# What Drives Provincial Health Expenditure?

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**PRÉCIS**

Cet article utilise les données des provinces canadiennes pour la période de 25 ans comprise entre 1975 et 2000 pour évaluer l'incidence du revenu, du temps et de la distribution de la population par groupes d'âge sur les dépenses en matière de santé des gouvernements provinciaux. Les résultats montrent que le vieillissement de la population a entraîné une hausse des dépenses en matière de santé au Canada mais que son effet serait relativement modeste si d'autres variables étaient prises en compte. L'augmentation des dépenses liées au vieillissement est attribuable en grande partie au groupe des 75 ans et plus; le groupe des 64-74 ans est en réalité associé à un recul des dépenses provinciales dans le domaine des soins de santé. Les effets du temps expliquent environ 40 % de l'augmentation des dépenses gouvernementales brutes en soins de santé par habitant, pour la période comprise entre 1975 et 2000. Au mieux, les effets du temps représentent une estimation de la limite supérieure de l'incidence du changement technologique sur les dépenses en matière de santé puisqu'ils permettent de refléter les effets de l'évolution technologique, des changements de politiques, des nouvelles maladies et des changements dans les préférences et les attentes des usagers des services de santé. Parmi les autres facteurs qui expliquent les dépenses des provinces dans les soins de santé, mentionnons le revenu, le nombre de médecins, l'apport du secteur privé dans le domaine des soins de santé sous la forme d'un partage des dépenses en santé en général, et l'importance que les gouvernements accordent aux soins de santé.

**ABSTRACT**

This article uses Canadian provincial data for the 25-year period 1975 to 2000 in order to assess the impact of income, time, and the distribution of population by age on provincial government health expenditure. The results show that aging of the population has driven up provincial health expenditure in Canada but that if one controls for other variables the effect has been relatively modest. Most of the age-related increase in spending is attributable to the proportion of population that is aged

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75 or more; the 65-to-74 age group is actually associated with a decline in provincial spending on health care. Time effects explain about 40 percent of the increase in real per capita provincial government expenditure on health care between 1975 and 2000. At best, time effects represent an upper-bound estimate of the impact of technological change on health spending, since they can account for the effects of technological change, as well as policy shifts, new diseases, and shifts in preferences and expectations by users of health services. Other drivers of provincial spending on health care are income, physician numbers, private spending on health as a share of health spending in general, and the importance that governments attach to health care.

**KEYWORDS:** HEALTH CARE EXPENDITURES ■ AGE ■ INCOME ■ TECHNOLOGY

**CONTENTS**



## INTRODUCTION

Much of the empirical literature on the determinants of health expenditure has focused on the income elasticity of health spending, even though it has gradually become apparent that changes in income account for only a small proportion of the changes in health spending. The literature has generally avoided undertaking the more complex specifications associated with the distribution of population by age group or technological change as drivers of health spending. This article uses Canadian provincial data for 1975 through 2000 in order to assess the impact on real per capita provincial government expenditure on health care of income, time, the distribution of population by age group, and other variables.

The results show that aging of the population has driven up health expenditure but that the effect is relatively modest if one controls for a variety of other variables. Most of the age-related increase, however, is attributable to the over-74 age group. The 65-74 group is actually associated with a decline in spending. Time effects explain about 40 percent of the increase in real per capita provincial government expenditure on health between 1975 and 2000. Time effects encompass the effects on health expenditure of technological change, along with policy shifts, new diseases, and changes in the preferences and expectations of the users of health services. The results also identify several other important determinants of health spending: the number of physicians per capita, private spending on health as a share of total spending on health, and the relative importance that provincial governments assign to health care. Overall, given the aging of the population, the pace of technological change, and the accompanying changes in other variables, forecasting trends in public health expenditure in Canada will remain an important but complicated endeavour.

## ISSUES AND CONTEXT

Numerous studies have used international, national, or regional data to identify the determinants of health expenditures.[1] The early studies were based on simple bivariate regressions that used single cross-sections. Data sets later expanded sufficiently to permit both the use of multivariate regressions on cross-sections and pooled time-series techniques. Both kinds of studies used a "determinants" approach, in which the researcher regressed per capita health-care expenditure on variables that appeared to affect this expenditure. The variables for a given region or nation included income per capita, the proportion of population either over age 65 or under age 15, the public share of spending on health care, the extent of urbanization, the amount of foreign aid received, and the number of physicians per capita.

Many researchers have focused on the role of income in explaining variations in expenditure on health care. The income elasticity of expenditure on health care is the percentage change in this expenditure in response to a given percentage change in income. If the income elasticity is less than 1.0, then expenditure on health care is income inelastic and health care is a "necessary" good. If the elasticity is greater than 1.0, then expenditure on health care is income elastic and health care is a "luxury" good. To put the matter in another way, if the elasticity is greater than 1.0, expenditure on health care will increase more quickly than income, whereas if the elasticity is less than 1.0, expenditure on health care will increase more slowly than income.

The income elasticity of expenditure on health care is important for several reasons. First, it is important to understand the role of income in determining spending on health care because of the light it sheds on the ultimate question: What amount of expenditure on health care is optimal for a given society? Although economists and policy analysts have determined which countries spend the largest and the smallest proportions of their GDP on health care, economic theory has yet to determine what the optimal proportion ought to be.[2] Second, the income elasticity has implications for the financing of health care, since those who feel that health care is a necessity often favour greater public involvement in its provision, whereas many of those who feel that health care is a luxury would prefer to see its provision left to market forces alone.[3]

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1 For an excellent survey of the international literature on the determinants of health expenditure, see Ulf-G. Gerdtham and Bengt Jönsson, "International Comparisons of Health Expenditure: Theory, Data and Econometric Analysis," in Anthony J. Culyer and Joseph P. Newhouse, eds., *Handbook of Health Economics*, vol. 1A (Amsterdam: Elsevier Science, 2000), chapter 1.

2 See James W. Henderson, *Health Economics and Policy*, 2d ed. (Cincinnati: Thomson South-Western, 2002), 3.

3 For overviews of the debate about the relative merits of public health care and private health care, see Livio Di Matteo, "The Determinants of the Public-Private Mix in Canadian Health Care Expenditures: 1975-1996" (2000) vol. 52, no. 2 *Health Policy* 87-112; and A.J. Culyer, "Public or Private Health Services? A Skeptic's View" (1983) vol. 2, no. 3 *Journal of Policy Analysis and Management* 386-402.

