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Physician numbers as a driver of provincial government health spending in Canadian health policy☆

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ABSTRACT

Physician spending is one of the fastest growing Canadian public sector health categories of recent years but despite their recent growth physician numbers are a relatively small contributor to the increases in total provincial government health expenditure. Regression models of the determinants of provincial government health spending are estimated and show physician numbers are a positive and significant driver of provincial government health care spending after controlling for other factors though the overall contribution is relatively small. From 1975 to 2009, the increases in physician numbers accounted for a range of 3.2–13.3 percent of the increase in real per capita total provincial government health expenditures ranging from a low of 1.9 to 7.6 percent for Manitoba to a high of 5.3 to 18.3 percent for Quebec. These are modest contributions to total health spending but vary more substantially across provinces when hospital and physician spending alone are considered particularly for Quebec and British Columbia. Nevertheless, these results suggest that physician numbers alone are a modest policy concern when it comes to restraining health costs and other factors such as utilization and fees are more important.

1. Introduction

The Canadian Institute for Health Information (CIHI) puts total nominal health expenditure in Canada at 193.1 billion dollars in 2010, 200.6 billion in 2011 and 207.4 billion in 2012 – for annual increases of 5.9, 4.0 and 3.4 percent respectively.[1] Physician spending in Canada was recently highlighted as one of the fastest growing public sector health categories of recent years, with half of the growth attributable to increases in physician fee schedules.[2] While it is not surprising that physician spending might grow during a period of perceived physician shortages as physicians negotiate substantial fee increases, the period since 2003 has also seen growth in the number of physicians in Canada due to higher medical school enrollment and the immigration of international medical graduates. The rapid growth is physician expenditures is notable given that compared to many other countries, Canada still has relatively fewer physicians. According to OECD Statistics, at 2.4 practicing doctors per 1000 of population Canada ranks 27th out of 40 countries.[3]

In the wake of recent growth in physician numbers, this paper reexamines the role of physician supply as a

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[1] CIHI, National Health Expenditure Trends [20].

[2] CIHI, Health Care Cost Drivers: The Facts [21].

[3] In 2009, the numbers range from a high of 6.1 per 1000 population for Greece to a low of 0.2 for Indonesia with an average across 40 countries of 2.8. Source: OECD, Health at a Glance [22].

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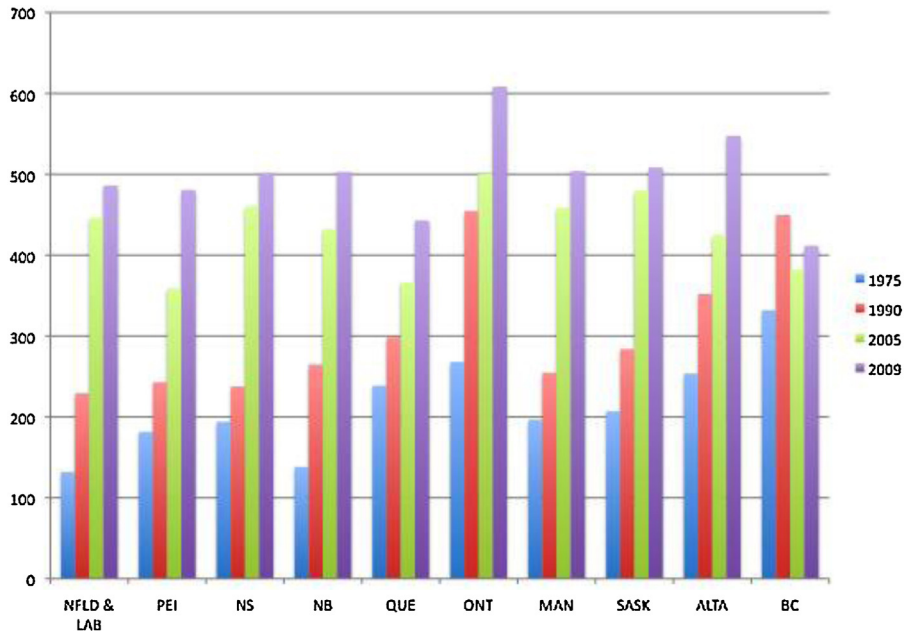


Fig. 1. Real per capita provincial government physician expenditures, 1975–2009 (1997 dollars; data source: Canadian Institute for Health Information).

cost driver in provincial government health expenditures. Province level data is used to estimate a regression model of health expenditure determinants with physician supply as a key variable, while controlling for confounding factors. More importantly, separate regression models are run by health expenditure category to examine the differential effect of physician numbers across health expenditure categories with the physician numbers broken up into family and specialist physicians. The results pinpoint the expenditure categories where physician numbers have had their greatest impact on the provincial government systems of health expenditures.

The results show that physician numbers are a positive and significant driver of provincial government health care spending but the overall contribution to real per capita spending is relatively small for most provinces. However, there are larger differences across provinces when separate expenditure categories are considered which means there are no one size fits all approaches to restraining physician health expenditures. This variation within the Canadian federation can provide a parallel to international diversity in health systems and expenditures but within the simplifying framework of a common currency and labor market. The broader implication is that public policy approaches to restraining rising health expenditures that emphasize physician numbers and their gatekeeper role in the health care system should more carefully re-consider their cost driver role within the context of their own health systems.

1.1. Physicians as cost drivers in the health care system

CIHI national health expenditure data reports that[4] provincial and territorial governments' nominal health expenditure per capita is expected to average $3870 in 2012. The highest per capita spending among the provinces is projected to be in Newfoundland and Labrador ($5190) and Alberta ($4606), while the lowest is forecast to be in Quebec ($3513) and British Columbia ($3690). Rising real per capita spending since 1975 has occurred in three phases – a period of increase from 1975 to 1990, a period of retrenchment from 1990 to 1996 and then a period of even steeper increases since 1996.

Indeed, the period from 1998 to 2008 saw Canadian public health care spending grow at an average of 7.4 percent annually – double the rate of government revenue.[5] This period saw rapidly growing health expenditures driven by cost drivers such as population aging, general inflation, rising physician and health professional remuneration, changes in prescription drug costs driven by volume and mix, and utilization of new diagnostic technologies.[6] However, these rising costs and expenditures were also accompanied by new resources in the form of rising provincial government own-source revenues, increases in federal transfer payments in the wake of the 2004 Health Accord[7]

[4] CIHI, National Health Expenditure Trends [20].

[5] CIHI, Health Care Cost Drivers: The Facts [21].

[6] CIHI, Health Care Cost Drivers: The Facts [21]. See also Di Matteo [23].

[7] The 2003 First Minister's Health Accord led to the implementation of 2004 Health Accord which was a ten year funding plan that emerged in the wake of the Romanow Royal Commission Report and was designed to reinvest in health care in the wake of the restraint of the 1990s so as to buy transformative change. See: Health Canada [65] Fact Sheet – 2003 First Ministers Health Accord. http://www.hc-sc.gc.ca/hcs-sss/delivery-prestation/fptcollab/20. From 2004 to 2014, the Federal government provided the provinces and territories with additional funding totaling 41.3 billion dollars the bulk of which was through 6 percent annual increases in the Canada Health Transfer. See Standing Senate Committee on Social Affairs, Science and Technology (2012: 9) [24].

