

An Examination of the Relationship between Specific
Health Expenditures and Health Outcomes in Canada

By

Michael Johnston
(3909578)

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Supervisor: Professor Catherine Deri

ECO 7997

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Introduction

One goal of health economists and policymakers is to determine the ‘best’ allocation of resources to maximize some measure of a population’s health, taking into consideration budget limitations and notions of equity. The current approach, which dates from the unanimous passage of the Canada Health Act (CHA) by Parliament in 1984, did not emerge overnight. The origins of a ‘national’ health policy lay in the reconstruction of Canadian society at the end of the Second World War. “In 1948 the National Health Program was enacted, which provided federal grants to each province in the fields of hygiene and health” (Francis et al., 2005, p.450). With these federal grants, the individual Canadian provinces could choose what amounts they wanted to put towards the health sector. Over the five decades that followed, the health care system changed, though it always remained a provincial responsibility. One important step occurred in 1962, when Saskatchewan introduced a health insurance plan for residents of its province. Six years later, in 1968, Ottawa enacted a renewed national health care program that provided financial assistance to all provinces except Quebec, which set up its own plan. The three guiding principles at the time were that health care had to be comprehensive, publicly administered and portable (Francis et al., 2005) Because of the steadily increasing costs of health care in Canada, it is a program or plan that has been under close scrutiny since the late 1960s.

By the early 1980s, many provincial governments were anticipating or were already experiencing a crisis with health care. Costs were rising faster than their means to meet them using the traditional funding arrangements. The provinces looked to the federal government to come up with a solution, i.e. more money. In 1984, as described,

the Canadian Parliament passed the CHA to deal with the growing concerns from the provinces. The five criteria for transfers according to the Canada Health Act are: universality, accessibility, comprehensiveness, portability and a publicly administered health insurance system. These criteria must be met by the provinces before any transfers are issued from the federal government.

With the CHA being universal, many may believe that all health care across Canada is the same in all provinces. But, as Di Matteo and Di Matteo (1998) describe, it is “largely up to the provincial governments to actually deliver funded health care to citizens. About 47% of health care spending in Canada is financed by provincial governments while another 22% comes from federal transfers which means that provincial governments in Canada are responsible for nearly 70% of health care expenditures in Canada” (Di Matteo and Di Matteo, 1998, p. 212). As such, it is apparent that provinces spend different per capita amounts on health care. Essentially, there are ten different health care systems, each deciding on different spending levels and allocations to the different health care areas.

While there are thus many differences in how the provinces spend money, all provinces' health care expenditures have increased dramatically over the past few decades. Figure 1 plots the CPI adjusted trends for aggregate health care spending in Canada (as well as provincial examples of British Columbia and Nova Scotia) for 1975-2003. British Columbia's population is one of the largest in Canada, and has remained relatively steady since the mid 1990s. The figure for BC shows a constant increase in health care expenditures over the past few decades. Nova Scotia was chosen to represent

a small province, with a stable population near 900,000 for the past 15 years, but the figure shows a large increase in health spending from 1997 onward.

In the 1970s, the percentage of GDP devoted to health care expenditures was approximately 7.0% for Canada. Today the amount has increased to 10% (Statistics Canada, 2005). Many economists wonder if this amount is sustainable or even if it is an appropriate amount to put towards health care expenditures given other priorities. Most importantly, there is the question as to whether or not the substantial increase in health expenditures has resulted in improvements in the health outcomes of the population.

Also, there is a common concern regarding the sustainability of the Canadian health care system in the face of an ageing population in Canada and the associated increased costs¹. The number of persons in Canada over the age of 65 is expected to reach 18% of the total population by 2025 (Marzouk, 1991), which is why there is a need for studies to know how to effectively spend health care funds.

The economics literature provides insight into the relationship between spending and health care outcomes. Most of the studies address the following questions: How much spending on health care is optimal? Is there a need to devote such a large percentage of Canada's GDP towards health care? What types of health care expenditures are most effective at reaching successful health outcomes? This study will review the literature and attempt to provide more information on some of these issues and questions.

The focus of the paper's empirical work will revolve around the last question: 'What specific health care expenditures should be the focus for spending to help Canadians become healthier for years to come?' There is a recent paper (Cremieux et al., 1999) showing that higher health spending does in fact lead to better health outcomes in

¹ Please see the Romanow report (2002) for more details on this issue.

Canada. However, they do not answer the question of on what types or sectors of health care spending should a government concentrate spending to increase the health of relatively “unhealthy” provinces?

The objective of the paper is to estimate the effects various components of health expenditures have on health outcomes over the time period from 1981 – 1998, using data for the ten Canadian provinces. As compared to previous work (Cremieux et al., 1999), health expenditures will not be examined as a single variable, but as five separate variables: hospital expenditures, physician expenditures, drugs, other healthcare professionals, and all other expenditures². These variables are obtained directly from the Canadian Institute for Health Information (CIHI). Since the 1970s the first four of these divisions (Hospitals, Physicians, Drugs, Other Professionals) in health spending has accounted for over 70 percent of the total health spending in Canada. The fifth variable is the summation of the remaining expenditures that are present in the Canadian health care system, called ‘all other expenditures’ for the regressions. All other expenditures includes: other institutions, capital, public health and administration, and other health spending³. This paper’s underlying objective is to allow the Canadian government to see where health care expenditures should be focused to increase the public’s health.

Following the methodology of Cremieux et al. (1999) I use provincial data from 1981-1998 to determine which specific per capita health care expenditures have a significant impact on health outcomes, as measured by gender specific infant mortality

² Other healthcare professionals include: privately practicing dentists, denturists, chiropractors, massage therapists, orthoptists, osteopaths, physiotherapists, podiatrists, psychologists, private duty nurses, and naturopaths. Source: CIHI, 2005.

³ The reason I chose to combine these sectors of spending into one variable for my analysis is due to the fact that their total share combined makes up approximately 25% (since 1975) of total spending on health care within Canada.

rates and life expectancy rates. This paper will use a generalized least squares model framework (correcting for both cross-section heteroskedasticity and contemporaneous correlation) for the empirical analysis.

Further, more than limiting the discussion to only measures of aggregated health care spending, the empirical work and analysis will also consider separately the effect of private spending on the same set of health outcomes. Private spending as a share of total health expenditures across Canada has been increasing since the 1970s (please see Figure 2) and has been near 30% of total health-care expenditures since 1996 (Canadian Institute for Health Information, 2005)⁴. Some studies show that increases in private spending and or in the prevalence of private insurance for health care appear to lead to better health outcomes, compared to increases in total or public expenditures⁵. Therefore, I examine both the impact of total and private expenditures' effect on health outcomes.

The results from the analysis are that drug spending (for total funds and private funds only) is a significant determinant of life expectancies for both males and females at the 5% significance level. My estimates indicate that if there was a 20% increase in drug spending (in total funds) there would be an average increase in the male life expectancy of 1.3 months and a similar increase to private funds would increase the male life expectancy by 0.7 months. The same increase in drug spending from total funds would increase the female life expectancy by 1.5 months if from private funds, the female life expectancy would increase by 1.1 months.

⁴ Figure 2 plots the CPI adjusted trends for private health care spending in Canada, as well as provincial examples of New Brunswick and Alberta for the years 1975-2004. New Brunswick was chosen to represent a small province with a steady population, and Alberta represents a province experiencing large increases in the population. As shown in the figures, private expenditures for both have been constantly rising.

⁵ See for example Berger and Messer (2002) and references therein, which will also be described in detail below.

This is not the only health care expenditure variable that seems to affect life expectancies though. It is also determined that the physician expenditure variable is a significant determinant of life expectancies. A 20% increase (of total funds) in physician expenditure would cause an increase in male life expectancy of 2.2 months and 1.3 months in females⁶.

The results for infant mortality rates are not as conclusive. Male infant mortality rates are significantly affected by total expenditures on hospitals. My estimates indicate that a 20% increase in hospital expenditures would cause a decrease in the male infant mortality rate by a significant 1.2%. The female infant mortality rate models that are performed in this study do have statistically significant expenditure variables that influence this health measure. However, the expenditure variables do not cause economically significant effects on the mortality rate when increases in them occur in simulations. For example, increasing drug spending by 20% only decreases the female infant mortality rate by 0.17%. Therefore, more research or data may potentially be needed to see what is affecting the female infant mortality rate. More discussion of these results and their implications for Canadians will be described below.

The paper proceeds as follows. In the first section, I review the relevant literature, which is sub-divided into three sections. In section 2, I describe the research objectives, methodology, and data used. The third section provides the results and regressions obtained from the empirical model. The final section is devoted to a discussion of the significance of the results and their potential policy implications.

⁶ Total funds are the summation of public funds and private funds.

Section 1:

Literature Review

The literature review is divided into three sections. First, there is an examination of how or whether income levels affect health care expenditure levels. It is not sufficient to only include health expenditures as a regressor in a health outcomes regression, but that income should be controlled for as well when one examines the effects of health expenditures on health outcomes. Therefore, it is important to understand the relationship between per capita health expenditures and health outcomes for the analysis. The next section of the literature review describes the influence health care expenditures have on health care outcomes. Lastly, the literature review will briefly outline some of the debates that revolve around the efficiency of public spending versus private spending in the health care market.

1) GDP influence on expenditures levels: Is health care a necessity or a luxury good?

Several studies have examined the relationship between a country's GDP and its respective health care expenditures. One of the earliest works in this field is a study by Kleiman (1974). Using cross-sectional international data from developed countries, the author finds that GDP levels are significant indicators of health care expenditures in a country.