Culyer[4] discusses the notion that health care is a luxury good because its income elasticity of demand is greater than 1.0. One objection to this notion, Culyer notes, is that it is counterintuitive—because intuition suggests that health care is more a necessity than it is a luxury.[5] Moreover, since health care is often heavily subsidized, one would expect ability to pay to be less important as a determinant of health expenditure than it is as a determinant of other kinds of expenditure. Culyer also suggests that the view of health care as a luxury good is based on a misspecification of the determinants of health.[6] In addition, Getzen[7] makes the case that income elasticity varies with the level of analysis. He found that individual income elasticities are typically close to zero, whereas national health expenditure income elasticities are often greater than 1.0.[8]

Newhouse,[9] who took the classic approach to the subject, regressed per capita medical expenditures on per capita gross domestic product for 13 countries circa 1970. He found that "over 90 percent of the variance in per capita medical expenditure in these countries can be explained by variation in per capita GDP" and consequently that spending in health care was income elastic; the elasticity ranged from 1.15 to 1.31.[10] In more recent work, however, Newhouse argued that health care is a normal good but that expenditure for health care is income inelastic.[11] Over the period 1940 to 1990 in the United States, he noted, overall spending on health increased by over 700 percent, but income alone accounted for an increase of only 35 to 70 percent. Newhouse believed that the bulk of the residual increase was

4 A.J. Culyer, *Health Care Expenditures in Canada: Myth and Reality; Past and Future*, Canadian Tax Paper no. 82 (Toronto: Canadian Tax Foundation, 1988), 5.

5 Ibid., at 20.

6 Culyer, ibid., at 46, argues that omitting a variable may be a cause of misspecification but that the missing variable is probably "too subtle to be readily quantified." It may be present in the public budgeting mechanism used to fund health care. Indeed, recent work by Sen based on OECD data suggests that omitted-variable bias, in addition to the presence of unobserved country- and year-specific effects, may be confounding factors in estimates of income elasticity. See A. Sen, "Is Health Care a Luxury? New Evidence from OECD Data" (unpublished manuscript, 2002).

7 Thomas E. Getzen, "Health Care Is an Individual Necessity and a National Luxury: Applying Multilevel Decision Models to the Analysis of Health Care Expenditures" (2000), vol. 19, no. 2 *Journal of Health Economics* 259-70.

8 Thomas Getzen, in "Aggregation and the Measurement of Health Care Costs" (unpublished manuscript, 2001), has further argued that analysis of health expenditure requires one to match the units of observation to the units at which decision making for health actually occurs.

9 Joseph P. Newhouse, "Medical-Care Expenditure: A Cross-National Survey" (1977) vol. 12, no. 1 *The Journal of Human Resources* 115-25; and Joseph P. Newhouse, "Cross-National Differences in Health Spending: What Do They Mean?" (1987) vol. 6, no. 2 *Journal of Health Economics* 159-62.

10 Newhouse, "Medical-Care Expenditure," supra note 9, at 117.

11 Joseph P. Newhouse, "Medical Care Costs: How Much Welfare Loss?" (1992) vol. 6, no. 3 *The Journal of Economic Perspectives* 3-21.

attributable to technological change, including innovations in both medical techniques and pharmaceutical products. For example, pharmaceuticals have replaced other health services, including institutionalization (with the introduction of antipsychotic drugs) and surgery (anti-ulcer drugs), and they have perhaps even reduced the amount of time that physicians spend with their patients.[12]

Many early studies of the determinants of health expenditure used single cross-sections and focused on income. When they did examine demographic factors, the variable they generally used was the proportion of the population aged 65 or more. The first generation of studies generally found health expenditure to be quite income elastic.[13] Later studies that used pooled time-series cross-sectional international data found much lower estimates of income elasticity. Estimates of less than 1.0 were quite common.[14]

Some recent studies of the determinants of expenditure on health care have criticized the earlier time-series literature on the basis of the issue of stationarity

12 W. Davidson, D.W. Molloy, and M. Bédard, "Physician Characteristics and Prescribing for Elderly People in New Brunswick: Relation to Patient Outcomes" (1995) vol. 152, no. 8 *Canadian Medical Association Journal* 1227-34.

13 These studies often used international data. See Robert E. Leu, "The Public-Private Mix and International Health Care Costs," in A.J. Culyer and Bengt Jönsson, eds., *Public and Private Health Services* (Oxford: Basil Blackwell, 1986), 41-63; David Parkin, Alistair McGuire, and Brian Yule, "Aggregate Health Care Expenditures and National Income: Is Health Care a Luxury Good?" (1987) vol. 6, no. 2 *Journal of Health Economics* 109-27; Malcolm C. Brown, *Caring for Profit: Economic Dimensions of Canada's Health Industry* (Vancouver: Fraser Institute, 1987); Ulf-G. Gerdtham, Jes Søgaard, Fredrik Andersson, and Bengt Jönsson, "An Econometric Analysis of Health Care Expenditure: A Cross-Section Study of the OECD Countries" (1992) vol. 11, no. 1 *Journal of Health Economics* 63-84; and Kwame P. Gbesemete and Ulf-G. Gerdtham, "Determinants of Health Care Expenditure in Africa: A Cross-Sectional Study" (1992) vol. 20, no. 2 *World Development* 303-8.

14 See Theo Hitiris and John Posnett, "The Determinants and Effects of Health Expenditure in Developed Countries" (1992) vol. 11, no. 2 *Journal of Health Economics* 173-81; P.P. Barros, "The Black Box of Health Care Expenditure Determinants" (1998) vol. 7, no. 6 *Health Economics* 553-44; and Ulf-G. Gerdtham, Bengt Jönsson, Maitland MacFarlan, and Howard Oxley, "The Determinants of Health Expenditure in the OECD Countries: A Pooled Data Analysis," in Peter Zweifel, ed., *Health, the Medical Profession and Regulation: Developments in Health Economics and Public Policy*, vol. 6 (Boston: Kluwer Academic, 1998), 113-34. Livio Di Matteo and Rosanna Di Matteo, "Evidence on the Determinants of Canadian Provincial Government Health Expenditures" (1998) vol. 17, no. 2 *Journal of Health Economics* 211-28, estimated the determinants of Canadian provincial government spending on health over the period 1965 through 1991 and found an income elasticity of 0.77. Ruolz Ariste and Jeff Carr, *New Considerations on the Empirical Analysis of Health Expenditures in Canada: 1966-1998*, Health Policy Research Working Paper 02-06 (Ottawa: Health Canada, 2003), also use provincial government data on health expenditure and find an income elasticity of 0.88. An exception to pooled time-series cross-sectional analysis with income inelastic results is Theo Hitiris, "Health Care Expenditure and Integration in the Countries of the European Union" (1997) vol. 29, no. 1 *Applied Economics* 1-6; Hitiris used data for 10 members of the Organisation for Economic Co-operation and Development (OECD) countries for the period 1960 through 1991 and found that the income elasticity of health expenditure ranged from 1.14 to 1.17.