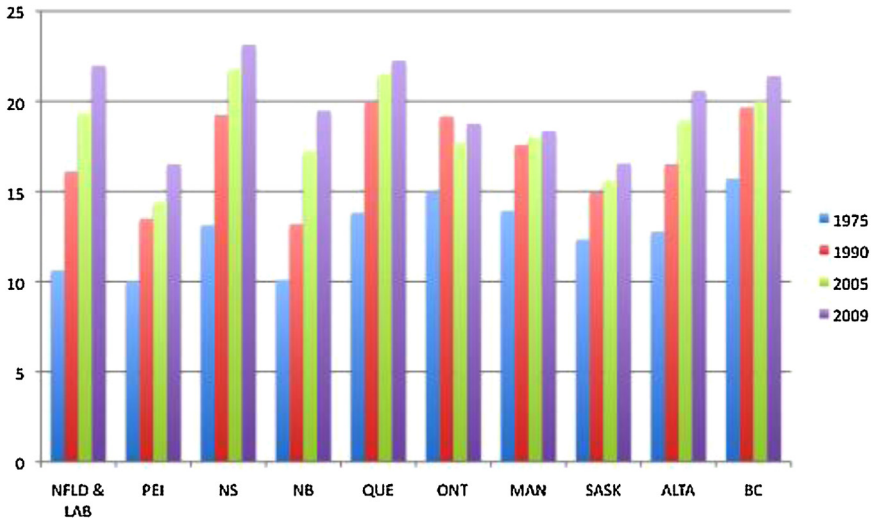


Fig. 2. Total physicians per 10,000 population, Canadian Provinces, 1975–2009 (data source: Canadian Institute for Health Information).

and a fiscal dividend from declining public debt service costs.[8]

Physician spending is the second largest component of provincial government health spending after hospitals averaging 20 percent of spending over the period 1975 to 2009. In 2009, the share of provincial government health spending by physicians ranged from a low of 15 percent in Newfoundland and Labrador to a high of 24 percent in Ontario. As Fig. 1 shows, growth in real per capita provincial government physician spending over time parallels growth in total provincial government health spending but with variation across the provinces. Ontario and British Columbia have traditionally been the largest per capita spenders on physician services but over the last decade while Ontario's spending has further soared, Alberta and Saskatchewan have moved into second and third place, while British Columbia and Quebec have become the lowest per capita spenders.

In 1975, the average number of total physicians per 10,000 of population across the ten provinces was 12.7. This grew to 17.0 by 1990 and increased to only 17.8 by 2000. Growth resumed after 2000 and reached an average of 20.0 in 2009. Fig. 2 shows that in 1975, the total number of physicians per 10,000 of population ranged from a high of 15.7 in British Columbia to a low of 10.0 in Prince Edward Island. By 2009, the high was 23.1 in Nova Scotia and the low was 16.5 in both Prince Edward Island and Saskatchewan.

Real per capita provincial government expenditure (1997 dollars) on physicians rose from an average of 214 dollars in 1975 and reached 499 dollars in 2009 – an increase of 133 percent – while the average for real per capita total provincial government health spending rose from 1149 dollars to 2718 dollars – an increase of 137 percent. Fig. 3 plots real per capita provincial government health expenditures versus the total number of physicians per 10,000 of population and fits a linear trend. The results show a positive relationship between per capita provincial government health spending and per capita physician numbers.

In 2009 there were 68,101 physicians across Canada up from a total of 56,914 in 1999.[9] The increase in supply of physicians, rising fees and the increasing utilization of health care per capita are recognized as important and intertwined factors driving expenditure for physician services. According to the Canadian Institute for Health Information, physician spending has been among the fastest-growing health categories in recent years, increasing at an annual rate of 6.8 percent per year from 1998 to 2008 with more than half of this growth attributable to increases in physician fee schedules and the remainder due to population aging, population growth and rising utilization.[10]

Physician supply is traditionally identified as a driver of health care costs. Indeed, one of the arguments used to restrict medical-school admissions in Canada in the early 1990s was that physicians were in oversupply and a primary cost driver in the health system because of their role as gatekeepers.[11] A key driver of these policies was the research and recommendations of the Barer–Stoddart

[8] Landon et al. [25] for the period 1988/89 to 2003/04 find rising health spending and other government expenditures was funded out of increasing revenues and the fiscal dividend from debt reduction.

[9] CIHI, National Physician Database Release [26].

[10] CIHI, Health Care Cost Drivers: The Facts [21]. By way of comparison, for the United States, Koenig et al. [27] use regression analysis to identify and rank the key contributors to health care costs using state level physician cost data and find that between 1990 and 2000 nominal physician expenditures per capita grew 4.7% annually. Forty-two percent of this growth was attributable to general price inflation as measured by the gross domestic product price deflator. Next were general economic variables at 17%, followed by physician supply and provider structure (12%) and technology and treatment patterns (11%). The remaining 18 percent was contributed by operating costs, health status, healthcare regulation, and health insurance benefit and product design.

[11] See Tyrell and Dauphinee [28] for a discussion of the growing concern by Canadian government officials in the early to mid-1980s about the growing number of physicians. Also, see Esmail (2011: 13) [29].

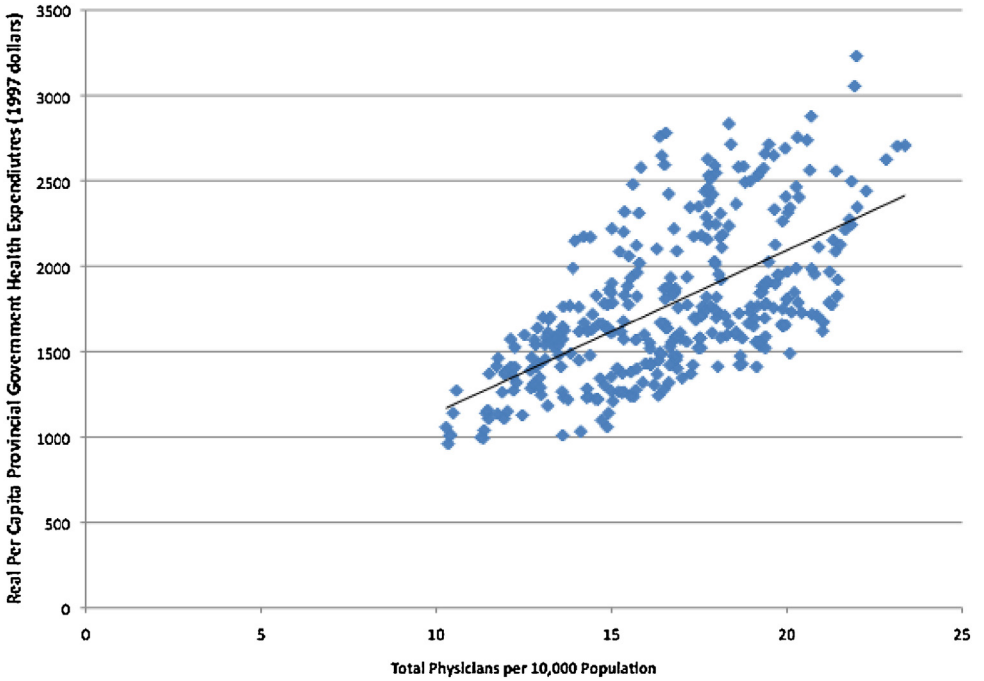


Fig. 3. Real per capita provincial government total health expenditure versus total physicians per 10,000 population, 1975–2009 (with linear trend).