However, a more specialized paper on the subject was Newhouse (1977), in which per capita health care expenditures were regressed against per capita GDP for a sample of 13 developed countries, for varying years between 1968-1972. Newhouse's work on the topic established that income levels have a significant influence on the amount of money a country devotes to the health-care system. As described by Hiteris

and Posnett (1992), “over 90 percent of the variation between countries in per capita medical care expenditure in Newhouse’s work could be explained by variations in per capita GDP” (Hiteris and Posnett, 1992, p. 173). Newhouse concludes in this paper that health care is a luxury good finding an income elasticity ranging between 1.15-1.31⁷.

Leu (1986) performed a similar study to the Newhouse paper analyzing data from the 1977 OECD report. Leu uses all OECD countries to see what the main determinants are that influence the amount of health expenditures within a country⁸. He finds that “GDP per capita is highly significant...accounting for about 89% of the variance in medical care expenditures” (Leu, 1986, p.53). As well, much like in Newhouse (1977), Leu’s income elasticity for health care is at a range of 1.18-1.36.

Parkin et al. (1987) find that if one accepts that differences in GDP per capita account for most of the differences in countries’ health care expenditures, then this “means that other possible explanatory variables are of little importance” (Parkin et al 1987, p. 109). Most studies including the ones above are based on cross-country data and therefore need to adjust for fluctuations in exchange rates. For example, in the paper described above, Newhouse (1977) uses the market exchange rates prevailing at the time for his sample of 13 countries to get a data set with similar monetary amounts. As Parkin et al. (1987) explain there are numerous problems that exist when using this technique and suggest that the more appropriate adjustment is to use a Purchasing Power Parity (PPP)⁹. Parkin et al. use Purchasing Power Parity dollars (PPP\$) instead of using exchange rate conversions and show that health care is in fact a necessity rather than a

⁷ A luxury good is defined as a good whose expenditure share rises as income rises.

⁸ Leu uses all OECD countries except Luxembourg, Iceland, Japan, Portugal and Turkey.

⁹ See Parkin et al. (1987), p. 114 for more detail.

luxury good¹⁰. Parkin et al.'s primary goal was to show that cross-country comparisons for such a topic can be problematic. The results derived from Newhouse (1977) had been readily accepted, but Parkin et al. suggest that the issue of health care, because it is unique, needs more analysis before studies can be so widely acknowledged¹¹.

However, other studies including Hiteris and Posnett (1992) (having 560 pooled time-series and cross-sectional observations across OECD countries) find similar results to Newhouse (1977) and Leu (1986) with much broader and more recent samples. Hiteris and Posnett's main conclusion is essentially the same as that of Newhouse (1977), which is that a strong positive relationship exists between per capita health spending and GDP.

One study that examines this question in the Canadian context is Di Matteo and Di Matteo (1998). Using data for the ten Canadian provinces from 1965-1991, the authors establish that "the key determinants of real per capita provincial government expenditures on health care over the period 1965-1991 are real per capita provincial income, the proportion of the provincial population over age 65, and real provincial per capita federal transfer revenues" (DiMatteo and Di Matteo, 1998, p.212). Per capita income influences the amount of money spent on health care, a result that has been widely established elsewhere in the literature. The third key determinant in their study (federal transfer revenues) makes sense from a theoretical standpoint, since more transfers entail more potential spending on health care. The proportion of the provincial

¹⁰ They find an elasticity of 0.90 when PPP\$ are used versus an elasticity of 1.12 when exchange rates are used. See Parkin et al. (1987), p. 118.

¹¹ As was the case in all of these international studies and discussed at great length in Parkin et al.'s (1987) paper, there are significant problems because of varying definitions of results, expenditures and the issue dealing with exchange rates from one country to another.

population aged 65 and over as a determinant is likely of the highest concern for policy makers given the expected increase in elderly persons going forward in Canada.

Di Matteo and Di Matteo find that the income elasticity for health care is estimated at 0.77, which implies that health care is in fact a necessity contrary to the findings of Newhouse (1977) and Leu (1986). Recall that Newhouse's and Leu's ranges are between 1.15-1.31 and 1.18-1.36, respectively.

The literature has established that a region's GDP (or income level) largely determines the amount of health care expenditures within that region. Health care has been shown to be either a luxury good or a necessary good depending on the study and data set. Different authors have summarized these results, but the point to be made is that income levels influence the amount devoted to health care. The question to be addressed in the following section of the literature review is: 'Do increases in spending on health care result in better health outcomes?'

2) Health Care Expenditure Influences on Health Outcomes

There are studies, including Newhouse and Friedlander (1980), which show that additional resources to the health care sector may not be associated with positive health outcomes. The authors "regress physiological indices on measures of the quantity of medical resources in a given area", (Newhouse and Friedlander, 1980, p.202) and control for the usual demographic and socio-economic characteristics for the data set of 1960. They choose not to use measures of mortality and morbidity as health outcome measures, but rather physiological measures including: diastolic blood pressure, serum cholesterol concentration, electrocardiogram, chest X-rays, varicose veins, and periodontal disease¹².

¹² To see why Newhouse and Friedlander (1980) chose these six measures for health status please see a complete description of these variables p. 204.

The authors elaborate, “the first three of the measures are associated with cardiovascular disease, which was responsible for 55% of the mortality in 1960 (in the U.S.)” (Newhouse and Friedlander, 1980, p. 204). Note that Newhouse and Friedlander do acknowledge that at least some measures contained in their indices are known to be predictive of mortality.

The study essentially shows that their health measures were not significantly influenced by additional resources. Newhouse and Friedlander draw the conclusion that “the results are consistent with the view that what an individual does for himself is probably more important to his health than the quantity of medical resources in his area” (Newhouse and Friedlander, 1980, p.214). It must be mentioned that the two authors of the paper are reluctant to make policy prescriptions based on their work in this paper due to the fact that the study was based on data from one year only (1960). The sample size is small, and there have been medical advances since the 1960s which would influence the measures they chose. However, the point that must be taken from this paper is that additional resources may not always be a way of attaining positive results in the health care sector.

A similar study was undertaken on the international level, by Leu (1986), which is described in the above section as well. Leu regresses health measures (age- and sex-specific mortality rates of adults and infant mortality rates) against GDP levels across 19 developed OECD countries, with data from a 1977 OECD report. Leu’s results from the paper show that there is “little relationship between medical care expenditures and mortality rates” (Leu, 1986, p.58). As mentioned above, one of the difficulties that is always present when comparing international data, which may be present in Leu’s study,

is that there are differences in currency exchanges, but also differences in definitions for health indicators including, for example, infant mortality rates.

As briefly described in the introduction, Cremieux, Ouellette and Pilon (1999) show that more resources may in fact lead to better health outcomes when the health measures are mortality and morbidity. These authors examine this relationship among the 10 Canadian provinces' per capita health care expenditures and the subsequent health outcomes. Specifically, they choose the widely employed gender-specific life expectancy rates and gender-specific infant mortality rates as their health status measures. Cremieux et al. (1999) employ a regression covering the 1978-1992 period. The authors control for the usual supplementary variables including economic, socio-demographic, lifestyle, nutritional, and geographical differences that would be present among the Canadian provinces. The study shows that within Canada, even small increases in health care expenditures result in statistically significant increases in health care outcomes. Their findings show that a 10% reduction in health care spending is associated "with infant mortality rates higher by 0.5% among males and 0.4% among females and life expectancies lower by 6 months for men and 3 months for women" (Cremieux et al. 1999, p.638).

Increased spending leading to better health results may be confirmed by studies like Cremieux et al. (1999), but as described in studies like Newhouse and Friedlander (1980) or Leu (1986), there are examples which challenge this idea. The results of various papers done on this topic seem to depend on which measure of health outcomes one chooses. There are obviously numerous ways in which one can assess a region's or a person's health status, which brings in a level of subjectivity. Health measures could

include the number of sick days taken by workers, the number of visits to a doctor, life expectancy, mental health, infant mortality, quality of life, disability adjusted life expectancy, etc. Results could potentially differ depending on which health outcome measure one chooses. As described above, the literature shows differing results for the influence health care expenditures has on health outcomes.

3) Public / Private Health Expenditures and Their Influence on Health Outcomes

Over years and decades, in countries like Canada, there are constantly new reforms that take place either intended to curb spending on health care (with cutbacks) or there are initiatives aimed at spending more money on health. There are different ways in which a region, country or province can increase (decrease) the amount of its health care spending. Within Canada, recently there has been a considerable increase in total health care spending and this may be in part due to an increase in private spending¹³. We will now turn to the literature that looks at the effect private spending has on health outcomes versus public spending results.

Berger and Messer (2002) assess the effectiveness of private spending versus public spending on the health-care sector with data from a sample of 20 OECD countries between the years of 1960-1992. When countries do plan initiatives to change spending on health care, the governments want to know the effects of potential changes. This is ultimately the question that governments have to balance when devoting money to the health care system. Through the analysis of their data, Berger and Messer (2002) find results showing that “increases in the share of health expenditures that are publicly financed are significantly associated with higher mortality rates.” (Berger and Messer,

¹³ See Figure 1 for trends in Canadian total health care spending and Figure 2 for trends in Canadian private health care spending.

2002, p. 2111) Concluding with some policy options, the authors explain that governments “may want to avoid increasing the proportion of their expenditures that are publicly financed” (Berger et al., 2002, p. 2112). Their study makes it apparent that there can be large variations in health results depending on whether it is private spending or public spending that change over time.