and have adopted a co-integration approach to time-series data.[15] A feature of time-series studies that use a co-integration approach, however, is that their results vary with the test for stationarity that one uses. As Gerdtham and Jönsson wrote, "The most likely explanation for the differing results is difference in methods, and it is an open question which test is most reliable."[16] Overall, however, the time-series studies do not differ significantly from the main body of the literature, since they, too, find that the income elasticity of health care spending is not significantly different from 1.0. In addition, one recent time-series study concludes that "researchers and policy makers modeling health expenditures and GDP in a panel regression framework can get meaningful results that are not spurious, if structural changes are allowed."[17]

In Canada, the ongoing debate about health care reform has produced a number of policy reports that have influenced the literature on the determinants of health expenditure. A recent report by the provincial and territorial ministers of health[18] forecasts that under modest assumptions health expenditures will grow at a rate of

15 A stationary time series is one whose mean and variance do not change over time. If the variables in a regression are non-stationary, then the regression may be spurious. If the error term is stationary, then the two variables are co-integrated with the error term that represents short-term deviations from that relationship. Tests for stationarity are available, but their power is limited by both the quality and the time span of the data. (See Terence C. Mills, *Time Series Techniques for Economists* (Cambridge, UK: Cambridge University Press, 1994), 92-103 and 273-79; David F. Hendry, "Econometric Modelling with Cointegrated Variables: An Overview" (1986) vol. 48, no. 3 *Oxford Bulletin of Economics and Statistics* 201-12; Allan W. Gregory and Alfred Haug, *Conflicts Among Tests for Cointegration*, Institute for Economic Research Working Paper no. 973 (Kingston, ON: Queen's University, Institute for Economic Research, 1998), 273-79; Russell Davidson and James G. MacKinnon, *Estimation and Inference in Econometrics* (Oxford: Oxford University Press, 1993), 715-22; and Vito A. Muscatelli and Stan Hurn, "Cointegration and Dynamic Time Series Models" (1992) vol. 6, no. 1 *Journal of Economic Surveys* 1-43). For studies of the determinants of health expenditure that use this approach, see Vasudeva N.R. Murthy and Victor Ukpolo, "Aggregate Health Care Expenditure in the United States: Evidence from Cointegration Tests" (1994) vol. 26, no. 8 *Applied Economics* 797-802; Paul Hansen and Alan King, "The Determinants of Health Care Expenditure: A Cointegration Approach" (1996) vol. 15, no. 1 *Journal of Health Economics* 127-37; Å.G. Blomqvist and R.A.L. Carter, "Is Health Care Really a Luxury?" (1997) vol. 16, no. 2 *Journal of Health Economics* 207-29; and Jennifer Roberts, "Spurious Regression Problems in the Determinants of Health Care Expenditures: A Comment on Hitiris (1997)" (2000) vol. 7, no. 5 *Applied Economics Letters* 279-83. In the case of panel data, recent research suggests that stationarity may not be a serious problem if one uses panel-level tests. Therefore, "researchers studying national health expenditures need not be as concerned as previously thought about the presence of unit roots in the data." See Suzanne K. McCoskey and Thomas M. Seldon, "Health Care Expenditure and GDP: Panel Data Unit Root Test Results" (1998) vol. 17, no. 3 *Journal of Health Economics* 369-76, at 375.

16 Gerdtham and Jönsson, supra note 1, at 48.

17 Todd Jewell, Junsoo Lee, Margie Tieslau, and Mark C. Strazicich, "Stationarity of Health Expenditures and GDP: Evidence from Panel Unit Root Tests with Heterogeneous Structural Breaks" (2003) vol. 22, no. 2 *Journal of Health Economics* 313-23, at 322.

18 Provincial and Territorial Ministers of Health, *Understanding Canada's Health Care Costs: Final Report* (Provincial and Territorial Ministers of Health, August 2000).

approximately 5 percent per year. According to the report, certain cost accelerators may produce an even higher rate of growth. They include emerging and new technologies (such as major joint surgery, neonatal and fetal technologies, dialysis, organ transplantation, and genetic testing and therapy), increased incidence of chronic and new diseases (such as heart disease, diabetes, and AIDS), changes in pharmaceuticals, and increases in expectations that may lead to increased rates of use. The report expects aging to account for approximately 21 percent of total expenditure growth, population growth for 13 percent, inflation for 43 percent, and all other factors for 21 percent.

Another report[19] uses a similar methodology and a sensitivity analysis to decompose past expenditure trends and apply them to the future. It finds that over the period 1998 to 2030 aging of the population is likely to account for just 31 percent of growth in real per capita health expenditure in Canada. More important than this finding, however, is the uncertainty associated with any projection of expenditure growth in the health-care sector as a result of trends in illness and in population health, age-related changes in the cost of health-service delivery, and changes in medical technology.

Both reports based their forecasts of spending growth on what were essentially simple extrapolations of past trends in inflation, aging, and population growth. A better approach is to estimate values for the determinants of expenditure on health by assessing the impact on expenditure of key variables while controlling for the effect of other factors. This is the approach I shall use here. Moreover, I shall augment it by specifying both narrow and broad models of health expenditure in order to illustrate the importance of specification in determining results.

## DATA AND ESTIMATES

The data on health expenditure that I have used in this article are from the Canadian Institute for Health Information. I have used data from Statistics Canada's Canadian socio-economic information system (CANSIM) to construct additional socioeconomic and demographic variables.[20] Provincial government expenditures on health care fall into eight categories:[21]

19 Seamus Hogan and Sarah Hogan, *How Will the Ageing of the Population Affect Health Care Needs and Costs in the Foreseeable Future?* Commission on the Future of Health Care in Canada Discussion Paper no. 25 (Ottawa: Health Canada, 2002).