Report [1] which as part of a general strategy also recommended reducing medical school enrollments, reducing the number of provincially funded post-graduate training positions and reducing reliance on foreign trained doctors.

The reduction in medical school admissions in the wake of the Barer–Stoddart report fueled debate on whether or not there indeed was an oversupply of physicians.[12] A report by Denton et al. [2] suggested that for Ontario, even with the reduction in admissions to medical school, there would still be an oversupply of physicians by 2010. Ryten [3] argued that Denton et al., overestimated physician supply and that medical school admission levels were too low.

Evans [4] has argued that this debate obscured the new policy environment in which new ways to deliver medical care to Canadians can be explored. Simply expanding medical school enrollment would foreclose upon these new options. Despite a widespread perception of physician shortages, Evans and McGrail [5] argued that the Barer–Stoddart Report and the associated medical school enrolment cuts did not "create" a physician shortage. The physician to population ratio has been stable since 1989 and with rising per capita physician service spending, the current expansion of enrolments threaten future fiscal problems as well as preempt any significant system reforms.[13]

After the period of relative stability in per capita physician numbers during the 1990s, recent physician supply growth is substantial and contrary to the perception of shortage. Chan [6] documents how the perception of oversupply evolved into one of shortage and suggests factors driving the perception of shortages may include the decline in family practice training positions relative to specialists, reduced flexibility in the physician pool and changes in the comprehensiveness of care with fewer family physicians working in hospital emergency departments or hospital wards. As well, there are changes in physician practices, which have resulted in physicians, particularly younger ones, working fewer hours. Watson et al. [7] and Crossley et al. [8] both find declines in the self-reported average weekly hours of direct patient care suggesting that a decline in work effort rather than physician numbers is what generated the perceptions of a shortage.[14]

The focus on the number of physicians as a cost driver is traditionally linked to the argument that physicians influence the demand for their services – supplier induced demand.[15] Supplier induced demand is where health care providers have and use their superior knowledge to take advantage of the information gap between health care professionals and their patients and thereby influence demand

[12] Medical school admissions in Canada were reduced from a peak of 1894 students in the 1980–81 academic year to 1610 students by 1994–95. See Ryten (1995: 1395) [3].

[13] Indeed, as pointed out by Evans and McGrail (2008: 20) [5] the Barer-Stoddard Report "made 53 recommendations, in an integrated package, and emphasized that "cherry-picking" from this package could easily do more harm than good.

[14] Evans and McGrail (2008: 23) [5]. See also Barer et al. [30].

[15] According to McGuire [31], there are really three mechanisms whereby physicians affect the quantity of care provided to patients. These are: quantity setting of a non-re-tradeable service, influencing demand by setting the level of a non-contractible input ("quality"), and, in an asymmetric-information context, taking an action to influence patient preferences. The third mechanism is known as "physician-induced demand."

for the purposes of self-interest.[16] The underlying notion can be understood as an agency problem in that reliance of the patient on a physician gives the physician a degree of discretionary influence given a licensed physician is a billing physician. Indeed, one of the arguments used to restrict medical school admissions in Canada in the early 1990s was that physicians were a primary cost driver in the health system because of their role as gatekeepers. Reducing the number of physicians and augmenting or replacing their services with nurse practitioners was seen as a way of reducing costs.[17]

Folland et al. (2010: 299–304) [9] provide a simple supply and demand model of supplier induced demand. This is useful as a starting point in framing the analysis despite the absence of a "demand curve" relationship between fees and demand in the Canadian context. Starting out at an initial equilibrium of price and quantity of physician services, an increase in the supply of physicians would either increase or decrease total physician expenditure depending on the elasticity of the demand curve. However, in response to the fall in price, should physicians use their discretionary influence to raise the demand for medical services, then they could shift the demand curve to the right and increase total expenditure on physician services. In extreme cases, one could raise total expenditure as well as raise the price above the original equilibrium.

The new equilibrium fee could be higher or lower but the case with a higher equilibrium fee has come to be called the Uwe Reinhardt "fee test" of inducement. Under this test, evidence that fee increases follow physician supply increases is viewed as support for supplier induced demand. However, such a test is difficult to conduct in health care systems where fees and prices are administered or regulated. As a result, most of the early empirical support for SID came not from Reinhardt-type tests but from studies showing a positive correlation between physician availability and utilization rates as well as studies that look at geographic variations in surgery rates.

For example, Evans [10] finds a negative relationship between the number of physician services per patient and the number of patients per physician. Escarce [11] finds that 43 percent of variation in rates of cataract surgery is explained by socio-economic variables of income, educational level and number of physicians but attributes the remainder of the variation to a residual which is ascribed to physician practice style. Norregaard et al. [12] employ international data and find differences in cataract surgery rates and ascribe the differences to socio-demographic differences, access to care, patient demand and surgeon's willingness to operate.

Delattre and Dormont [13] examine the existence of physician-induced demand (PID) for French physicians using a representative sample of 4500 self-employed French physicians over the 1979–1993 period. These physicians received a fee-for-service payment but the fees were controlled. They show that physicians experience a decline of the number of consultations when they face an increase in the physician to population ratio. However this decrease is very slight and physicians counterbalance the fall in the number of consultations by an increase in the volume of care delivered in each encounter providing support for the existence of PID in the French system for ambulatory care. Given the controlled fees, the implication of an increase in the volume of care results in increased expenditures thus implying a relationship between an increase in the physician to population ratio and total expenditures.

Filippini et al. [14] find that in addition to an assortment of confounding socio-economic variables, the density of medical practices is a positive and significant determinant of outpatient antibiotic consumption. Crivellei et al. [15] using regional data for 26 Swiss cantons find that a larger share of old people tends to increase health costs and that physicians paid on a fee-for-service basis swell expenditures, thus highlighting the presence of supply-induced demand.

An empirical approach relating the supply of physicians to either utilization or total health expenditures is more tractable and certainly more relevant in the Canadian case as physician fees and compensation are highly regulated in Canada with price rigidities that mean there is effectively no demand curve relationship. However, there has been change and experimentation physician compensation in Canada in recent years as well as changes in the nature of the physician workforce.