There may be some who feel that increases in health care spending, whether it comes from public or private, should result in the same outcomes. Self and Grabowski (2003) address this issue in their study and examine the effectiveness of public health-related spending in improving overall health. The health outcome measure they use is the World Health Organization’s disability adjusted life expectancy (DALE) measure¹⁴. The authors wanted to see the effectiveness of public versus private spending and insurance for high-, medium- and less-developed countries using data from the World Health Report in 2000. Discussing that private markets for health care exist even with the role of governments, the authors explain, “In spite of the growing importance of the role of government, the private sector continues to exist and compete in health care markets and this raises questions relating to governments’ attainment of efficiency and society’s equity objectives through its intervention in health care markets.” (Self and Grabowski, 2003, p. 836)

Within Canada, as mentioned, the existence of private markets in the health care system is apparent because since 1996, the percentage of total health care spending from private funds has been near 30% (Canadian Institute for Health Information, 2005), despite the national public health care system that exists across Canada. Therefore, Self

¹⁴ DALE, as is explained in the paper, “combines morbidity and mortality aspects of health while accounting for other health-related and non-health-related factors which affect health.” (Self and Grabowski., 2003, p. 836)

and Grabowski (2003) want to ascertain whether increases in public health spending have been improving the health of people or if private spending is actually more efficient. The results obtained from the paper “show that the contribution of the public sector with respect to improving healthy life expectancy is insignificant for the developed countries where it accounts for the largest share of total health expenditures” (Self and Grabowski, 2003, p. 840). However, when there are increases in public involvement in less- and middle- developed countries, there can be significant improvements to health outcomes (as measured by DALE)¹⁵.

Essentially, the implications for policy-makers using this study as a guideline for a developed country like Canada are that putting a lot of resources into public provision of health care may be an inefficient way to increase the health of the public. This may not be the case for all studies, but with the data set these authors use, and more importantly with the health measure they use, these are the results that drive these policy implications.

One of the largest increases in private spending within Canada is due to increases in drug spending¹⁶. Seeing drug expenditures rising over the past few decades leads to the question of whether or not there were increases in health outcomes. Cremieux et al. (2005) observe the relationship between drug spending and health outcomes in Canada from data between the years 1981-1999. The authors of the paper do find there to be a strong relationship between drug spending and health outcomes, namely infant mortality and life expectancies. Once the results of my paper are presented below, the Cremieux et al. (2005) paper will again be mentioned in the discussion section.

¹⁵ Please see Self and Grabowski (2003), p. 837 for more details on this topic.

¹⁶ Drug spending has increased from 8% of total health care expenditures in 1975 to 17% in 2004. As well, 62% of total drug spending is from private funds. Source: CIHI, 2005.

As the literature described above indicates, this topic needs more examination because private spending remains a large percentage of total health care expenditures. My paper aims to add to this expanding literature.

Section 2:

Description of Methodology and Data to be used:

The model underlying the estimating equation used for my paper can be thought of as having health outcomes (H) as a function of per capita health-care expenditures (HX) within a province and other province-specific factors (X). That is, $H_{i,t} = f(HX_{i,t}, X_{i,t})$, where the health-care expenditures are separated into five different categories. The province-specific factors are the other variables that may affect a province's health outcomes due to health behaviors, socio-economic differences, educational attainment, etc. If these other variables are omitted from the analysis, there may be a biased estimate of the effect that health expenditures in specific areas have on the health outcomes in a given province. For example, having a higher income in a region may provide people with more health care resources or services. Therefore, if the GDP per capita within provinces is not controlled for, one would see 'wealthier' provinces being 'healthier' for no apparent reason because this factor was not controlled for. Although many of the provinces are similar in nature, by including these variables, it serves to correct for any potential differences that exist among the provinces.

The model for my study is estimated using a Generalized Least Squares (GLS) methodology which corrects for both cross-section heteroskedasticity and any contemporaneous correlation. This modeling technique will aid in exploring the relationship between health outcomes and per capita health spending for the ten provinces

over time. There are also provincial fixed effects and year effects in the models¹⁷. The estimating equation used in the analysis is a linear regression (estimated separately for men and women) of the form:

$$H_{i,t} = \beta_1 \text{Hospitals}_{i,t} + \beta_2 \text{Physicians}_{i,t} + \beta_3 \text{Drugs}_{i,t} + \beta_4 \text{OtherProfessionals}_{i,t} + \beta_5 \text{OtherExpenditures}_{i,t} + \beta_6 X_{i,t} + \delta Z_i + \gamma t + \varepsilon_{i,t}. \quad (1)$$

where H is the health outcome measure, X is a vector which includes all of the supplementary variables, Z is a provincial fixed effect dummy for each province, t is the time trend variable, i is the given province and t is time.

Outcomes for men and women have been separated for the regression analysis due to the fact that there are inherent health differences between the sexes. For example, it is typical for women to live longer than men and for this reason alone, the regressions must be performed separately in order to control for these health variations between the genders. It must also be mentioned that women and men use different amounts of health care services during their life which can also affect outcomes. To observe some of the differences in the infant mortality rates and life expectancies between males and females, please see Table 2.

Regressions will also be done using both total health expenditures and private spending only to see which variables affect the gender-specific health outcome measures. Data for the five health-specific expenditure categories between the years 1981-1998 are used for the study, which is available from the Canadian Institute for Health Information (CIHI). Therefore, regressions for the CIHI classifications of spending will be examined to see which variables significantly influence health outcomes. A sample regression

¹⁷ The year effects are taken into account in the regressions by adding a time trend variable.

equation is provided below using private funds and male life expectancy as the outcome measure, but the other regressions will be of the same form as this example:

$$H_{i,t}(\text{MaleLE}) = \beta_1 \text{Hospitals(Private)}_{i,t} + \beta_2 \text{Physicians(Private)}_{i,t} + \beta_3 \text{Drugs(Private)}_{i,t} + \beta_4 \text{OtherProfessionals(Private)}_{i,t} + \beta_5 \text{OtherExpenditures(Private)}_{i,t} + \beta_6 X_{i,t} + \delta Z + \gamma t + \varepsilon_{i,t}. \quad (2)$$

The problems that can exist in these types of studies revolving around currency exchange rates (as explained in Parkin et al. (1987)) will not be an issue for my study. Such problems, which currently exist in the literature, can be ignored in this study since all data come from provinces within Canada, all of which use the same currency.

The key coefficients of interest for the study are the β_1 to β_5 values in each of the regressions. A significant coefficient for any of the health expenditure variables would indicate that they are associated with the health outcome measure, either life expectancy or infant mortality, and would imply that the health outcomes may benefit from having more funds devoted to them¹⁸. More discussion of this will come in a later section once the results are presented.

Description of Variables

To understand why the variables have been chosen for the regressions, this section of the paper is devoted to defining all of the variables and their importance or potential influence on health outcomes. A good starting point for the descriptions of the variables is the health indicators (dependent variables). Throughout all of the analyzed studies, a common feature is that the authors need and use a measure of health status. There are obviously numerous ways in which someone can establish whether a country or region is healthy or not. These include life expectancies, psychological and mental health

¹⁸ The significance level used for the study is at the 5% level.

status, infant mortality rates, DALE, etc. As mentioned above, the health indicators used as outcome variables for my study are gender-specific life expectancy and infant mortality rates by province and year. One limitation to using these measures as outcome variables is that they do not include morbidity or quality of life factors in their calculation. They are, however, used frequently as health measures in these types of studies and the data are easily accessible, and they are not subjective.

The per capita health expenditure variables are straightforward. They are simply the health expenditure amounts each province spends on the given type of health care provision, i.e. hospitals, physicians, drugs, other health care professionals, and all other health care expenditures¹⁹. These variables are reported in millions of current dollars from the CIHI. Therefore, I have adjusted the nominal values by converting them into real dollar amounts using the annual all-items CPI values for each province from Statistics Canada.

As described in the literature, higher per capita health care expenditures can lead to better health-care outcomes, but there are also many other factors that can influence health outcomes. These other factors are described in the methodology section above as supplementary regressors. By controlling for province-specific effects including economic and socio-demographic variables, my study intends to show which types of health care spending significantly affect health outcome indicators.

The supplementary regressors included in the regressions above should be explained in detail in order to describe how or why they are controlled for in the study.

The economic regressors are the number of physicians per 100,000 population and

¹⁹ Recall that all other health care expenditures is the sum of the remaining expenditures present in the Canadian health care system including: other health institutions, capital, public health and administration, and other health spending; Source: CIHI, 2005.

provincial GDP per capita income. These two variables are included because “greater resources will improve the fulfillment of fundamental needs associated with better health” (Cremieux et al. 1999, p.631). A complication in estimating a health outcomes model with both income and health expenditures is that one would expect these two explanatory variables to be highly correlated (Di Matteo and Di Matteo, 1998). It is established in some of the described literature above that income does have a strong effect on health expenditure levels, but there are other effects income may have on health. For example, income may influence people’s stress levels, ability to provide health prolonging activities (with gym memberships), proper nourishment, and socio-economic status²⁰. Therefore, the inclusion of income in addition to health expenditures should capture these additional effects if they are significant.

Some may also believe that number of physicians per 100,000 population variable would be highly correlated with physician spending per capita and by having the two in the same equation may be counting the effect of physicians within a province twice. Therefore, I test for correlation between the number of physicians per 100,000 and per capita physician spending. Some of the correlations of these variables within the provinces are elevated past 0.80, but any potential collinearity between these two variables does not appear to affect the standard errors. Including physicians per 100,000 population does not appear to adversely affect the results and this may be due to the fact that this variable is capturing other effects. For example, number of physicians per 100,000 population should be accounted for because “an insufficient number of

²⁰ Wilkinson (1996) and Evans et al. (1994) among others, find that socio-economic status as measured by an individuals’ income level is positively correlated with health even when controlling for health expenditures.

physicians will lead to queuing, which will reduce quality and therefore the effectiveness of health care” (Cremieux et al. 1999, p.631).

The first socio-demographic effect controlled for is the percentage of the population in the province aged 65 years or more. This is included among the supplementary regressors because of the relationship between advanced age and increased health care needs and spending. Another socio-demographic variable controlled for is population density. Higher population density within a province would lead to a lowering of the average price of some health care services, therefore, it also must be entered into the different regressions as a supplementary variable.

