basic public services could be more important in improving health outcomes than increasing public health expenditures.

Both the inefficient delivery of health services and the importance of economic, social, demographic and lifestyle factors can explain why the relationship between public health expenditures and self-assessed health status is statistically insignificant in Canada. Indeed, seven of ten provinces conducted health reviews between 1994 and 1999 and after examining these reviews, the National Forum of Health concluded that:

> ...without exception, all reviews have concluded that the health care system needs better management, not more money.[17]

Furthermore, Tremblay, Ross and Berthelot (2002) conducted a study whose goal was to determine the influence of regional socio-economic environment on the self-rated health of Canadians. Tremblay et al. used data from the first cycle of the 2000/2001 Canadian Community Health Survey as well as the 1996 Census, the Canadian Vital Statistics Database, and the Demography and Geography Divisions of Statistics Canada. They modeled fair and poor health using a multilevel logistic regression and a logit function was used to model the relationship between health outcome and various explanatory variables. Their study finds that overall, age, sex, socio-economic position, smoking, obesity, and infrequent exercise are factors that accounted for much of the variation between health regions in reporting of fair or poor health, while the social environment only had a modest influence on individual health status.

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[17] National Forum on Health. (1997) "Striking a Balance Working Group Synthesis Report", in *Canadian Health Action: Building on the Legacy, Volume II of the Report of the National Forum on Health.* Ottawa: Minister of Public Works and Government Services, p.5

6.2 The Effect of Income and Employment on Health Status

In this study, the influence of income on health status is found to be positive and significant at the 1 per cent level of significance. Indeed, being in the upper or middle-upper income class positively influences health status while being in the lower or lower-middle income class negatively influences health status. In both cases, the absolute value of the t-test statistic is greater than the 1 per cent critical value, suggesting that income does have a significant impact on self-assessed health status. Furthermore, the marginal effect of income on health status paints a similar picture. The probability of an individual evaluating his (her) health as poor or fair decreases if an individual is in the upper or upper-middle income class and increases if he (she) is in the lower or lower-middle income class. This reinforces the findings of Ettner's (1996) study. Indeed, Ettner concluded that an increase in income significantly improved mental and physical health.

The influence of employment on health status is also found to be statistically significant and positive at the 1 per cent significance level. This is as expected, since working individuals are not subjected to the negative psychological consequences of unemployment (Theodossiou, 1998). Furthermore, the marginal effect of employment on health status suggests that the probability that an individual will assess his (her) health as poor or fair decreases if he (she) is employed.

It is also interesting to note that being employed has a slightly larger effect on health status than being in the upper or upper-middle income class. Indeed, being employed lowers the probability of being in the lowest health category by 0.73 percentage points, while being in the upper or upper-middle income class lowers it by only 0.67 percentage points.

6.3 The Effect of Social, Demographic and Lifestyle Factors on Health Status

All the socio-demographic variables have statistically significant coefficients and in general, they all have the expected signs. The influence of AGE2 on health is found to be statistically significant and negative at the 1 per cent significance level, with Canadians aged 65 and over more likely to report fair or poor health than the reference age group (aged 64 or less). The characteristic of being female was found to have a positive and significant impact on health at the 5 per cent significance level, with negative marginal variations in the probabilities of poor or fair health if the respondent is female as opposed to male. Overall, the negative influence of being 65 years of age or older on health is greater than the positive impact of being female. Indeed, while being female lowers the probability of reporting poor health by 0.16 percentage points, being 65 years of age or older raises it by 1.75 percentage points.

The marital status of the respondent is also found to have a significant impact on health status at the 1 per cent level of significance. Both the state of being married and the state of being divorced or separated are found to have a negative, statistically significant impact on health status, with the probability of reporting fair or poor health increasing if the individual is married or divorced or separated. Intuitively, one would expect married individuals to have a higher health status, but this assumes a healthy, functional marriage. Unfortunately, this is not always the case. Often individuals are married but unhappy and under tremendous amounts of emotional stress and as such, these individuals are most likely to negatively assess their health. As well, married individuals are also more likely to have children than non-married individuals and since there are stresses associated with child rearing, this may also account for the unexpected sign of the MARRIED variable. However, overall, the probability of reporting poor or fair health for married individuals is lower than for divorced or separated individuals.

Education was also found to have a statistically significant impact on health status at the 1 per cent level of significance. Having either a secondary diploma (BASED) or a Bachelor, Master or Doctorate degree was found to have a positive and significant impact on health status. However, looking at marginal effects, although individuals with either a basic education (secondary diploma) or a university education (Bachelor, Master or Doctorate degree) have a lower probability of reporting fair or poor health as compared to individuals with no education, it is also true that having a university degree lowers the probability of reporting poor health by more than having a secondary diploma. Indeed, having a university degree reduces the probability of being in the lowest health category by 0.84 percentage points while having a secondary diploma lowers it by only 0.14 percentage points. This result is similar to that found by Rivera (2001) and Tremblay et al. (2002). Indeed, Rivera found that the individual is more likely to value his (her) health status good or positive if he (she) has university qualifications while he (she) is more likely to value his (her) health negatively if he (she) has no qualifications. Tremblay et al. find that a lower education level was associated with greater odds of reporting fair or poor health and in fact, they find that for both education and income, each step down the socio-economic ladder resulted in a greater probability of reporting fair or poor health (except for those with secondary education).