Recent studies suggest Canadian physicians have changed hours of patient care substantially in the last few decades. For example, in 2003, physicians under the age of 45 spent 20 percent less time providing direct patient care than they did in 1982[18]. The increasing proportion of female physicians, who work on average fewer hours than male physicians, can account for some of the trend over this period, but more important was reductions in hours of direct patient care by male physicians.[19] More recently, the 2007 National Physician Survey (2008) revealed that 27.7 percent of Canadian family doctors (FP/GPs) reduced their work hours between 2005 and 2007 and that 33.9 percent of them (37 percent of males, 29.1 percent of females) planned further reductions in their weekly work hours between 2007 and 2009, while only 8.1 percent planned to increase their weekly working hours.[20]

[16] The classic expositions by Shain and Roemer [32] and Roemer [33] were applied to hospital spending. They argued that hospital beds that are built are occupied regardless of whether there are few or many beds per capita. Their research found positive correlations between short-term general hospital beds per 1000 population and hospital days per 1000 population. This phenomenon is described as: "a bed built is a bed filled" and the effect became known as Roemer's Law.

[17] Primary care reforms have sought to create team-based approaches that enhance the complementary role of nurse practitioners as well as generate some potential cost savings by using them for initial screening. Denton et al. [34] estimated for as early as for 1980 that 10 percent of all medical costs could have been saved had nurse practitioners been substituted for physician time in cases where it was safe and feasible. For Ontario and a phase in of nurse practitioners over the 1981–2001 period, Lomas and Stoddart [35] also indicated potential reductions in general practitioners and cost savings.

[18] Buske [64].

[19] Crossley et al. [8].

[20] Jeon and Hurley [36].

On a provincial level, physician fees rather than physician numbers have become a renewed target for expenditure control particularly in Ontario in the wake of the Drummond Report[21] and the spring 2012 provincial budget. Freezing or reducing physician fees may reduce the rate of physician expenditure growth, yet some researchers argue that it may cause rapid increases in the number of services physicians provide, because under fee for service system physicians can regulate their own work patterns and budgets.[22]

One might also expect that greater government control over the levels of physicians spending can be achieved with alternative payment mechanisms for physicians such as salary or capitation. However, the devil is in the implementation details, and there is little to no evidence that such alternative mechanisms actually do much to control costs. The physicians who sign on to these sorts of arrangements may simply tend to be those who believe that they offer an economic advantage. If they offer an economic advantage to the physician, then they cannot simultaneously be effective at controlling costs as generally speaking, the "costs of physicians services are generally equivalent to incomes of physicians."[23]

While salaried mechanisms may reduce the likelihood that unnecessary services will be delivered, they may increase the risk that necessary services may be withheld.[24] Nassiri and Rochaix [16] suggest that when physicians are paid per service provided, they provide more services than when they are given a fixed total payment showing that physicians are sensitive to financial considerations. In order to defend their income, they are prepared to adjust both quantitatively and qualitatively their choice of consultation type. In another study using data from a survey of Canadian physicians, Ferrall et al. [17] showed that physicians who worked under fee-for-service see patients 5.9 more hours each week than physicians who are primarily salaried, yet fee-for-service physicians worked 5.5 h less per week in total.

1.2. Model

To estimate the impact of physician numbers of health expenditures, health expenditures across a number of categories are regressed on physician numbers as well as other confounding factors. A pooled time-series cross-section regression[25] model is estimated for each provincial government health expenditure category of the form:

$$H_{it} = f(\mathrm{PHY}_{it}, Y_{\mathrm{it}}, z_{1it}, z_{2it}, \ldots .z_{nit}) \quad (1)$$

where H_{it} is real per capita government health expenditures of the i-th province at period t, PHY_{it} is the number of physicians of the i-th province at time t, Y_{it} is the per capita income of the i-th province at time t, and z_1 to z_n represent a vector of social, demographic, economic and policy variables of the i-th province at time t which are determinants of H_{it}. These determinants are essentially expenditure-drivers and the literature has identified these key drivers to include population growth, population aging, income growth, inflation and enrichment factors such as technological change as accounted for by time trend.[26]

Specifically, the determinants of real per capita government health spending[27] are real per capita GDP, population, time trend[28], the proportion of population aged 65–69 years, 70–74 years, 75–79 years and the proportion aged 80 years and over,[29] real per capita federal cash transfers[30]

[21] Ontario Government [37] *Commission on the Reform of Ontario's Public Services, Queen's Printer, Ontario*.

[22] Barer et al. [38].

[23] Barer et al. (1988: 2) [38]. As well, another concern with capitation payment or salary is the potential that physicians would work less without the incentives of FFS. Hutchison et al. [39] found that a group of primary care physicians who switched from fee for service to capitation in the 1980s still had the same hospital user rates as colleagues still being paid by fee for service. In another study dealing with surgeons, Stanton and Shortt [40] found the behavior of surgeons receiving negotiated payments instead of fee for service had similar behavior to other surgeons who remained on fee for service.

[24] Blake and Carter [41]. See also Sarma et al. [42,43].

[25] The pooled regression is preferable to single province estimates because pooling allows for a larger sample and more degrees of freedom.

[26] See Constant et al. [44].

[27] For an excellent survey of the international health expenditure determinants literature, see Gerdtham and Jonsson [45]. The first generation of such determinants studies often used international data. See Leu [46], Parkin et al. [47], and Gerdtham et al. [48]. See also Hitiris and Posnett [49], Barros [50], Gerdtham et al. [51], Di Matteo and Di Matteo [52] and Ariste and Carr [53].

[28] A time trend (YEAR) is sometimes used to account for technological change's impact though modeling the impact of technological extension on health care spending can be a complicated issue. If new techniques generate cheaper health procedures, there could be expenditure reductions associated with technological change. Cutler et al. [54] report that between 1983 and 1994, the real quality-adjusted price of heart attack treatments declined at an annual rate of 1.1 percent. At the same time, with expensive new treatments, technological change can be associated with rising health expenditures. Given that technological change occurs over time, a time index is a way to control for the effect of technological change on health expenditures but it is an imperfect one.

[29] An aging population is a source of some debate as to its importance as a health care expenditure driver. For a sample of papers for Canada, see Denton and Spencer [55], Hogan and Hogan [56] and Seshamani and Gray [57]. While aging is seen as a factor in rising health expenditures, its contribution has recently been determined to be relatively small compared to factors such as rising care expectations, time to death, rising input prices and technological extension. There is also a vast international literature on the importance of an aging population on health expenditure impact, which has reached similar conclusions. See Palangkaraya and Yong [58], Bryant et al. [59], Spillman and Lubitz [60], Getzen [61].