Another important socio-demographic effect to be controlled for is the province’s overall education level. The effect education has on health is detailed in Grossman (1972) and Lleras-Muney (2002)²¹. The measure to capture this effect is the proportion of each province’s population with a bachelor’s degree or higher. The basic theory behind the relationship education has on people’s health is that more educated people are healthier or have a better understanding of health-prolonging activities. It has also been shown in work done by Fuchs (2000) that the relationship between these two variables may be due to a third unobservable factor. He finds that the people who invest in education are the same type of people who will invest in health-prolonging activities. No matter what the exact nature of the relationship, the literature shows that there is a correlation between education and health status, which will therefore be controlled for in this study. As well, the prevalence of poverty within the province should be controlled for due to the strong relationship between income level and health outcomes (Ettner, 1996). Poverty “restricts

²¹ Grossman (1972) shows that better education can lead to better health status, with his model. As well, Lleras-Muney (2002), using compulsory education as an instrumental variable, establishes a strong positive relationship between education and health.

an individual from acquiring the proper nourishment, housing, exercise and care which directly affect a person's overall health status" (Cremieux et al., 1999, p.632).

Lifestyle variables have a significant effect on people's health and need to be addressed as well. Some examples of these variables include alcohol and tobacco consumption. There are significant variations in smoking rates and alcohol consumption among the provinces. Smoking has a significant impact on both cancer rates and cardiovascular disease and alcohol consumption has been shown to negatively influence health (Makomaski and Kaiserman, 1991; Blackwelder et al., 1981). With smoking and drinking having negative effect on a person's health status, then it becomes obvious that one should control for these effects by adding them as supplementary variables. It must be mentioned that smoking and drinking typically affects people's health in the long run, and not in the short run. Therefore, current consumption levels of these goods may not capture the total long run affects on health, but it will capture some of the negative health outcomes for the regressions. Also, the issue of tobacco smuggling in Canada should be addressed. In the early 1990s, there was a problem among the Canadian provinces with a large influx of smuggled cigarettes, before the Canadian government enacted new tax measures to discourage smuggling²². The variable for cigarette consumption for this study is provincial per capita tobacco sales. This may not be the most effective proxy for tobacco use, because of these smuggling issues, but this data is readily available and has been used in many other studies²³.

²² Please see Figure 3, which shows the trend in Canadian tobacco consumption.

²³ The main results presented in the tables below, from the regressions, do not change when this potentially flawed variable (tobacco sales per capita) is omitted from the regressions.

Data

The previous section described the importance of the different variables for the regressions in the study. This section outlines details about the data itself. The data on the specific per capita health care spending and most of the control variables are available from Statistics Canada and the Canadian Institute for Health Information (CIHI) for the years 1975-2004. Cremieux and Ouellette, from the Cremieux et al. (1999) study, have provided some data for my study as well, including the variables I use for poverty, tobacco use, and population aged 65 years and over.

As mentioned above, this study is an extension of the work done by Cremieux et al. (1999), in which they use total per capita health spending over the period of 1979-1994. The period for my study is 1981-1999²⁴. With this longer data set, I have the benefit of a slightly larger sample size and more recent data as well. The data are collected nationally and provincially (which is the unit of observation for my study, as described above). Through the CIHI, the data for health care expenditures is not only divided by area of expenditure, but it can also be divided by source of funds (public or private)²⁵. For a complete listing of all of the data, variable definitions, and their sources please refer to Table 1.

Table 2 shows some of the variations that exist among the provinces for both the gender-specific infant mortality rates and the life expectancies over time. The data presented in Table 2 show that there are different rates of decreases in the infant mortality rates (for males and females) over time between the provinces. For example, the

²⁴ Despite having health care expenditures from 1975-2004 from CIHI, there are some control variables and health outcome measures that are not available for all of these years. This is why the time frame for my study is from 1981-1999.

²⁵ It must also be mentioned that the data for the variables are in levels and not logs.

Saskatchewan male infant mortality rate was at 12.6 in 1980 and decreased to 8.6 in 2000, compared to New Brunswick, where the rate dropped from 11.7 in 1980 to 4.0 in 2000. Equivalently, there are different rates of increases in the life expectancies among the ten provinces as well, but all of the Canadian provinces have increasing life expectancies over time. Also provided, in Table 3, are the descriptive statistics and means for all of the variables used in this study. The data from the means table will be used in simulations (described below) to see what affect increases to certain health care expenditures would have on infant mortality rates and life expectancies.

Section 3:

Regression Results

1) Total Expenditures (One expenditure variable) Table 4

To begin, I attempt to replicate the results of Cremieux et al. (1999) in order to establish that per capita health care expenditures does affect health outcomes among the provinces, as they show in their work. As described above in their study, health spending is a significant determinant for infant mortality rates (IMR) and life expectancies (LE) for both males and females. For this study, the same type of regression is attempted in order to confirm their results. The proposed regression is of the form:

$$H_{i,t} = \beta_1 AllHealthExpenditures_{i,t} + \beta_2 X_{i,t} + \delta Z_i + \gamma t + \varepsilon_{i,t}. \quad (3)$$

From the results presented in Table 4, one can see that the results of my analysis confirm the work done by Cremieux et al. (1999)²⁶. The results show that all of the β_1 coefficients for the different regressions are statistically significant at the 5% significance

²⁶ The province fixed effects are estimated in this model (and the models to follow), but are not reported in the result tables.

level and have the theoretically expected sign. That is, the coefficients in the infant mortality rate equations are negative, implying that higher spending will reduce the infant mortality rate while the coefficients in the life expectancy equations are positive, implying that health spending positively affects life expectancies. The sample size is larger than that of Cremieux et al. (1999), and some of my control variables have somewhat different definitions from their study. For example, their definition for tobacco use was the percentage of smokers in the province while for my study per capita expenditure on tobacco products was used as the measure for tobacco use. Regardless, their results are confirmed in my paper, which implies that the results from Cremieux et al. (1999) are quite robust²⁷.

2) Total expenditures (Five expenditure variables) Table 5

Since it is established that total per capita health care expenditures positively affect health outcome measures (shown above), it will now be established which specific health spending types are more efficient at reaching positive health outcomes. This is the main topic of the study, and the main research objective for the empirical work. The results for equation (1) are presented in Table 5. I have also tested to see if the coefficients of the different health spending categories are identical. That is, to test if $\beta = \beta_1, \beta = \beta_2, \beta = \beta_3, \beta = \beta_4, \beta = \beta_5$, where β is the coefficient for the aggregated level of spending. It is established that the coefficients for the different categories of spending are

²⁷ Cremieux et al. (1999), which performed their study in levels as well, find coefficients of -0.003 for male IMR model and -0.002 for female IMR model, which is quite similar to the -0.001 and -0.001 results presented in Table 4 below. Also, Cremieux et al. find coefficients of 0.003 and 0.001 for the male and female LE models respectively and Table 4 shows coefficients of 0.00065 for the male LE model and 0.00059 for the female LE model.

different than the coefficient for the aggregated level of spending and therefore need to be looked at independently, which is what Table 5 shows²⁸.

For the life expectancy models, of both males and females, drug spending and physician spending are the only health expenditure variables with significant coefficients. That is, the β_2 and β_3 coefficients in the above regression are both statistically significant and have the expected sign associated with them when life expectancy is the health outcome measure. It is established from the results in Table 5 that male life expectancy would increase by 2.2 months for physician expenditures increasing by 20% and would also increase by 1.3 months if drug expenditures increased by 20%. The results also show that a similar 20% increase in physician and drug spending would increase the female life expectancy by approximately 1.5 months for both as well²⁹.

There are no other health expenditure coefficients that are significant determinants for these health outcome measures. But, as expected, I find some of the control variable coefficients for the regression models of life expectancy (male and female) to be significant, including the per capita number of physicians.

As described, the results for the life expectancy model were quite straightforward, with drug spending and physician spending being the major determinants. However, for the infant mortality rate model, the results varied greatly between males and females. With regards to the infant mortality rate model for males, the significant health spending variable coefficients are hospital expenses, physician spending, and other health professionals spending. The hospital and physician spending variables had the expected

²⁸ This test is performed by calculating 5 separate tests of the form: $[\beta - \beta_i] / [\text{standard error of } \beta] = X$, with X following a t-distribution (and where i is the 5 separate coefficients).

²⁹ These results and the simulations to follow in the paper are calculated by multiplying the coefficients by the sample means (reported in Table 3). I have then multiplied this value by the 20% and, for the case of life expectancies, converting to months imply that one multiply by 12.

negative sign associated with them, but the sign for the other health professionals coefficient has a positive sign. Analyzing the results from Table 5 show that a 20% increase in hospital spending would decrease the infant mortality rate for males by 1.2% and similarly a 20% increase in physician expenditures would decrease the male infant mortality rate by 0.35%. These two variables greatly affect the infant mortality rate for males, but the other variable that was shown to be statistically significant for this model (other health professionals) does not appear to have a strong effect on the outcome measure. As shown in the results, the coefficient of this expenditure variable does not have the expected sign, which may indicate a case where funds are being inefficiently allocated to the detriment of health measures. However, the results indicate that an increase of funds in this sector (other health professionals) by 20% would only lead to an increase in the male infant mortality rate of 0.06%, which is not a powerful effect.

For the female infant mortality rate model, the significant health spending coefficients are physician spending and drug spending. Simulations of these results show that if there was an increase of 20% in drug spending, the female infant mortality rate would decrease by 0.17%. Similarly, if there was a 20% increase in the physician spending variable, that would lead to an increase in the female infant mortality rate of 0.2%, contrary to what to this change would do to the male infant mortality rate.

Despite the results for the male and female infant mortality rate models being quite different, there are some commonalities shown with the control variables. For example tobacco, alcohol, and poverty measures were all shown to be significant determinants of both male and female infant mortality rates. Each of these, when increased within a province, would lead to increases in the male and female infant

mortality rate. The fact that the results vary for infant mortality rates between males and females is rather puzzling as it would suggest either an inherent biological difference exists or that there is a gender-specific factor that I have omitted from my set of control variables.