20 CANSIM had two overlapping data series on provincial GDP covering the period 1975 through 2000. Data from two shorter periods were combined to construct a series over the full period. I constructed the data on federal cash transfers from data obtained from the federal Department of Finance. For details on the construction of the provincial GDP series and the federal cash transfer variable, see Livio Di Matteo and Paul Grootendorst, "Federal Patent Extension, Provincial Policies, and Drug Expenditures, 1975-2000" (2002) vol. 50, no. 6 *Canadian Tax Journal* 1913-48, appendix.

21 For a more detailed description of these categories, see the Canadian Institute for Health Information Web site at http://www.cihi.ca/.

1) *Hospitals:* Expenditures for public acute- and chronic-care hospitals and for specialty hospitals such as hospitals for pediatrics and neurology.
2) *Other institutions:* Expenditures for residential care facilities, such as homes for the aged, homes for the physically and mentally handicapped, and facilities for treating drug or alcohol problems.
3) *Physicians:* Expenditures for professional health services provided by physicians, excluding physicians on the payrolls of hospitals or public agencies; their remuneration is included in the relevant category.
4) *Other professionals:* Expenditures for dentists, chiropractors, optometrists, private-duty nurses, and physiotherapists.
5) *Drugs:* Expenditures for provincial government prescription drug plans.
6) *Capital expenditures:* Expenditures for the construction, machinery, and equipment of hospitals and other health institutions.
7) *Public health and administration:* Expenditures on measures that are intended to prevent the spread of communicable diseases or to ensure food, drug, or workplace safety and spending on health administration.
8) *Other:* Expenditures for home care, medical transportation, hearing aids, and eyeglasses, and any other items not included in the first seven categories.

In 1975, total provincial government health expenditure was approximately $9 billion. Of this amount, approximately 57 percent went to hospitals, 9 percent to other institutions, 20 percent to physicians, 1 percent to other professionals, 2 percent to drugs, 4 percent to capital expenditure, 4 percent to public health and administration, and 3 percent to all other health expenditures.

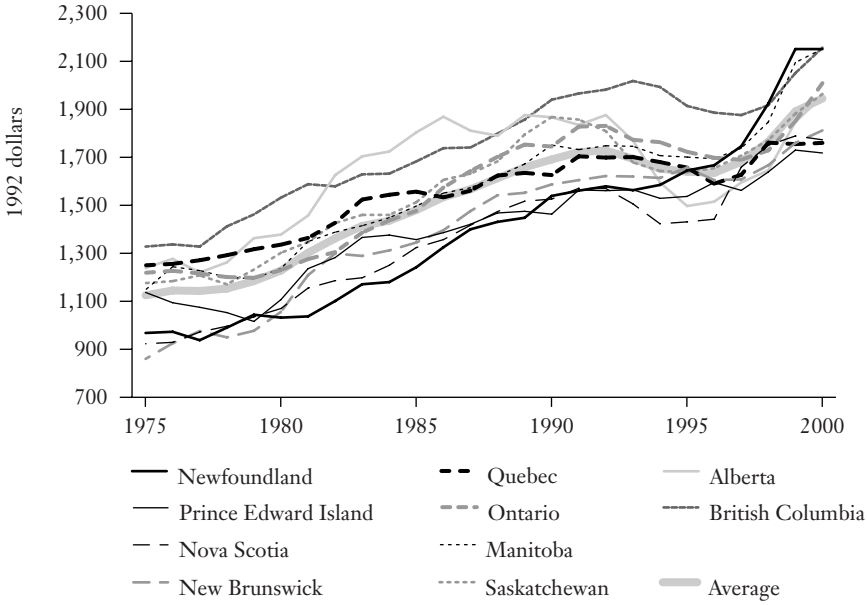
Between 1975 and 2000, provincial government spending on health grew at an annual rate of about 8 percent; by 2000, it was approximately $63 billion. About 44 percent of this amount went to hospitals, 10 percent to other institutions, 20 percent to physicians, 1 percent to other professionals, 7 percent to drugs, 5 percent to capital expenditure, 7 percent to public health and administration, and 6 percent to all other health expenditure. Thus spending grew most rapidly over the period in the categories of drugs, capital expenditure, other health expenditure, and public health and administration, and spending on hospitals declined substantially as a share of total spending on health care.

Figure 1 presents real per capita provincial government health expenditure in 1992 dollars. The figure shows that spending rose steadily between 1975 and the early 1990s, declined somewhat between 1992 and 1996, and thereafter resumed its rise. Average real per capita provincial government spending on health rose from $1,125 in 1975 to $1,728 in 1992, declined to $1,635 per capita between 1992 and 1996, and rose sharply to $1,945 per capita between 1996 and 2000. In 2000, the largest spenders per capita were Newfoundland ($2,151 in 1992 dollars) and British Columbia ($2,157), and the smallest were Prince Edward Island ($1,718) and Quebec ($1,760).

The econometric model that I estimate here is of this general form:

$$h = f(y, a, z), \tag{1}$$

**FIGURE 1 Real Per Capita Provincial Government Expenditure on Health Care, 1975 Through 2000**




where $h$ is real per capita provincial government health spending, $y$ is real per capita income, $a$ is age, and $z$ represents a vector of additional social and economic variables that are deemed to influence real per capita health expenditures. Because the model uses real per capita spending, it automatically adjusts for the effects of inflation and population growth. The model includes the following independent variables: real per capita income, real per capita federal cash transfers to the provinces, each of several age groups as a share of population, the number of physicians per capita, private spending on health as a share of total spending on health, provincial spending on health as a share of all provincial government spending, provincial dummies, and a time-trend variable. Table 1 sets out the full specification of the model.

The inclusion of real per capita income as a variable is standard in studies of determinants of spending on health care. These studies routinely assume that own-source revenue, and with it spending on health care, increases with income.[22] The income variable that I shall use in this article is real per capita provincial gross domestic product. Federal transfers are another source of revenue for provincial governments that varies in importance across provinces and over time. Until fairly recently, provincial governments derived about 20 percent of their revenue from

22 Income is a measure of the potential resources available to a jurisdiction for public expenditure and is an indicator of ability to pay.