[30] The variable is the real per capita value of *total* federal cash transfers as total federal cash transfers are important operating revenue sources for Canada's provincial governments – approximately 20 percent of provincial revenues – though their importance varies across the provinces. About half of federal transfers are specifically marked for health. However, general-purpose transfers like equalization can also be applied to health. It is difficult to separate out the extent of health transfers given the large amount of change in transfer arrangements over time both in dollar amounts as well as institutional arrangements. At present, federal cash transfers to the provinces and territories are provided in four main programs: the Canada Health Transfer (CHT), the Canada Social Transfer (CST), Equalization and the Territorial Formula Financing (TFF) for total federal cash transfer support in 2011–12 of 57.5 billion dollars. The Canada Health Transfer of cash to the provinces has grown steadily from $20.3 billion in 2005 and is expected to reach 30.3 billion in 2013–14 – an annual growth rate of nearly six percent. After 2017, the Canada Health Transfer will increase in line with nominal GDP growth with a floor of 3 percent.

and real per capita provincial debt interest.[31] As well, a set of transfer regime dummy variables is also specified to capture the onset of new federal transfer regimes and programs and a dummy variable for the onset of the Canada Health Act in 1984.[32] Furthermore, the private share of health spending is included to capture the effect of changing private shares on real per capita spending. Inflation is accounted for in all these regressions by using real expenditure data (in 1997 dollars).

The variable for physician numbers is the number of physicians per 10,000 people. The intent is not to capture the effect of the total number of physicians on provincial government health spending but the effect of physician deepening. In other words, what is of interest is not extensive but intensive growth in physicians.[33] As the number of physicians per capita increases, is more spent per capita as a result of the greater relative supply of physicians? The incentives for supplier-induced demand should be stronger if physician numbers increase faster than population – a deepening of physician stock.[34] Moreover, two physician number variables are specified – one for family physicians and the other for specialist physicians in order to separate out any potential differences in effects on expenditures.[35]

Province dummies are also included in the regressions for the provinces to capture time invariant regional fixed effects not captured by other variables in the model.

Table 1
Regression variables.

Dependent variables
Real per capita health expenditures in 1997 dollars deflated using the Government current expenditure implicit Price Index.
Real per capita provincial government total health expenditures.
Real per capita provincial government hospital expenditures.
Real per capita provincial government other institutions expenditures.
Real per capita provincial government physician expenditure
Real per capita provincial government other professionals expenditure.
Real per capita provincial government drug expenditure.
Real per capita provincial government capital expenditure.
Real per capita provincial government public health expenditure.
Real per capita provincial government health administration expenditure.
Real per capita provincial government all other health expenditure.
Independent variables
Number of family physicians per 10,000 population.
Number of specialist physicians per 10,000 population.
Real per capita gross domestic product in 1997 dollars. Deflated using the Government Current Expenditure Implicit Price Index.
Real per capita Federal Cash Transfer Revenues. In 1997 dollars, deflated using the Government Current Expenditure Implicit Price Index.
Real per capita provincial government own source revenue (1997 dollars).
Real per capita provincial government debt interest (1997 dollars).
Proportion of population aged 65–69.
Proportion of population aged 70–74.
Proportion of population aged 75–79.
Proportion of population aged 80–84.
Proportion of population aged 85 or greater.
1 if Newfoundland & Labrador, 0 otherwise.
1 if Prince Edward Island, 0 otherwise
1 if Nova Scotia, 0 otherwise.
1 if New Brunswick, 0 otherwise.
1 if Quebec, 0 otherwise.
1 if Ontario, 0 otherwise.
1 if Manitoba, 0 otherwise.
1 if Saskatchewan, 0 otherwise.
1 if Alberta, 0 otherwise.
1 if British Columbia, 0 otherwise.
Provincial Population (thousands).
Private sector proportion of health expenditure.
Canada Health Act. 1 if Canada Health Act in effect (1984–2009), 0 otherwise.
Established Program Financing. 1 if Established Program Financing in effect (1977–1995), 0 otherwise.
Canada Health and Social Transfer. 1 if combined Canada Health and Social Transfer in effect (1996–2004), 0 otherwise.
Canada Health Transfer. 1 if Canada Health Transfer/Canada Social Transfer are separate (in effect 2005–2009), 0 otherwise.
Medical School Enrollment Restrictions. 1 if period with reduction in medical school admissions and enrollment reductions (1992–1998), 0 otherwise.
Year (defined as a time indicator variable running from 1 to 35).

Changes in physician labor market characteristics, fee schedules and payment methods invariably complicate the analysis of the effect of physician numbers of spending and the changes can vary across the provinces making provincial fixed effects important considerations.

The variables are defined in Table 1. The data for these regression variables were obtained from the National Health Expenditure database constructed by the Canadian

[31] Balanced budgets after the mid 1990s opened up a fiscal dividend that enabled provinces to spend more on health, even while lowering income and corporate taxes. See Landon et al. [25].

[32] Over the years a number of regime changes have occurred with respect to transfers. In 1977, there was the onset of Established Program Financing (EPF), which replaced federal-provincial cost sharing on health with a block grant. In 1984 there was the onset of the Canada Health Act (CHA), which tied the receipt of federal transfers to running a health care system that met basic conditions. In 1996, EPF and the Canada Assistance Plan, which funded income support, were collapsed into one transfer (and the cash portion reduced by one-third). This new transfer was called the Canada Health and Social Transfer (CHST). Finally, in 2005 the CHST was broken up into two transfer payments – the Canada Health Transfer and the Canada Social Transfer.

[33] Extensive growth measures the increase in the absolute or total number of physicians. Intensive growth measures the increase in physicians per capita. Any growth in physicians numbers should take population growth into account hence making per capita measures of physician supply and their growth – intensive growth – more relevant.

[34] Another way to assess the impact of physicians as a cost driver would be to estimate the multiplicative effect of physician expenditures on total health expenditures via their role as gatekeepers. Thus total provincial government health spending (H) would be equal to aP where P is provincial government expenditure on physicians and a is the physician expenditure multiplier. Over the period 1975–2009, the value of "a" has averaged between 5 and 6 across the provinces with a slight decline over time. However, "a" would be multiplying the effect of fees, the volume of services as well as the number of doctors. As a result, a physician per capita variable is a more appropriate approach to isolating the effect.

[35] It should be noted that even including family and specialist physician variables is unable to fully adjust for variations in the intensity of clinical activity by physicians over time as well as the possible interaction effects between specialist and general practitioners in regions where there are few specialists available. For example, as a physician population ages, clinical hours of work may change as older physicians move increasingly to change their mix of activities. This would not be reflected in the crude count of physician supply used here, which could then bias the apparent marginal impact of changes in physician supply on per capita expenditures on physician (and other types of health care) services.