3) Private spending (One expenditure variable) Table 6

Up to now, in this results section, the focus has been on total expenditures (public and private funds combined). The analysis will now shift to private sector spending only, which has been the subject of more recent literature and papers. As outlined by Berger and Messer (2002) and Self and Grabowski (2003) in the literature review above, because of the potential benefits private spending has for health outcomes, as opposed to public spending, this topic must be examined in this study as well. With such a large percentage of total health-care expenditures coming from private spending in Canada³⁰, it must be determined which increases in private spending, in specific areas, have led to improved health outcomes across provinces.

This regression is similar to the analysis shown in Table 4 only now performed with private funds replacing total funds. Table 6 summarizes the results of a regression for total private health care expenditures (as a single variable), which is of the form:

$$H_{i,t} = \alpha + \beta_1 AllHealthExpenditures(Private)_{i,t} + \beta_2 X_{i,t} + \delta Z_i + \gamma t + \varepsilon_{i,t}. \quad (4)$$

The results presented in Table 6 show that per capita private health expenditures (as a whole) are a significant determinant of both male and female life expectancies and of the male infant mortality rate. The coefficient for private per capita health expenditures are, however, not significant for the female infant mortality model.

³⁰ Recall, the share of private spending in total health care expenditures in Canada has been near 30% since 1996, Source: CIHI.

For the male infant mortality model, private health expenditures coefficient is significant, but it has the wrong theoretical sign for the coefficient. As I will show in the next section, once private spending is divided into the five different categories of health care spending, certain types of expenditures do have the expected sign. For the female infant mortality rate regression model, all private health expenditures is not a statistically significant explanatory variable, but many of the control variable coefficients have the appropriate signs and are significant (at the 5% level) including poverty, tobacco use, and alcohol use.

As shown in these results, private funds can be a significant influence on some health outcome measures. As discussed in the literature review, Berger and Messer (2002) find that the mix of public-private spending has a significant impact on different health outcome indicators. They show that “not only does the level of health care expenditures matter in determining mortality rates, but so does the mix of expenditures, as represented by the type of financing” (Berger and Messer, 2002, p. 2112). But which types of private spending are most beneficial to the public’s health? I will now address this question in the following section.

4) Private spending (Five expenditure variables) Table 7

The analysis now turns to a highly pertinent topic for private expenditures - namely the results that occur when private health care expenditures are divided into five categories. The regression to be analyzed is equation (2) and the results are presented in Table 7.

As was the case with the total health care spending model (Table 5), one of the significant health care expenditure variable coefficients for life expectancies (both male

and female) is drug spending. With the drug spending coefficient being statistically significant for both total and private health care expenditure models, it becomes apparent that this is a strong determinant of the health of Canadians, no matter which source it comes from. The estimates suggest that a 20% increase in private funds to drug spending would lead to an increase in male life expectancy by 0.7 months and an increase in female life expectancy by 1.1 months³¹. The other significant health care expenditure coefficient, which is significant in both life expectancy models for males and females, is the other health care professionals variable coefficient (β_4).

For the male infant mortality rate model, the significant expenditure variable coefficients are: hospital spending, other health professionals, and all other health expenditures. For the female infant mortality rate model, drug spending, physician spending and all other health expenditures are significant expenditure determinants³². The coefficients that had the expected signs were hospital spending for males, and drug and physician spending for females. The percentage private funds makes up of total funds devoted to hospitals and physician salaries is a small amount in Canada, mostly due to the fact there is universal health care³³. This implies that increasing private funds to these types of health care expenditures would have a minimal affect on the health outcome measure (infant mortality rate). However, private funds constitute approximately 62% of total spending on drugs (CIHI, 2005). It is determined from the results that increasing

³¹ Drug spending from private funds is also statistically significant when the regression contains both private and public spending in the same model.

³² When both private and public funds are in the same model – the estimates of the effects of private other professionals and other expenditures is significant in the male infant mortality rate regression. For the female infant mortality rate, when public and private funds are in the same regression model, private drug spending and other expenditures are significant.

³³ Private funds to hospital expenditures makes up 7% of total funds and private funds devoted to physician salaries only makes up 1% of total funds. Source: CIHI, 2005.

private funds in drug spending by 20% would lead to a decrease in the female infant mortality rate of 0.16%. For the control variables, once again the results show that the coefficients for poverty, tobacco use and alcohol use all negatively affect both the male and female infant mortality rates.

All other health expenditures is the only health care expenditure coefficient (β_5) which is shown to be significant in both male and female models. All other health expenditures (which is the sum of expenditures on other institutions, capital, public health and administration, and other health spending) for males and females also has a positive sign, which suggests that increases in this area of expenditures are statistically associated with increases in infant mortality rates. This could, again, be a case of money being inefficiently allocated rather than having funds towards other, more productive areas. Private money may be more efficient if used in other areas of the health care sector, and not devoted to the components that make up this all other health expenditures variable. More discussion of these issues will be offered in the following section of the paper.

Section 4:

Discussion / Conclusions

This study may be of interest to Canadians and policymakers due to the fact the cost of health care is rising. Therefore health care spending may need to be curbed from one possible section to another in order to help the population's health. Both provincial and federal governments are interested in any information that can help to dictate the optimal allocation of health care dollars. Recently, governments and the general public are being asked to become more accountable for where dollars are spent and the results in terms of improved health outcomes. While higher health care spending does lead to better

health outcomes according to Cremieux et al. (1999), it is unclear to which sectors of the health care system society should devote the money or resources.

This study's results show that drug spending appears to be the one of the most significant determinants of both life expectancies and infant mortality rates (for total funds and private funds). In a recent paper, Cremieux et al. (2005) obtain similar findings to this paper. As described by the authors, "improved infant mortality rates and life expectancies for both genders have resulted from increased public and private drug spending" (Cremieux et al., 2005, p.115). It appears beneficial to put more money to aid in drug spending within the provinces or create drug reimbursement plans to help the public, rather than pouring money into some other health care areas.

However, it is apparent that there are other influences on the Canadian health outcome measures that should also be addressed. The results presented in my paper show the importance of the physician expenditure variable for the benefit of life expectancies. Therefore, the health care system should possibly devote more funds to this type of spending in order to help with the health of Canadians.

When using infant mortality rates as the health outcome measure, the results are slightly more complex than for the life expectancy models. That is, the male infant mortality rate seems to be greatly affected by hospital spending (for both total funds and private funds) and the female infant mortality rate is greatly affected by drug spending, as described in the previous section. From these results, there could be potential for the Canadian government to change the way resources are spent on health care in Canada, in order to receive health benefits for decades to come.

Despite the contributions of this study, there are some limitations or potential drawbacks that may be identified in this type of research. There are obviously various ways to measure and define "health." Life expectancy and infant mortality are used in this study as measures of health. It is acknowledged that these measures of mortality do not fully encompass the World Health Organization's definition of health, "the complete physical, mental and social well-being and not merely the absence of disease" (WHO, 2005). There is debate on which variables best describe health outcomes and which do not. Therefore, when describing provincial health outcomes, there is the general problem with the health indicators of life expectancy and infant mortality rate because these variables may not combine all aspects of one's health. These could be considered crude measurements of health outcomes in any country or province. However, this problem should not be large because the definition for these measures remains the same between the Canadian provinces, therefore one would get solid evidence of an increase or a decrease in a province's health because the definition remains the same across Canada. Despite any potential issues with these health outcome measures, these two measures are widely used, readily available, and reliable.

However, for future research or studies, it may be appropriate to add other health indicators to gain more perspective into the health of one region compared to another. A possibility for an extension of the health indicator variable would be to add another health indicator, like a quality of life variable. The potential to include a QALY (quality adjusted life year) indicator that represents the quality of life for each year, would add to the definition of overall health, as described above from WHO. There is also the potential for future research on this issue to be done on the assessment from the standpoint of the

individual instead of having the study on the provincial level. This study is done using provinces as the unit of observation, but it would be possible to run this analysis with individual data to see if the results change. The potential benefit of doing this study with individual data would be to see specific benefits to a person's health rather than having information for the whole province. Another extension for this work could always be using more data, on an extended time frame.

Despite any potential limitations, this paper does add to an expanding literature on these issues. The results described in the empirical work will aid policymakers and health economists decide what sectors of the health care should be targeted to help with growing concerns about the Canadian health care system.