**TABLE 1 Regression Variable Definitions**

| Variable | Definition |
|---|---|
| RHPGC ..... | Real per capita provincial government total health expenditure (1992 dollars). |
| RGDPC ..... | Real per capita provincial gross domestic product (1992 dollars). |
| RNFCASHC ... | Real per capita provincial revenue from federal cash transfers (1992 dollars). |
| PR65PL ..... | Proportion of population aged greater than 65. |
| NFLD ..... | 1 if Newfoundland, 0 otherwise. |
| PEI ..... | 1 if Prince Edward Island, 0 otherwise. |
| NS ..... | 1 if Nova Scotia, 0 otherwise. |
| NB ..... | 1 if New Brunswick, 0 otherwise. |
| QUE ..... | 1 if Quebec, 0 otherwise. |
| ONT ..... | 1 if Ontario, 0 otherwise. |
| MAN ..... | 1 if Manitoba, 0 otherwise. |
| SASK ..... | 1 if Saskatchewan, 0 otherwise. |
| ALTA ..... | 1 if Alberta, 0 otherwise. |
| BC ..... | 1 if British Columbia, 0 otherwise. |
| PRP017 ..... | Proportion of provincial population aged 0 to 17. |
| PRP1844 ..... | Proportion of provincial population aged 18 to 44. |
| PRP4564 ..... | Proportion of provincial population aged 45 to 64. |
| PRP6574 ..... | Proportion of provincial population aged 65 to 74. |
| PRP75 ..... | Proportion of provincial population aged 75 or more. |
| PHYSC ..... | Number of physicians per capita specified as physicians per million of population. All physicians in total. |
| PRIVSH ..... | Private proportion of total health expenditure. |
| PRVGHSH .... | Provincial government expenditure on health divided by total provincial government expenditure. |
| TIME ..... | Time-trend variable. |

Note: Provincial government expenditures, federal transfers, and GDP are deflated on the basis of the government expenditure implicit price index. All indexes, 1992=100.

Source: Canadian Institute for Health Information.

federal transfers. By the late 1990s, however, the federal government's deficit-fighting agenda had reduced the figure to about 15 percent.

The estimated value of federal cash and tax-point transfers to the provinces and territories in 2000-2001 was $43 billion.[23] About 30 percent of this amount consisted of general-purpose transfers (such as equalization grants),[24] and the remainder

23 Federal transfers to the provinces consist of a cash component and revenue from tax points that the federal government surrendered to the provinces with the creation of EPF in 1977. Since the tax points are now firmly part of the provinces' tax room, the provinces do not consider it legitimate to count the value of the tax points as part of the annual CHST transfer. See *Understanding Canada's Health Care Costs*, supra note 18.

24 Equalization is provided to provinces with below-average fiscal capacity. All of the provinces except British Columbia, Alberta, and Ontario have been usual recipients of equalization, and recently British Columbia too has become a recipient.

consisted of specific-purpose transfers, of which by far the largest was the Canada health and social transfer (CHST).[25] The 1990s saw both a reduction in federal transfer funding and significant changes in the institutional arrangements that governed those transfers. The most important of these changes was the introduction of the CHST, which by incorporating federal health transfers into a much more general transfer payment, has made it difficult to obtain specific data on federal health transfers. Even before the arrival of the CHST, however, the provinces had some discretion in the use of federal transfer income, particularly if they received equalization cash transfers.

For the purposes of this article, I have constructed a variable in which I attempt to include all federal cash transfers to the provinces that the provinces could conceivably spend on health care.[26] The transfers are cash payments under the equalization program, the cash component of established programs funding (EPF), the cash component of the CHST entitlement, and the value of health grants for the two years before the onset of EPF in 1977.

Age is another important determinant of health expenditure. Discussion in the popular media has treated the aging of the population as a major cause of increases in the cost of health care, whereas academic analysis has argued that the importance of this factor has been overstated.[27] Any assessment of the effect of an aging population on health expenditure is complicated by differences among age cohorts in both the level of demand for health services and the nature of the services demanded, by the effect on expenditure of new techniques and technologies, by demographic uncertainty, and even by age-related changes on the overall cost of health services.[28]

Although the aging of Canada's population is only a secondary factor in the rise in health expenditure, it is not a negligible one.[29] Studies have shown that in Canada the per capita cost of health care for a 70-year-old is nearly triple and for a 60-year-old nearly double the cost for a 40-year-old.[30] A 1989 study of physician expenditures

25 See Canada, Department of Finance, "Federal Transfers to Provinces and Territories," available on the Department of Finance Web site at http://www.fin.gc.ca/FEDPROV/ftpte.html.

26 For additional data on the transfer variable and a table that illustrates the data, see Di Matteo and Grootendorst, supra note 20, at 1942.

27 Robert G. Evans, Kimberly M. McGrail, Steven G. Morgan, Morris L. Barer, and Clyde Hertzman, "Apocalypse No: Population Aging and the Future of Health Care Systems" (2001) vol. 20, supplement 1 *Canadian Journal on Aging* 160-91; and William B.P. Robson, *Will the Baby Boomers Bust the Health Budget? Demographic Change and Health Care Financing Reform*, C.D. Howe Institute Commentary no. 148 (Toronto: C.D. Howe Institute, February 2001).

28 Hogan and Hogan, supra note 19, at v.

29 Ibid.

30 Frank T. Denton and Byron G. Spencer, "Health-Care Costs When the Population Ages" (1975) vol. 8, no. 1 *The Canadian Journal of Economics* 34-48, at 38. For additional discussion of the impact of an aging population on Canada's health-care costs, see Frank T. Denton and Byron G. Spencer, "Population Aging and Future Health Costs in Canada" (1983) vol. 9, no. 2

in British Columbia estimated that the average annual increase in the per capita cost of health care for people aged 75 and over was 5.5 percent; growth in the use of specialist care was especially rapid.[31] Studies for the United States show similar patterns and trends.[32]

In 1961, the proportion of the Canadian population over age 65 was 7.6 percent; by 2025, it is expected to reach 18 percent.[33] Thus, the aging of the population will certainly contribute to future increases in health expenditure.[34] It is important to note, however, that the costs of health care do not necessarily increase linearly after age 65. As a rule, indeed, most of an individual's expenditure for health care occurs in the last year or two of life; consequently, it may increase more rapidly for individuals in their 70s and 80s than for individuals in their late 60s. As well, the baby-boom generation is currently under age 65, so a disproportionately large share of the population is in the age range for which the cost of health care is relatively low. As the baby boomers age, a larger fraction of the population will move into the higher—and higher-cost—age range.[35] In order to capture the possible non-linear effects of demographic variables on health spending, my model includes variables for the proportions of the population aged 0 to 17, 18 to 44, 45 to 64, 65 to 74, and 75 or more.[36]