Table 2
Regression estimates for determinants of real per capita provincial government total health expenditures in specifications I to VI.[a]

	I		II		III		IV		V		VI	
	Coeff	*z*	Coeff	*z*	Coeff	*z*	Coeff	*z*	Coeff	*z*	Coeff	*z*
Family physicians per 10,000 population	***40.00***	***4.96***	***85.54***	***9.84***	***58.10***	***7.38***	***29.14***	***3.68***	***18.00***	***2.58***	7.91	1.08
Specialist physicians per 10,000 population	***48.67***	***5.18***	***95.55***	***10.19***	***68.73***	***8.96***	***23.05***	***2.19***	***39.62***	***4.07***	6.33	0.67
Real per capita GDP			***0.01***	***5.73***	***0.01***	***3.67***	***0.01***	***4.22***	***0.01***	***2.29***	0.00	1.69
Real per capita Federal Cash Transfer Revenues			***0.05***	***3.55***	***0.06***	***4.24***	−0.03	−1.94	0.02	1.25	0.00	0.21
Real per capita provincial government own-source revenues			0.01	1.22	***0.02***	***2.05***	−0.01	−0.66	0.00	0.33	0.00	−0.32
Real per capita provincial government debt interest			−0.04	−1.00	−0.02	−0.41	***−0.20***	***−5.10***	***−0.15***	***−4.22***	***−0.16***	***−4.57***
Proportion of population aged 65–69					4594.21	1.14	***14,804.64***	***3.76***	***10,474.42***	***3.36***	***13,174.13***	***3.85***
Proportion of population aged 70–74					***−21,405.22***	***−3.80***	4537.33	0.87	−6986.31	−1.63	−2689.60	−0.61
Proportion of population aged 75–79					9195.96	1.31	***13,520.15***	***2.15***	***−14,800.88***	***−2.65***	***−13,701.35***	***−2.43***
Proportion of population aged 80–84					***36,840.24***	***3.87***	***21,528.98***	***2.59***	***21,728.81***	***3.02***	1358.24	0.17
Proportion of population aged 85 and over					14,976.70	1.87	***59,222.76***	***8.15***	***16,139.52***	***2.16***	14,217.20	1.46
Newfoundland & Labrador							***422.96***	***4.83***	65.77	0.59	***1231.79***	***2.65***
Prince Edward Island							***−321.11***	***−2.83***	−127.33	−0.99	***1469.03***	***3.21***
Nova Scotia							***−301.29***	***−3.40***	−194.10	−1.87	***1140.24***	***2.70***
New Brunswick							−49.76	−0.53	−116.61	−1.01	***1156.41***	***2.64***
Quebec							80.37	0.72	***−108.27***	***−2.22***	***397.96***	***3.25***
Manitoba							−158.02	−1.85	−67.18	−0.71	***1220.44***	***3.01***
Saskatchewan							***−354.30***	***−3.13***	−32.33	−0.30	***1351.93***	***3.26***
Alberta							***378.40***	***3.64***	27.27	0.32	***1285.52***	***3.40***
British Columbia							***−185.18***	***−2.13***	−59.56	−0.75	***1138.49***	***3.51***
Provincial Population									−0.01	−0.82	***0.19***	***3.24***
Private sector proportion of health spending									***−998.35***	***−6.05***	***−1074.23***	***−6.17***
Canada Health Act									−9.87	0.48	−8.29	−0.37
Established Program Financing									−28.44	1.35	−33.12	−1.46
Canada Health and Social Transfer									***−109.53***	***−3.47***	***−114.76***	***−3.46***
Canada Health Transfer/Canada Social Transfer separate									−74.84	1.90	−80.94	−1.92
Medical School Enrollment Restrictions									***−67.18***	***−4.52***	***−73.72***	***−4.80***
Year									***34.20***	***12.11***		
Newfoundland & Labrador × Year											***57.15***	***8.99***
Prince Edward Island × Year											***37.66***	***10.70***
Nova Scotia × Year											***49.58***	***9.75***
New Brunswick × Year											***48.94***	***9.33***
Quebec × Year											***26.16***	***4.01***
Ontario × Year											***13.64***	***1.31***
Manitoba × Year											***49.97***	***11.26***
Saskatchewan × Year											***42.22***	***7.84***
Alberta × Year											***26.82***	***4.79***
British Columbia × Year											***27.70***	***4.38***
Constant	***659.18***	***5.88***	191.10	−1.94	−52.25	−0.53	***−702.70***	***−6.42***	***710.42***	***5.77***	−475.29	−0.87
Wald chi^2 statistic	43.61		423.23		650.73		2954.62		3560.78		4369.85	

[a] Bold italics denote significant at the 5 percent level.

Institute for Health Information[36] and also from CANSIM-Statistics Canada and the Federal Fiscal Reference Tables. [37] The estimation package is STATA 11 and testing was conducted on the data.

[36] Physician numbers were also obtained from the Canadian Institute for Health Information National Physician Database. See also Canadian Institute for Health Information [19].

[37] More specific details on the variable sources are available in Di Matteo [23], Appendix II.

Table 3
Regression estimates for determinants of real per capita provincial government health expenditures by category[a] (specification V from Table 2).