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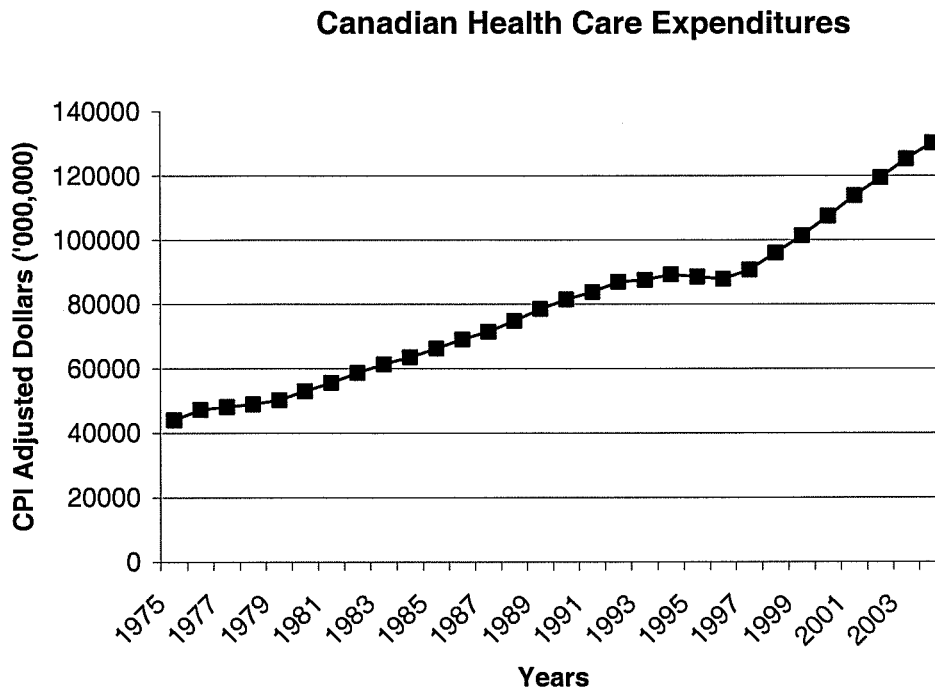
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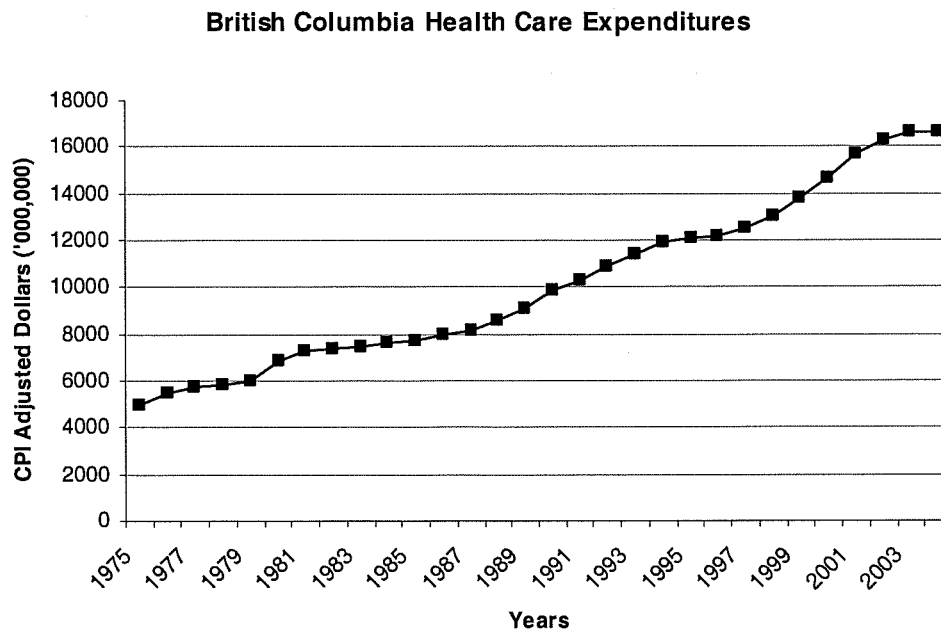
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Figure 1: General Trend of Increasing Health Care Spending (Example: Canada)

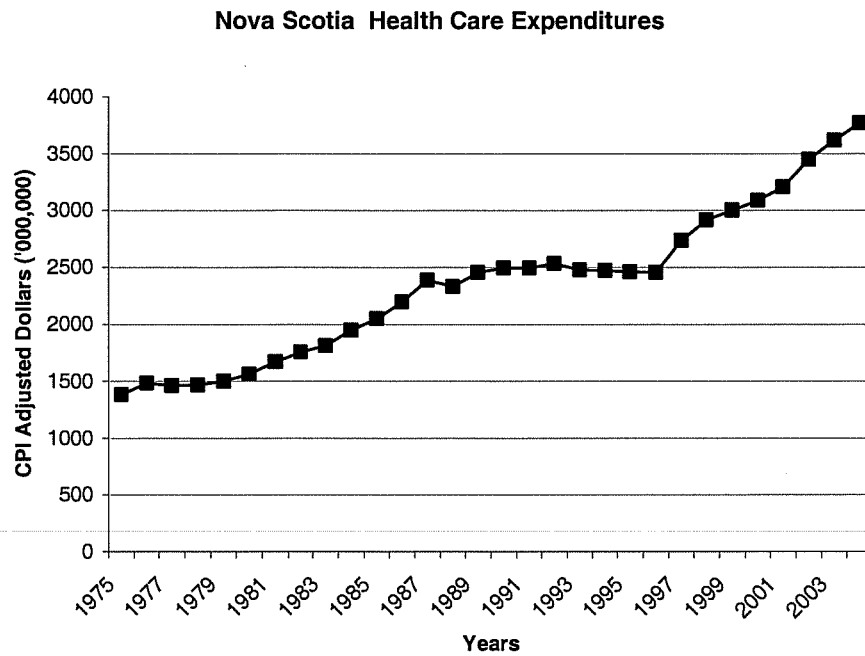


Source: Canadian Institute for Health Information, 2005.

General Trend of Increasing Health Care Spending (Example: BC)

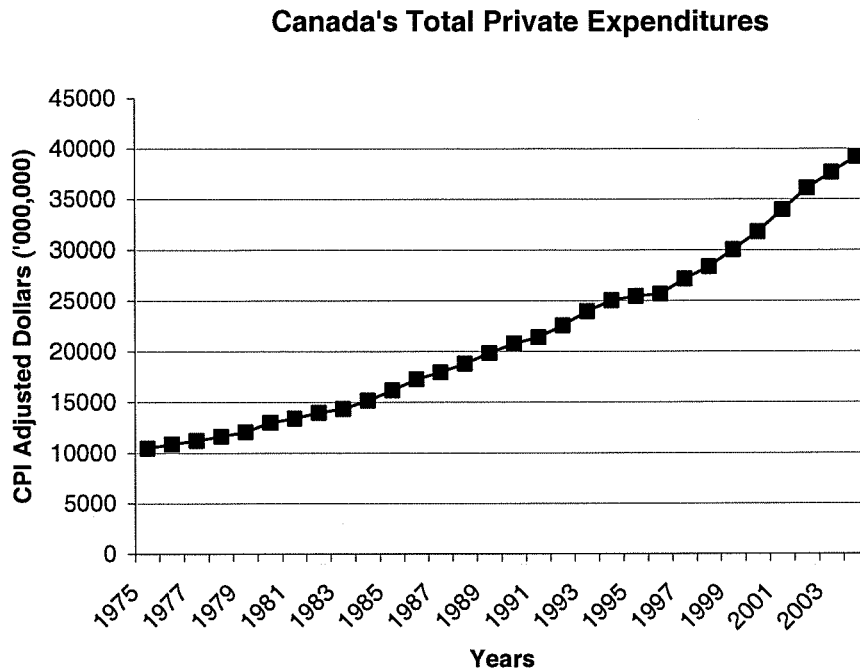


Source: Canadian Institute for Health Information, 2005.

Figure 1 continued:**General Trend of Increasing Health Care Spending (Example: NS)**

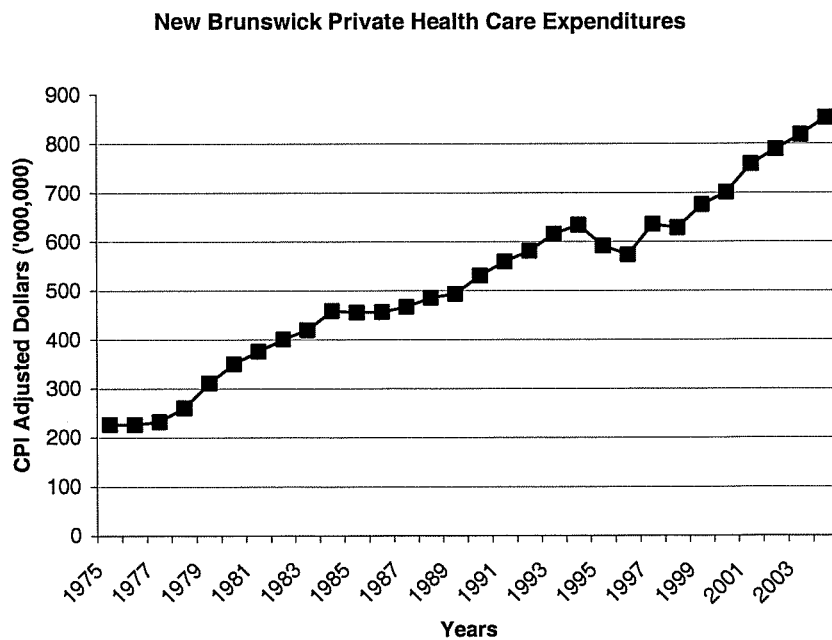
Source: Canadian Institute for Health Information, 2005.

Figure 2:
General Trend of Increases in Private Spending Over Time (Example: Canada)

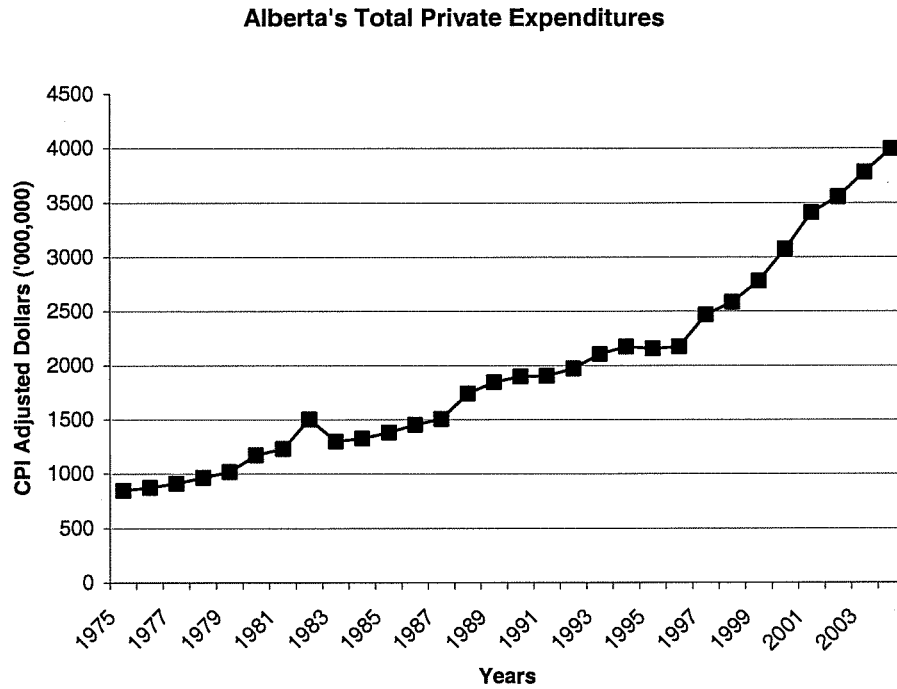


Source: Canadian Institute for Health Information, 2005.