The model also includes the number of physicians per capita in each province. There is no a priori basis for predicting the sign of this variable. An increase in physician density might increase the number of patients who are receiving care and thereby increase costs; on the other hand, it might increase the average amount of time that a doctor spends with a patient, which in turn might reduce the total

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*Canadian Public Policy* 155-63; Frank T. Denton, S. Neno Li, and Byron G. Spencer, "How Will Population Aging Affect the Future Costs of Maintaining Health-Care Standards?" in Victor W. Marshall, ed., *Aging in Canada: Social Perspectives*, 2d ed. (Richmond Hill, ON: Fitzhenry and Whiteside, 1987), 553-68; Frank T. Denton and Byron G. Spencer, "Demographic Change and the Cost of Publicly Funded Health Care" (1995) vol. 14, no. 2 *Canadian Journal on Aging* 174-92; and Frank T. Denton, Amiram Gafni, and Byron G. Spencer, "Exploring the Effects of Population Change on the Costs of Physician Services" (2002) vol. 21, no. 5 *Journal of Health Economics* 781-803.

31 M.L. Barer, I.R. Pulcins, R.G. Evans, C. Hertzman, J. Lomas, and G.M. Anderson, "Trends in Use of Medical Services by the Elderly in British Columbia" (1989) vol. 141, no. 1 *Canadian Medical Association Journal* 39-45.

32 Daniel R. Waldo, Sally T. Sonnenfeld, David R. McKusick, and Ross H. Arnett, "Health Expenditure by Age Groups, 1977 and 1987" (1989) vol. 10, no. 4 *Health Care Financing Review* 111-20; and Ronald A. Schrimper and Robert L. Clark, "Health Expenditures and Elderly Adults" (1985) vol. 40, no. 2 *Journal of Gerontology* 235-43.

33 M.S. Marzouk, "Aging, Age-Specific Health Care Costs and the Future Health Care Burden in Canada" (1991) vol. 17, no. 4 *Canadian Public Policy* 490-506.

34 This statement assumes that age-specific rates of health-care use remain constant.

35 Hogan and Hogan, supra note 19, at 7.

36 Data were available for these age groups by gender, but their use introduced a substantial collinearity problem into the estimation.

number of visits—and hence the total billings—per physician. The overall impact would depend on the relative sizes of these two effects.

The model also incorporates private spending on health care as a share of total spending on health care. Increases in the private health expenditure as a share of total expenditure may imply a substitution of private spending for public spending by provincial governments. The evidence suggests that between 1975 and 1996 private health expenditure did increase relative to total health expenditure in Canada.[37]

Finally, the model attempts to take into account the relative importance of spending on health care in provincial budgets. This variable is defined as provincial government expenditure on health care divided by total provincial government expenditure. It can serve both as a measure of how the provinces differ in their "generosity" toward health care and as a measure of the importance that each province places on health care relative to expenditure for other purposes.

The impact of technological change on spending for health care is difficult to model. One study observes that despite claims of the importance of technological change to medicine, the "research measuring the potential contributions of technology to rising health care costs has been scanty."[38] One reason for its scantiness is the difficulty of measuring technological change as a component of aggregate health-care data. In the context of health care, one may define technological change as any change in the stock of knowledge related to treatment. A change of this kind may reduce the cost of achieving a given outcome and thereby reduce the overall cost of health care. On the other hand, a change in the stock of knowledge may result in expensive new treatments and hence increase the overall cost of health care.

My model uses a simple linear time-trend variable to measure the effects of technological change on expenditure. A time-trend variable, however, has the drawback that it will capture the effect of any influences on health spending, in addition to technological change, that are not directly controlled for, such as government policy shifts, changes in public expectations and preferences, and new diseases. At best, the coefficient estimates for the time variable represent an upper-bound estimate of the impact of technological change on spending for health care.

Finally, the model includes province dummies in order to capture any time-invariant regional effects that are not captured by other variables. The Canadian federation is quite diverse, and in addition to the factors that I have already mentioned, differences among the provinces' levels of expenditure on health care may arise from differences in regional preferences, culture, tax systems,[39] and geography.

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37 Di Matteo, supra note 3.

38 Albert A. Okunade and Vasudeva N.R. Murthy, "Technology as a 'Major Driver' of Health Care Costs: A Cointegration Analysis of the Newhouse Conjecture" (2002) vol. 21, no. 1 *Journal of Health Economics* 147-59, at 147.

39 For example, see Mark Stabile, "Private Insurance Subsidies and Public Health Care Markets: Evidence from Canada" (2001) vol. 34, no. 4 *Canadian Journal of Economics* 921-42, on how government subsidies through tax exemptions may affect the decision to purchase health insurance.

## RESULTS

Table 2 shows the regression results for real per capita health expenditure by provincial governments. Model I in table 2 represents a simple specification that relates expenditure to real per capita GDP, real per capita federal cash transfers, province-specific dummy variables, and the proportion of population over age 65. Model II represents a more complete specification: it takes into account the distribution of population over several age groups and adds variables for physician numbers, private health expenditure as a share of total health expenditure, and provincial government "generosity"; it also includes a time-trend variable. The table presents the results for the two models together in order to emphasize the limitations of the poorer specification.

The pooled time-series cross-section regression used SHAZAM 8.0 and the pooling technique developed by Kmenta[40] for data that is cross-sectionally heteroscedastic and time-wise autoregressive, given the constant slope coefficients assumption and the assumption of cross-sectional dependence in the error terms.[41] All significances are at the 5 percent level unless they are stated to be otherwise. The coefficients of the estimated models are statistically different from zero, given the use of F-statistic tests, and they generally account for approximately 83 to 86 percent of the variation in the dependent variable. I have used the results for the two models in table 2 to estimate the contribution of each variable to the growth in average real per capita provincial government health expenditure over the period 1975 to 2000; these estimates appear in table 3.