The coefficients of the lifestyle variables have the expected signs and are all found to be statistically significant at the 1 per cent significance level. As expected, both smoking and drinking are found to have a negative and significant influence on health status, with a greater probability of reporting fair or poor health if the respondent smokes or drinks regularly. As well, being overweight is found to have a negative and significant impact on health, with the probability of reporting poor or fair health greater for respondents who are obese than for respondents who are non-obese. In fact, being overweight has a slightly larger negative impact on health than smoking or drinking. While being overweight raises the probability of reporting poor health by 1.16 percentage points, being a smoker raises it by only 1.13 percentage points and being a regular drinker raises it by even less (0.27 percentage points).

Also, physical activity was found to play a statistically significant role in the way respondents evaluated their health. Better health status was associated with higher levels of physical activity, and in fact, the probability of reporting poor or fair health decreased if the respondent was active, as opposed to inactive. Furthermore, the positive impact of being physically active on health appears to offset the negative impact of drinking alcohol regularly, although it does not offset the negative impact of smoking or being overweight. In particular, while being physically active lowers the probability of being in the lowest health category by 0.98 percentage points, being a regular drinker raises that probability by only 0.27 percentage points. On the other hand, being a smoker raises the probability of reporting poor health by 1.13 percentage points and being overweight raises that probability by even more (1.16 percentage points).

Exercise during the course of work was found to have a negative, but insignificant impact on self-assessed health status. In particular, working in a physically strenuous job raises the probability of being in the lowest health category by 0.11 percentage points.

This may be due to the extra stress and unfavourable conditions that are sometimes attributed to these physically challenging jobs.

Furthermore, many respondents attested to doing something positive to improve their health. However, this is found to have a negative and statistically significant impact on health status, with the probability of reporting fair or poor health likely to increase if one does something to improve his (her) health. This is counterintuitive, but may be explained by the fact that many individuals who report doing something to improve their health are individuals who are in poor health to begin with. Therefore, although they may be doing something positive to improve their health, what they are doing is not sufficient to boost their health to a higher level. Furthermore, if these individuals continue with activities that negatively impact their health (i.e., smoking, drinking, infrequent exercise), the negative impact of these activities may override the positive impact of the health improving activities, resulting in an overall decrease in health status.

Overall, the individual is more likely to value his (her) health status positively if he (she) is female, has university qualifications, and is physically active. On the other hand, health status is more likely to be assessed negatively if the respondent is male, older than 65, married, divorced or separated, has no education or basic education, exercises infrequently, smokes, drinks or is obese.

7. CONCLUSION

The relationship between health expenditures and health outcomes is an area of study that has been extensively investigated, although conflicting results have emerged. The difference in the results can be attributed to the difference in health outcome proxies used as well as in the type of data employed. As such, this study uses self-assessed health status to measure health outcome since it is sensitive to improvements in quality of life and is shown to be strongly correlated with health, well-being and mortality. Furthermore, this study uses homogenous Canadian data to limit data heterogeneity and includes economic, social, demographic and lifestyle variables to limit specification bias.

The analysis is carried out using an ordered probit model to estimate the effects of public health spending on health levels. The results show that public health spending has no impact on health status. Two explanations can account for this. The first is that health care services are not delivered efficiently and the second is that economic, social, demographic and lifestyle factors play a more important role in influencing health outcomes than medical utilization. Indeed, the estimation results of this study show that economic, socio-demographic and lifestyle factors are significant determinants of health status. Therefore, if the primary goal of health care policy is to improve the health status of the population, better management of the health care system is needed. Furthermore, policies that encourage higher education, foster sustained income growth, and promote healthy lifestyles may be highly effective in improving health, perhaps more so than increased medical expenditures.

Future research could look at whether different socio-demographic, economic and lifestyle factors affect the health status of men and women differently in Canada as such a study could unveil some interesting results. As well, a study of the differences in health status across provinces combined with a look at differences in provincial health spending could provide some insight into the efficiencies and inefficiencies of the health care system, as some provinces may be providing health care services more efficiently than others. Needless to say, there are many prospects for future work in the area of health care in Canada, as improvements in the health care system are needed if public health expenditures are to improve the overall health status of Canadians.

Appendix 1

Real, Per Capita, Age-Adjusted Health Spending

In calculating per capita, age-adjusted health spending, a starting point, or base year t must be assigned. In this case, our base year is 1975. Next, aggregate health spending, H_t, is allocated across age groups using detailed estimates of public sector health expenditures from the Canadian Institute of Health Information (CIHI), yielding $H_{i,t}$ for i=1 to 91 years of age. Subsequently, both population by age group[18], $POP_{i,t}$ and a price index P are used to calculate average, real, per capita spending by age group, which is defined as:

$$(1)\ A_{i,t} = \frac{H_{i,t}}{P_t \cdot POP_{i,t}}$$

Total spending on health spending in the base year can therefore be expressed as:

$$(2)\ X_t = \sum_{i=1}^{91} A_{i,t} \cdot POP_{i,t} \cdot P_t$$

The relative age profile of H, defined as $R_{i,t} \equiv \frac{A_{i,t}}{A_{j,t}}$ (where A_j is the numeraire age group, which in this case corresponds to the 15 to 44 age group) is then calculated and with some manipulation and the incorporation of exogenous real per capita income growth g, the real, per capita, age adjusted health spending can be expressed as:

$$(3)\ H_{t+1} = (1+g) \cdot \left(\frac{\sum_{i=1}^{91} R_{i,t+1} \cdot POP_{i,t+1}}{\sum_{i=1}^{91} R_{i,t} \cdot POP_{i,t}} \right) \cdot (1+\pi) \cdot H_t$$

where π is the rate of inflation.

[18] Statistics Canada, *Annual Demographic Statistics 2001,* cat. 91-213-XPB

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