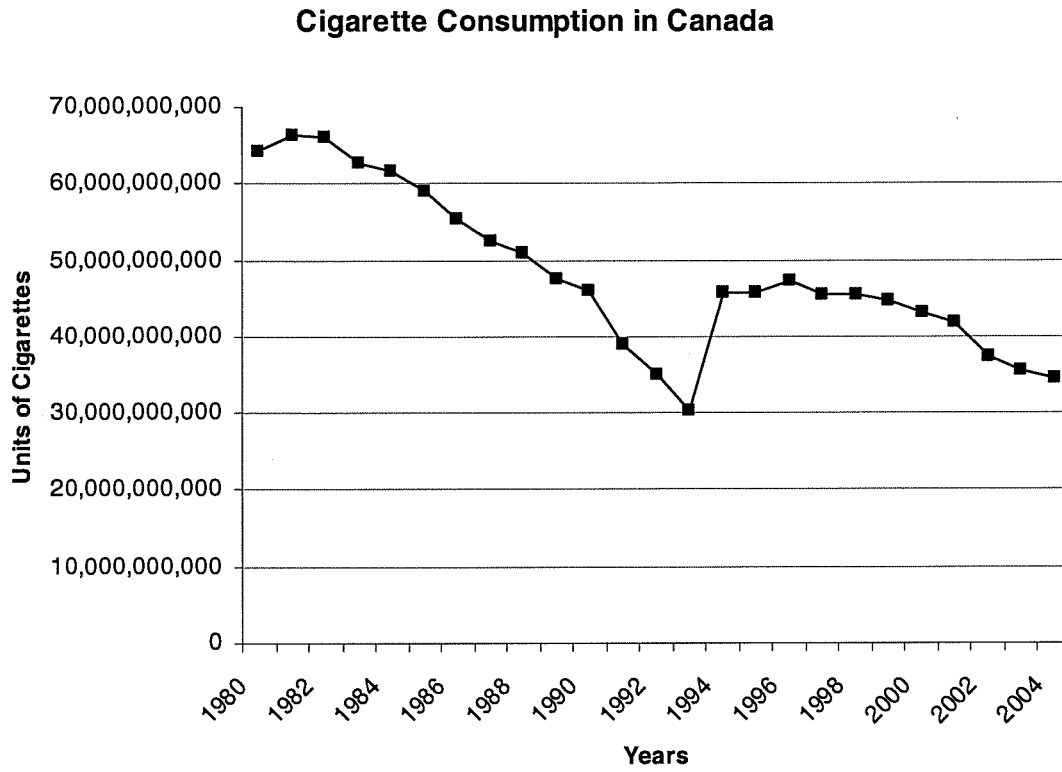
General Trend of Increases in Private Spending Over Time (Example: NB)



Source: Canadian Institute for Health Information, 2005.

Figure 2 continued:**General Trend of Increases in Private Spending Over Time (Example: AB)**

Source: Canadian Institute for Health Information, 2005.

Figure 3: Cigarette Consumption in Canada

Source: Health Canada, 2005.

Table 1:

Variables	Description	Source
Health Care Spending*	Division of spending into: Hospitals, Physicians, Drugs, Other professionals, Other Expenditures	CIHI, Available online at: www.cihi.ca
Life Expectancy at Birth	Life expectancy at birth	Statistics Canada, Cansim Table No.: 102-00251
Infant Mortality	Number of deaths in infants aged 0-1 per thousand live births	Statistics Canada, Cansim Table No.: 102-00301
Per capita number of physicians	Number of physicians per 100,000 population	CIHI, Southam Medical Database: Supply of Canadian Physicians
Per capita income	Gross Domestic Product per person; 1997 chained dollars	Statistics Canada, Cansim Table No.: 384-0013
Density	Provincial population divided by the geographical area	Statistics Canada, Cansim Table No.: 051-00011,2
Education Level	Education of at least a university degree or higher / population size	Statistics Canada, Cansim Table No.: 282-000418,19
Poverty	Percentage of households using more than 56.2% of their income on food, housing and clothing	Statistics Canada, Obtained from Cremieux et al. (1999)
Alcohol use*	Per capita sales of total alcoholic beverages	Statistics Canada, Cansim Table No.: 183-000642
Tobacco use*	Per capita spending on tobacco products	Statistics Canada, Obtained from Cremieux et al. (1999)
Population aged 65+	Population aged 65+ / provincial population	Statistics Canada, Obtained from Cremieux et al. (1999)

* Deflated by All-Items CPI.

Table 2 *Infant mortality rates in Canada and Provinces***Males**

	Can	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
1980	11.6	12.3	16.4	13	11.7	10.7	10.7	11.6	12.6	14	12.6
1985	8.7	12.7	1.9	8.6	9.4	7.6	8.1	12.3	11	9	9.2
1990	7.5	10	7	6.6	8	7	6.8	9	8.8	8.9	8.3
1995	6.7	8.4	3.3	5.2	5.2	6.2	6.4	8	10.9	7.7	6.4
2000	5.9	4.8	5.3	5.2	4	5.8	5.7	6.9	8.6	7.6	4.2

Females

	Can	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
1980	9.2	8.9	5.4	8.8	10.1	8.8	8.3	11.4	9.9	11	9.3
1985	7.1	8.8	6.3	7.1	9.8	6.9	6.4	7.5	11	7	6.9
1990	6.1	8.4	4.9	6	6.4	5.4	5.7	6.9	6.4	7.2	6.7
1995	5.5	7.3	5.8	4.5	4.3	4.7	5.5	7.2	7.3	6.3	5.5
2000	4.7	5.1	1.5	4.7	3	3.6	5.4	6.1	4.8	5.6	3.2

Life expectancy at birth in Canada and Provinces**Males**

	Can	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
1980	71.7	72	72.4	70.7	70.8	70.8	72	72.2	72.5	71.7	72.5
1985	73.1	72.4	72.7	72.1	72.8	72.1	73.5	72.9	73.6	73.5	74.1
1990	74.4	73.1	73.1	73.5	74	73.4	74.8	74.5	74.9	74.8	75.1
1995	75.1	74.2	73.8	74.7	74.1	74.3	75.6	74.7	74.9	75.6	76
1999	76.3	75.2	75.7	75.7	75.1	75.4	76.8	75.1	75.4	76.6	77.3

Females

	Can	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
1980	78.9	78.1	79.7	78.1	78.6	78.5	78.9	78.8	79.9	78.9	79.9
1985	79.9	79.1	80.6	78.9	80.1	79.6	79.8	80	80.2	80.1	80.5
1990	80.8	79.3	80.5	79.9	80.7	80.7	80.9	80.5	81.2	81.2	81.1
1995	81.1	80.5	81.2	80.7	81.4	80.9	81.1	80.4	81.5	81.4	81.8
1999	81.7	80.2	81.2	81.6	81.6	81.5	81.8	80.8	81.8	81.7	82.6

Source: Statistics Canada, Cansim Table No.: 102-00301 (Infant Mortality Rate)

Source: Statistics Canada Cansim Table No.: 102-00251 (Life Expectancy)

Table 3: Descriptive Statistics

	Obs.	Mean	Maximum	Minimum	Std. Dev.
Drug spending per cap (all funds)	180	334.68	583.72	146.32	92.30
Drug spending per cap (private funds)	180	241.01	546.55	67.85	83.34
Drug spending per cap (public funds)	180	93.67	167.35	22.22	32.13
Hospital spending per cap (all funds)	180	1051.8	1288.17	778.27	115.63
Hospital spending per cap (private funds)	180	80.76	157.89	27.13	35.56
Hospital spending per cap (public funds)	180	971.04	1168.26	751.14	104.22
Other health spending per cap (all funds)	180	707.15	1180.93	392.52	163.90
Other health spending per cap (private funds)	180	148.76	266.69	65.34	42.55
Other health spending per cap (public funds)	180	558.38	1009.08	291.90	143.88
Physician spending per cap (all funds)	180	352.66	582.98	189.54	86.67
Physician spending per cap (private funds)	180	3.69	15.70	0.00	2.69
Physician spending per cap (public funds)	180	348.96	578.23	188.44	85.46
Other professionals spending per cap (all funds)	180	265.53	495.71	118.51	78.58
Other professionals spending per cap (private funds)	180	223.68	434.44	88.33	68.91
Other professionals spending per cap (public funds)	180	41.845	95.42	7.49	18.47
Male Infant Mortality Rate	180	8.23	17.20	1.90	2.30
Female Infant Mortality Rate	180	6.62	14.40	0.00	1.70
Male Life Expectancy	180	73.93	77.00	70.90	1.27
Female Life Expectancy	180	80.47	82.60	78.30	0.81
Population Density	180	7.52	24.05	1.33	6.89
University degree or higher / pop.	180	0.08	0.13	0.04	0.02
Per capita sales of alcoholic beverages	180	159.52	292.14	94.38	48.23
Number of physicians per 100,000	180	163.33	211.00	105.80	25.22
Per capita spending on tobacco products	180	725.44	1695.81	329.55	324.04
GDP per capita	180	23729.11	38868.00	14322.00	5280.12
Pop. aged 65+ / Prov. Pop.	180	0.11	0.15	0.07	0.02
Percent of households in poverty	180	12.38	19.60	5.00	2.56

These descriptive statistics are calculated directly from Eviews 4.1.