In model I, real per capita income is positive and statistically significant at the 5 percent level, and real per capita federal cash transfers are positive and statistically significant at the 10 percent level. In general, the result in model I is that provincial government expenditure on health care is income inelastic—a result that is in keeping with the results of earlier research.[42] Income and cash transfers are positive in model II as well, but in this case only income is statistically significant, at the 5 percent level. These results suggest that the more complex specification

40 Jan Kmenta, *Elements of Econometrics*, 2d ed. (New York: Macmillan, 1986).

41 The Kmenta pooled cross-section technique employs a set of assumptions that allows for cross-section heteroscedasticity, cross-section dependence, or independence and time-wise autogression. The Kmenta method is a generalized linear model method. I also estimated the two regressions by using ordinary least squares (OLS) with results that generally paralleled the ones in table 2. The OLS results did generate a smaller coefficient for those aged 65 or more as a proportion of total population in model I and a larger coefficient for time in model II. These coefficients do result in percentage contributions to growth somewhat different from the ones presented in table 3. The OLS coefficients were 14,559.0 for the 65-and-over age group in model I and 19.688 for the time variable in model II. In model I, given the OLS estimates, the proportion of population aged 65 or more would explain 67 percent of the growth in real per capita provincial government expenditure on health between 1975 and 2000; the estimate in table 3 is 77 percent. In model II, given the OLS estimates, the time variable would explain 60 percent of the growth; the estimate in table 3 is about 43 percent.

42 Di Matteo and Di Matteo, supra note 14; and Ariste and Carr, supra note 14.

**TABLE 2 Regression Results: Determinants of Real Per Capita Provincial Government Expenditure on Health**

Functional form: linear specification.
Estimation range: 1975-2000.
Estimation technique: pooled time-series regression (Kmenta 1986).
Dependent variable: RHPGC.

| Variables | Model I | Model II |
|---|---|---|
| RGDPC | 0.013716 | 0.0078345 |
| | (5.649) | (3.193) |
| RNFCASHC | 0.039832 | 0.034454 |
| | (1.773) | (1.460) |
| NFLD | -394.40 | -388.57 |
| | (-6.464) | (-0.8681) |
| PEI | -995.44 | -490.06 |
| | (-10.37) | (-1.053) |
| NS | -932.72 | -674.95 |
| | (-11.81) | (-1.465) |
| NB | -807.68 | -534.95 |
| | (-11.09) | (-1.173) |
| QUE | -593.41 | -517.70 |
| | (-3.516) | (-1.144) |
| ONT | -659.55 | -487.18 |
| | (-6.185) | (-1.065) |
| MAN | -851.68 | -499.30 |
| | (-6.164) | (-1.087) |
| SASK | -1,005.5 | -434.24 |
| | (-9.541) | (-0.9405) |
| ALTA | -338.94 | -480.93 |
| | (-2.423) | (-1.127) |
| BC | -627.40 | -388.89 |
| | (-5.902) | (-0.8353) |
| PR65PL | 16,853 | — |
| | (18.75) | |
| PR1844 | — | 2,350.5 |
| | | (3.669) |
| PR4564 | — | 713.50 |
| | | (0.8131) |
| PR6574 | — | -4503.2 |
| | | (-2.194) |
| PR75PL | — | 9395.0 |
| | | (2.654) |
| PHYSC | — | 0.16695 |
| | | (2.609) |
| PRIVSH | — | -1017.7 |
| | | (-6.500) |
| PRVGHSH | — | 1188.6 |
| | | (7.746) |
| TIME | — | 14.027 |
| | | (3.027) |
| Buse-$R^2$ | 0.8567 | 0.8344 |
| Log of likelihood function | -1,327.83 | -1,298.04 |

**TABLE 3 Percentage Contributions to Growth in Average Real Per Capita Provincial Government Expenditure on Health Between 1975 and 2000**

| Variables | Model I | Model II |
|---|---|---|
| Real per capita GDP | 13.9 | 8.0 |
| Real per capita federal cash transfers | 2.0 | 1.9 |
| Proportion aged 65+ | 77.1 | — |
| Proportion aged 18-44 | — | 5.5 |
| Proportion aged 45-64 | — | 4.2 |
| Proportion aged 65-74 | — | -7.6 |
| Proportion aged 75+ | — | 27.1 |
| Physician numbers | — | 9.6 |
| Private share of total health expenditure | — | -3.2 |
| Health share of total provincial budget | — | 3.9 |
| Time | — | 42.7 |
| Total | 93.2 | 92.2 |

erodes the explanatory power of income variables. It is likely that in the simpler specification the income variables capture the effect of some of the other variables, such as time, age distribution, physician numbers, and the private share of health spending.

In model I, the proportion of population aged 65 or more is a positive and significant determinant of provincial government expenditure on health care, but its strength is a result of the inadequacy of the model's specification. Thus the more complex specification in model II reduces this variable's value as a positive and statistically significant determinant of spending on health care. Indeed, the age groups that drive health spending are now the 18-to-44 and 45-to-64 age groups, although the 45-to-64 group is not a statistically significant determinant. The proportion of the population aged 65 to 74 is negatively related to real per capita health expenditure, whereas the proportion aged 75 or more is related to it positively and significantly.

These results go against the popular perception that "aging" of the population necessarily leads to increases in health spending. The aging of Canada's population has increased health spending, but the results for model II suggest that the proportion of the population between the ages of 18 and 64 has been responsible for more of the age-related increase than has the proportion aged 65 to 74. Model II also suggests that the key source of age-related expenditure growth is the proportion of the population aged 75 or more.

As I noted above, over the period of the regression analysis the population under the age of 65 included the unusually large baby-boom generation. In general, one would not expect health-care costs to rise quickly during an era when a large proportion of the population is relatively young. Why, then, do the results for model II identify the relative size of the under-65 group as a factor in the rise in costs over the period of the analysis? One possible explanation is that the baby-boom generation

evolved new medical needs or demands that pushed health spending upward.[43] In addition, the results presumably reflect the fact that the 18-to-44 age group includes most women of childbearing age.

The number of physicians is a positive and significant determinant of provincial government spending on health care. Model II suggests that the addition of one physician per 1 million of population adds approximately 17 cents to real per capita expenditure. To put the matter in another way, over the period 1975 to 2000, each physician resulted on average in about $166,950 (in 1992 dollars) in additional health expenditure by provincial governments. Thus the physician shortage that currently afflicts the Canadian health system has actually been a source of economies for provincial governments. Any increase in the number of physicians per capita will inevitably entail higher provincial government expenditure on health care.