	I		II		III		IV		V	
	Hospitals		Other institutions		Physicians		Other professionals		Drugs	
	Coeff	*z*	Coeff	*z*	Coeff	*z*	Coeff	*z*	Coeff	*z*
Family physicians per 10,000 population	**9.22**	***2.13***	0.13	0.07	**6.41**	***4.05***	0.45	1.66	−0.13	−0.21
Specialist physicians per 10,000 population	**15.49**	***2.66***	0.99	0.41	**12.03**	***5.70***	0.07	0.20	−0.87	−1.04
Real per capita GDP	0.00	1.88	0.00	−1.26	0.00	0.64	0.00	1.21	**0.00**	***−2.40***
Real per capita Federal Cash Transfer Revenues	0.00	0.00	**0.01**	***3.56***	0.00	1.02	0.00	−0.41	**0.00**	***4.89***
Real per capita provincial government own-source revenues	0.01	1.64	0.00	0.96	0.00	−1.01	0.00	−0.89	**0.00**	***3.38***
Real per capita provincial government debt interest	**−0.07**	***−3.84***	0.00	−0.47	**−0.04**	***−5.72***	**0.00**	***2.89***	**−0.03**	***−7.31***
Proportion of population aged 65–69	**13,123.36**	***7.66***	**1907.60**	***2.04***	757.10	1.10	**696.06**	***5.37***	444.10	1.51
Proportion of population aged 70–74	940.81	0.36	**3300.72**	***2.84***	−226.77	−0.23	−81.79	−0.44	403.43	1.09
Proportion of population aged 75–79	**−10,078.26**	***−3.10***	**5334.52**	***3.74***	−1769.09	−1.54	**−505.38**	***−2.32***	715.79	1.58
Proportion of population aged 80–84	**12,388.32**	***3.03***	**6850.49**	***3.45***	−1371.10	−0.90	**−1150.39**	***−3.75***	**3143.53**	***5.58***
Proportion of population aged 85 and over	−6116.68	−1.50	**9710.15**	***3.97***	**9671.22**	***5.39***	**−1508.21**	***−3.98***	748.75	0.96
Newfoundland & Labrador	**−159.84**	***−2.02***	**−172.54**	***−4.48***	**−214.74**	***−4.31***	11.63	1.68	120.68	***12.73***
Prince Edward Island	**−277.74**	***−3.23***	**−394.09**	***−8.63***	**−251.40**	***−4.70***	**34.01**	***4.50***	**66.52**	***5.70***
Nova Scotia	**−264.89**	***−3.61***	**−349.14**	***−8.16***	**−231.40**	***−4.81***	**23.60**	***3.73***	**115.03**	***11.14***
New Brunswick	**−219.42**	***−2.82***	**−371.71**	***−8.65***	**−209.36**	***−4.27***	**14.71**	***2.15***	**96.58**	***9.51***
Quebec	**−124.11**	***−2.60***	**−55.23**	***−2.81***	**−148.50**	***−6.81***	**7.55**	***2.55***	**44.19**	***2.95***
Manitoba	**−245.37**	***−3.68***	**−287.42**	***−7.59***	**−215.97**	***−4.65***	**29.13**	***4.65***	**83.59**	***8.99***
Saskatchewan	**−318.64**	***−4.37***	**−346.56**	***−6.83***	**−195.28**	***−4.07***	**46.47**	***6.82***	**100.13**	***7.26***
Alberta	**−174.62**	***−2.82***	**−166.37**	***−5.55***	**−138.68**	***−3.31***	**36.92**	***5.06***	**96.01**	***12.45***
British Columbia	**−285.77**	***−4.94***	**−296.55**	***−4.29***	7.15	0.13	**33.99**	***6.52***	251.93	3.20
Provincial Population	**−0.04**	***−5.26***	**−0.03**	***−8.65***	**−0.01**	***−2.25***	**0.00**	***3.61***	**0.01**	***17.09***
Private sector proportion of health spending	−167.08	−1.90	**−164.97**	***−4.28***	**−79.29**	***−2.46***	−5.00	−0.92	−18.64	−1.50
Canada Health Act	5.13	0.47	−6.82	−1.63	−2.52	−0.70	0.25	0.36	−1.42	−0.79
Established Program Financing	**−27.36**	***−2.53***	1.03	0.25	**−9.22**	***−2.64***	0.84	1.24	−3.38	−1.92
Canada Health and Social Transfer	**−69.05**	***−4.42***	**12.76**	***2.08***	**−13.52**	***−2.70***	0.30	0.30	**−9.56**	***−3.72***
Canada Health Transfer/Canada Social Transfer separate	**−50.63**	***−2.53***	12.93	1.67	**−8.76**	−1.36	−0.33	−0.26	−5.58	−4.37
Medical School Enrollment Restrictions	−11.23	−1.49	−5.72	−1.90	**−7.05**	***−2.84***	−0.61	−1.25	**−5.55**	***−1.71***
Year	**11.41**	***6.59***	−1.21	−1.33	**4.96**	***6.51***	**0.47**	***3.00***	**3.56**	***12.78***
Constant	416.38	4.40	70.08	1.42	**4.96**	***5.51***	**0.65**	***0.07***	**−155.48**	***11.23***
Wald chi^2 statistic	1612.21		904.63		4270.41		568.59		6357.39	

	VI		VII		VIII		IX	
	Capital		Public health		Administration		All other health	
	Coeff	*z*	Coeff	*z*	Coeff	*z*	Coeff	*z*
Family physicians per 10.000 population	−0.72	−0.26	−1.42	−1.16	0.25	0.57	−0.44	−0.52
Specialist physicians per 10.000 population	**−8.45**	***−2.27***	−2.43	−1.40	0.43	0.67	−0.84	−0.79
Real per capita GDP	**0.00**	***3.06***	**0.00**	***5.15***	0.00	0.34	0.00	1.86
Real per capita Federal Cash Transfer Revenues	−0.01	−1.60	0.00	0.87	**0.00**	***2.31***	**0.00**	***−2.98***
Real per capita provincial government own-source revenues	−0.01	−1.76	**0.00**	***−1.99***	**0.00**	***2.20***	**0.00**	***−2.96***
Real per capita provincial government debt interest	0.00	−0.05	**−0.03**	***−4.15***	0.00	−1.31	0.00	0.61
Proportion of population aged 65–69	−953.10	−0.92	**−2137.16**	***−3.88***	260.00	1.08	**−1009.54**	***−2.86***

Table 3 (*Continued*)

	VI		VII		VIII		IX	
	Capital		Public health		Administration		All other health	
	Coeff	*z*	Coeff	*z*	Coeff	*z*	Coeff	*z*
Proportion of population aged 70–74	387.76	0.28	−615.94	−0.77	−322.22	−1.01	**−3083.78**	***−5.98***
Proportion of population aged 75–79	−278.89	−0.15	436.49	0.44	−570.15	−1.37	**1643.30**	***2.65***
Proportion of population aged 80–84	832.08	0.34	−2379.45	−1.79	941.38	1.81	**−2621.22**	***−3.09***
Proportion of population aged 85 and over	4169.45	1.42	**4416.43**	***2.78***	**−2945.39**	***−4.78***	**7093.27**	***7.52***
Newfoundland & Labrador	**117.67**	***2.59***	**199.62**	***8.08***	**−69.79**	***−6.46***	**137.18**	***3.35***
Prince Edward Island	95.71	1.92	**222.37**	***7.92***	**−29.96**	***−2.62***	**133.28**	***3.11***
Nova Scotia	**111.74**	***3.00***	**175.12**	***7.68***	**−38.55**	***−2.88***	**124.06**	***3.21***
New Brunswick	**99.64**	***2.25***	**183.58**	***7.61***	**−55.46**	***−5.52***	**156.09**	***3.57***
Quebec	**64.75**	***3.96***	**76.72**	***7.25***	**−10.94**	***−2.33***	−10.42	−0.42
Manitoba	63.34	1.83	**206.50**	***9.87***	**−45.85**	***−4.78***	**162.61**	***4.39***
Saskatchewan	49.75	1.15	**246.65**	***10.03***	**−46.83**	***−5.00***	**142.66**	***3.70***
Alberta	**97.76**	***2.36***	**182.97**	***8.66***	**−54.69**	***−6.08***	**107.88**	***3.23***
British Columbia	**73.24**	***2.80***	**164.35**	***9.98***	**−28.22**	***−3.80***	**122.56**	***4.06***
Provincial Population	**0.01**	***2.45***	**0.02**	***9.67***	**−0.01**	***−6.39***	**0.02**	***4.63***
Private sector proportion of health spending	**−330.97**	***−5.40***	−18.32	−0.59	−10.20	−1.00	8.64	0.48
Canada Health Act	−7.00	−1.45	−1.43	−0.59	−2.01	−1.65	0.23	0.16
Established Program Financing	−2.95	−0.61	3.62	1.49	**−2.75**	***−2.25***	1.76	1.21
Canada Health and Social Transfer	**−16.06**	***−2.31***	3.24	0.95	−2.62	−1.49	−1.47	−0.70
Canada Health Transfer/Canada Social Transfer separate	−8.51	−0.96	**11.26**	***2.54***	−1.00	−0.44	−4.00	−1.51
Medical School Enrollment Restrictions	**−15.39**	***−4.55***	**−4.10**	***−2.38***	**−2.48**	***−2.92***	−0.20	−0.19
Year	2.32	1.71	**2.89**	***4.27***	**1.53**	***5.31***	**2.89**	***5.77***
Constant	42.61	0.67	**−106.13**	***−3.12***	**91.38**	***−5.96***	**−83.95**	***−1.83***
Wald chi^2 statistic	383.17		2442.48		389.05		1542.2	

[a] Bold italics denotes significant at 5 percent level.