Table 4: Total Expenditures (One Expenditure Variable) Model

<u>Variable</u>	<u>Male IMR</u>	<u>Female IMR</u>	<u>Male LE</u>	<u>Female LE</u>
	<i>Coefficient (t-stat)</i>	<i>Coefficient (t-stat)</i>	<i>Coefficient (t-stat)</i>	<i>Coefficient (t-stat)</i>
<u>Health Expenditure Variables</u>				
All Health Expenditures	-0.0012 (-3.15)	-0.001259 (-3.76)	0.00065 (5.103)	0.00059 (3.77)
<u>Supplementary Variables</u>				
Physicians per capita	0.0025 (0.26)	-0.014 (-1.89)	0.0127 (4.47)	0.006 (2.01)
GDP per capita	0.0002 (3.57)	-0.0000149 (-0.37)	-0.000046 (-3.88)	-0.000062 (-4.2)
% population aged 65+	157.8 (6.205)	-18.22 (-0.81)	31.02 (3.59)	51.15 (6.16)
Population density	1.67 (5.55)	0.624 (3.23)	-0.105 (-2.26)	-0.028 (-0.35)
Educational level	-39.7 (-3.76)	10.72 (1.52)	4.044 (1.601)	0.099 (0.031)
Poverty	0.206 (5.58)	0.042 (2.02)	0.035 (5.16)	0.021 (1.97)
Alcohol	0.034 (3.01)	0.041 (6.99)	-0.0045 (-2.07)	0.00095 (0.32)
Tobacco	0.0048 (6.69)	0.0026 (6.51)	0.00044 (2.068)	-0.00036 (-1.77)
Time Trend	-0.189 (-2.31)	0.1636 (2.77)	0.124 (6.34)	-0.017 (-0.78)

Notes: Table above is the regression results of the estimated equation:

$$H_{i,t} = \beta_1 AllHealthExpenditures_{i,t} + \beta_2 X_{i,t} + \delta Z_i + \gamma t + \varepsilon_{i,t}. \quad (3)$$

Where H are the health measure outcomes, **X** is a vector which includes all of the supplementary variables, **Z** is a provincial fixed effect dummy for each province, t is the time trend variable, i is the given province and t is time.

Table 5: Total Expenditures (Five Expenditure Variables) Model

<u>Variable</u>	<u>Male IMR</u>	<u>Female IMR</u>	<u>Male LE</u>	<u>Female LE</u>
	<i>Coefficient (t-stat)</i>	<i>Coefficient (t-stat)</i>	<i>Coefficient (t-stat)</i>	<i>Coefficient (t-stat)</i>
<u>Health Expenditure Variables</u>				
Hospital Spending	-0.006 (-5.003)	-0.001 (-1.13)	0.0004 (1.41)	-0.0005 (-1.68)
Physician Spending	-0.005 (-2.29)	0.003 (2.41)	0.0026 (3.33)	0.0018 (2.75)
Drugs Spending	-0.0008 (-0.46)	-0.0026 (-2.86)	0.0016 (3.74)	0.0018 (4.01)
Other Health Professionals	0.0015 (2.93)	0.003 (0.89)	-0.002 (-1.54)	0.0027 (1.65)
All Other Expenditures	0.0018 (1.55)	-0.001 (-1.66)	-0.0001 (-0.57)	0.0001 (0.71)
<u>Supplementary Variables</u>				
Physicians per capita	0.023 (1.701)	-0.026 (-2.94)	0.009 (2.54)	0.0077 (2.25)
GDP per capita	0.0001 (2.19)	-0.0000079 (-0.18)	-0.0000619 (-3.98)	-0.0001 (-7.28)
% population aged 65+	151.36 (4.53)	-0.18 (0.006)	14.59 (1.42)	27.58 (3.06)
Population density	1.256 (3.36)	-0.36 (-1.63)	-2.35 (-3.07)	-0.245 (-2.76)
Educational level	-21.88 (-1.94)	18.26 (2.55)	-1.42 (-0.44)	-5.32 (-1.69)
Poverty	0.104 (2.18)	0.047 (1.95)	0.022 (2.804)	-0.016 (-1.51)
Alcohol	0.046 (3.99)	0.038 (6.32)	-0.0035 (-1.24)	0.001 (0.455)
Tobacco	0.004(6.04)	0.002 (4.81)	0.0001 (1.01)	-0.0004 (-1.93)
Time Trend	-0.311 (-3.08)	0.07 (0.93)	0.17 (6.99)	0.029 (0.99)

Notes: Table above is the regression results of the estimated equation:

$$H_{i,t} = \beta_1 \text{Hospitals}_{i,t} + \beta_2 \text{Physicians}_{i,t} + \beta_3 \text{Drugs}_{i,t} + \beta_4 \text{OtherProfessionals}_{i,t} + \beta_5 \text{OtherExpenditures}_{i,t} + \beta_6 X_{i,t} + \delta Z_i + \gamma t + \varepsilon_{i,t}. \quad (1)$$

Table 6: Private Expenditures (One Expenditure Variable) Model

<u>Variable</u>	<u>Male IMR</u>	<u>Female IMR</u>	<u>Male LE</u>	<u>Female LE</u>
	<i>Coefficient (t-stat)</i>	<i>Coefficient (t-stat)</i>	<i>Coefficient (t-stat)</i>	<i>Coefficient (t-stat)</i>
<u>Health Expenditure Variables</u>				
Private Health Expenditures	0.0029 (2.82)	-0.00073 (-1.08)	0.0012 (3.84)	0.0012 (3.65)
<u>Supplementary Variables</u>				
Physicians per capita	0.009 (0.99)	-0.013 (-1.81)	0.011 (3.87)	0.009 (2.88)
GDP per capita	0.00013 (2.31)	0.000026 (0.72)	-0.000056 (-4.07)	-0.000096 (-6.512)
% population aged 65+	117.61 (4.58)	-13.62 (-0.54)	27.07 (3.22)	43.72 (5.37)
Population density	0.918 (3.31)	0.407 (2.202)	-0.155 (-2.22)	0.01 (0.13)
Educational level	-53.57 (-4.27)	13.52 (2.07)	2.91 (0.96)	-5.78 (-1.81)
Poverty	0.15 (3.86)	0.053 (2.22)	0.021 (2.56)	0.002 (0.25)
Alcohol	0.025 (2.51)	0.0318 (4.53)	-0.0044 (-1.64)	-0.0007 (-0.28)
Tobacco	0.00348 (4.89)	0.0025 (5.94)	0.000058 (.035)	-0.0006 (-2.78)
Time Trend	-0.3 (-3.529)	0.05 (1.03)	0.13 (6.32)	-0.005 (-0.24)

Notes: Table above is the regression results of the estimated equation:

$$H_{i,t} = \beta_1 AllHealthExpenditures(Private)_{i,t} + \beta_2 X_{i,t} + \delta Z_i + \gamma t + \varepsilon_{i,t}. \quad (4)$$

Table 7: Private Expenditures (Five Expenditure Variables) Model

<u>Variable</u>	<u>Male IMR</u> <i>Coefficient (t-stat)</i>	<u>Female IMR</u> <i>Coefficient (t-stat)</i>	<u>Male LE</u> <i>Coefficient (t-stat)</i>	<u>Female LE</u> <i>Coefficient (t-stat)</i>
<u>Health Expenditure Variables</u>				
Private Hospital Spending	-0.014 (-2.56)	-0.0053 (-1.73)	0.0029 (1.68)	0.0012 (0.88)
Private Physician Spending	-0.0034 (-0.06)	-0.085 (-4.37)	-0.0011 (-0.09)	-0.015 (-1.39)
Private Drugs Spending	0.00078 (0.55)	-0.0035 (-3.92)	0.0012 (2.92)	0.0019 (4.15)
Private Other Professionals	0.017 (3.403)	-0.0015 (-0.64)	-0.0029 (-2.28)	0.0037 (2.58)
Private Other Expenditures	0.0084 (4.74)	0.0057 (7.94)	0.00038 (0.85)	-0.0011 (-1.79)
<u>Supplementary Variables</u>				
Physicians per capita	0.007 (0.59)	-0.025 (-4.35)	0.011 (3.45)	0.0095 (3.06)
GDP per capita	0.000071 (1.07)	0.000031 (0.93)	-0.000051 (-3.56)	-0.00011 (-6.82)
% population aged 65+	192.74 (5.38)	24.86 (1.47)	20.59 (2.24)	33.79 (4.25)
Population density	0.39 (1.21)	0.606 (3.97)	-0.02 (-0.27)	0.0059 (0.068)
Educational level	-30.67 (-2.57)	24.7 (4.51)	2.92 (1.03)	-7.79 (-2.33)
Poverty	0.11 (2.43)	0.073 (3.61)	0.02 (2.81)	-0.0082 (-0.82)
Alcohol	0.027 (2.43)	0.046 (7.39)	-0.0032 (-1.13)	0.0026 (0.93)
Tobacco	0.0036 (4.98)	0.003 (9.42)	-0.00005 (-0.21)	-0.00019 (-0.71)
Time Trend	-0.47 (-4.557)	0.05 (1.07)	0.15 (6.23)	0.044 (1.73)

Notes: Table above is the regression results of the estimated equation:

$$\begin{aligned}
 H_{i,t}(\text{MaleLE}) = & \beta_1 \text{Hospitals(Private)}_{i,t} + \beta_2 \text{Physicians(Private)}_{i,t} + \beta_3 \text{Drugs(Private)}_{i,t} + \\
 & \beta_4 \text{OtherProfessionals(Private)}_{i,t} + \beta_5 \text{OtherExpenditures(Private)}_{i,t} + \beta_6 X_{i,t} + \delta Z \\
 & + \gamma t + \varepsilon_{i,t}.
 \end{aligned}
 \tag{2}$$