Meanwhile, the private spending on health as a share of total spending on health has had a negative and significant effect on real per capita provincial government expenditure on health care. This result implies that increased privatization of spending on health does result in less spending on health by provincial governments. Indeed, the private share of health spending rose substantially between 1975 and 2000,[44] although there has subsequently been some moderation of this growth. Given that the trend to privatization has been driven in part by the decline in federal transfers to the provinces, the recent resumption of growth in federal spending on health suggests that this trend may not continue. As well, the larger is the proportion of provincial government spending devoted to health care, the greater is real per capita provincial government expenditure on health. In essence, those provinces that placed a greater budgetary priority on health care were likely to spend more per capita all other things given.

The more complex specification also finds that time has been a very important factor in the growth of real per capita provincial spending on health care. The results for model II suggest that over the 25-year period 1975 to 2000 time added about $14 per year to real per capita spending and was by itself responsible for $351, or 43 percent, of an average total increase of $820 per capita over the period.

Table 3 converts the regression results in table 2 into percentage measures of each variable's contribution to the growth of average real per capita provincial government expenditure on health. Between 1975 and 2000, average real per capita expenditure grew by $820. The simple regression specification, model I, suggests

43 I also ran initial specifications of these regressions for each of the eight health expenditure categories. The variation in results across age groups was especially marked in the case of hospital spending—an outcome that may be in part at least a consequence of the aging of the baby-boom generation. A recent report by the Canadian Institute for Health Information found that between fiscal 1994-95 and fiscal 2000-2001 the number of hip and knee replacements in Canada increased by 34 percent. The number of knee replacements performed on people under the age of 55 increased by 90 percent; hip replacements among this group increased by 30 percent. Source: *Canadian Joint Replacement Registry Report: Total Hip and Total Knee Replacements in Canada, 2000/01* (Ottawa: Canadian Institute for Health Information, 2003).

44 Di Matteo, supra note 3.

that aging of the population was responsible for the bulk of this increase. According to model I, the proportion of population aged 65 or more accounted for about 77 percent of the increase in spending, whereas per capita income and cash transfers together accounted for only about 16 percent.

In the complex specification, model II, per capita income and per capita federal cash transfers together accounted for about 10 percent of the increase in spending between 1975 and 2000. The 18-to-44 age group contributed 5.5 percent and the 45-to-64 group contributed 4.2 percent. In model II, the 65-and-over age group accounted for only 19.5 percent of the increase. However, upon breakdown, the 65-to-74 group contributed a decrease of 7.6 percent and the 75-and-over group contributed an increase of 27.1 percent in the expenditure growth of $820, resulting in a net contribution of 19.5 percent.

Like table 2, table 3 indicates that the impact of federal transfers on provincial health spending has been small. One likely reason for this result is the fact that over the period of the study federal transfers declined as a share of total provincial revenues. Moreover, although the Atlantic provinces, Manitoba, and Saskatchewan saw their real per capita federal cash transfer revenues rise substantially over the period, the other four provinces did not. In Ontario and Alberta, the real per capita value of federal cash transfers declined between 1975 and 2000. In British Columbia and Quebec, it increased on average by less than 1 percent per year. Thus a number of provinces do appear to have valid reasons for continually complaining about shortfalls in federal transfer funding.

In model II, the number of physicians per capita accounted for 9.6 percent of the increase in real per capita provincial government health spending over the period 1975 to 2000. The share of the provincial budget devoted to health care accounted for 3.9 percent of the increase. The increase over the period in private spending on health contributed a decrease in per capita expenditure equivalent to about 3.2 percent of the average increase from 1975 to 2000.

In model II, the most important variable is the time variable, which accounts for 42.7 percent of the increase in real per capita provincial government expenditure on health between 1975 and 2000. The time variable represents changes in consumer preferences and expectations, changes in technology, and changes in policy, though it is not possible to separate these elements. At best, the time variable represents an upper-bound estimate of the effect of new technology on real per capita health spending.

New technology and new expectations have been potent drivers of real per capita health expenditure. Previous models, however, by failing to include separate variables for age and time, have often confounded the effects of changes in technology and expectations with the effect of the aging of the population. Given the positive impact on expenditure of population groups under the age of 65, however, it is quite possible that differences among age groups in expectations about health expenditure may prove to be an important determinant of future health spending. To put the matter in another way, projections made on the basis of historical data may not remain stable over time.

## CONCLUSION

This article has used provincial data to examine the determinants of provincial government expenditure on health care. It has considered the impact on spending of income, time, federal transfers for health care, the distribution of the population by age group, the number of physicians per capita, private spending on health care as a share of total spending on health care, and provincial spending on health care as a share of total provincial budgets. The results of the analysis suggest that real per capita provincial expenditure on health is related positively and significantly to income, federal transfers, time, and the aging of the population, and negatively and significantly to private spending on health as a share of total health spending. The results also suggest that expenditure is related positively to the number of physicians per capita and to provincial spending on health as a share of total provincial spending.

The impact on health expenditure of the income and age variables depends on the complexity of the specification of the estimated model. Simple models of health expenditure invariably find that growth in health expenditure is largely attributable to growth in the 65-and-over age group relative to total population. Models that use a more complex specification for age and add other explanatory variables, including a time trend, find that time is by far the most important variable. Time effects alone explain about 40 percent of the increase in real per capita provincial government expenditure on health since 1975. Time effects presumably encompass the effects of technological extension, policy shifts, and changes in preferences and expectations. The result for the time-trend variable in the model I used here implies that provincial government expenditure on health will continue to rise dramatically independently of either the aging of the population or future increases in income. After time, the most important drivers of real per capita provincial government expenditure on health care are age distribution, physician numbers, income variables, the importance that a province accords to health spending relative to other spending, and private spending on health as a share of total health spending.

Although the age of the population is a key determinant of the costs of health care, the popular perception that aging of the population will inevitably drive up these costs is too simple. Changes in spending on health care are the product of a large set of interactive forces, of which the most important—in addition to changes in the age of the population—are technological change, changes in policy, and changing expectations. These forces, whose long-term effects on spending are bound to be uncertain, must be considered alongside variables such as the number of physicians per capita, the balance between private spending and public spending, and the priority that provincial governments place on health spending as reflected in its share of provincial budgets. The policy implication is that forecasting health expenditure should be regarded less as a science than as an art. It may very well be that the key determinant of provincial government expenditure on health will be what the public is willing to pay, as determined by economic, social, and technological constraints.