Normality plots of the key variables at the provincial level found real per capita GDP and transfers to be highly normally distributed while population and the proportion aged 65 and over were less likely to be so. Levin–Lin–Chu and Harris–Tzavalis[38] unit root tests for panel data with panel means and time trend both included and excluded were conducted for the variables in the data set and many of the variables exhibited a high degree of stationarity with the null hypothesis of a unit root being rejected for most of the variables.

As well, Westerlund [18] tests for co-integration in panel data performed for earlier specifications rejected the null hypothesis of no co-integration, meaning that there was co-integration and the regressions were not spurious. These tests were for each of the expenditure categories but on only six variables (the limit of the STATA module employed): total physicians per 10,000 population, real per capita GDP, population, real per capita federal cash transfers, proportion of population aged over 65 years and real per capita provincial own source revenues.

Box-Cox testing found the linear specification for real per capita total provincial government health spending to be more suitable than log-linear.[39] A Ramsay-Rest test on the same variables used in the Box-Cox test could not reject the null hypothesis that the model has no omitted variables. Finally, Hausman test statistics supported use of fixed-effects versus a random effects model and therefore a specification with province dummies was retained.

2. Results

The estimates are pooled time series cross sections using GLS, assuming heteroskedastic panels with cross-sectional correlation and panel specific ar(1) and the results are presented in Tables 2 and 3. Table 2 presents results for real per capita total provincial government health spending and does it for six specifications. These specifications range from most restrictive, which includes only the physician number variables and a constant (I), to

[38] The Levin–Lin–Chu test requires that the ratio of the number of panels to time periods tend to zero asymptotically and does not suit datasets with a large number of panels and relatively few time periods. The Harris–Tzavalis test assumes that the number of panels tends to infinity while the number of time periods is fixed. This data set has a small number of panels (10) and a fixed number of time periods. It should be noted that panel test outcomes are often difficult to interpret if the null of the unit root is rejected and the best that can often be concluded is that "a significant fraction of the cross section units is stationary or cointegrated". See Breitung and Pesaran [62].

[39] Box-Cox testing was performed by regressing a real per capita health expenditure variable on the variables of the model. Value of theta was 0.31.

Table 4
Regression estimates for determinants of real per capita provincial government health expenditures by category[a] (specification VI from Table 2).

	I		II		III		IV		V	
	Hospitals		Other institutions		Physicians		Other professionals		Drugs	
	Coeff	z	Coeff	z	Coeff	z	Coeff	z	Coeff	z
Family physicians per 10,000 population	4.85	1.15	−1.31	−0.71	***8.82***	***5.25***	0.23	0.85	***−1.62***	***−2.18***
Specialist physicians per 10,000 population	***13.18***	***2.65***	−2.14	−0.90	***9.73***	***4.40***	0.20	0.57	***−2.65***	***−2.83***
Real per capita GDP	0.00	1.26	0.00	−1.38	0.00	0.66	***0.00***	***2.27***	***0.00***	***−2.46***
Real per capita Federal Cash Transfer Revenues	−0.01	−1.58	***0.01***	***3.52***	0.00	0.15	0.00	−1.21	***0.01***	***5.25***
Real per capita provincial government own-source revenues	0.00	0.17	0.00	0.11	***0.00***	***−1.97***	0.00	−1.59	***0.00***	***3.05***
Real per capita provincial government debt interest	***−0.06***	***−3.30***	−0.01	−1.15	***−0.03***	***−3.67***	***0.00***	***1.99***	***−0.04***	***−8.06***
Proportion of population aged 65–69	***8536.37***	***4.35***	1169.14	1.30	−115.16	−0.15	***878.22***	***6.37***	***998.81***	***3.04***
Proportion of population aged 70–74	−3185.26	−1.20	1963.35	1.71	−403.53	0.39	−4.04	−0.02	539.66	1.32
Proportion of population aged 75–79	***−10,615.40***	***−3.30***	1058.44	0.75	−2002.47	−1.57	***−649.60***	***−2.79***	683.50	1.33
Proportion of population aged 80–84	4773.42	1.19	−3351.30	−1.69	***−4670.29***	***−2.50***	***−1186.35***	***−3.69***	***3345.72***	***4.57***
Proportion of population aged 85 and over	10.35	0.00	4142.76	1.69	***11,703.70***	***5.34***	***−2798.49***	***−6.93***	***−1763.93***	***−2.15***
Newfoundland & Labrador	344.28	1.19	36.65	0.24	−281.38	1.36	11.83	0.35	***149.60***	***2.94***
Prince Edward Island	455.10	1.61	99.62	0.66	−274.83	−1.34	45.14	1.30	***102.28***	***2.07***
Nova Scotia	355.62	1.35	−28.89	−0.21	−252.86	−1.32	25.33	0.80	***134.71***	***2.93***
New Brunswick	329.92	1.21	43.52	0.30	−253.94	−1.28	8.35	0.26	***135.19***	***2.83***
Quebec	***189.52***	***2.38***	−7.84	−0.17	69.41	1.26	5.56	0.61	***28.80***	***2.03***
Manitoba	373.19	1.48	113.42	0.84	−246.25	−1.33	25.58	0.83	***119.79***	***2.69***
Saskatchewan	434.47	1.71	67.75	0.49	−215.52	−1.16	47.75	1.54	***157.39***	***3.44***
Alberta	358.99	1.52	119.74	0.96	−169.52	−0.99	40.55	1.40	***122. 68***	***2.96***
British Columbia	193.11	0.95	86.62	0.73	−15.92	0.10	34.69	1.39	***122.42***	***3.46***
Provincial Population	0.05	1.36	0.02	0.66	−0.02	−0.82	0.00	0.46	***0.02***	***3.14***
Private sector proportion of health spending	−124.59	−1.40	***−102.62***	***−2.64***	−44.70	−1.29	−2.99	−0.53	***−28.20***	***−2.09***
Canada Health Act	−1.56	−0.12	−6.69	−1.72	0.24	0.07	0.47	0.69	−1.75	−0.87
Established Program Financing	***−27.80***	***−2.08***	0.62	0.15	−6.51	−1.84	0.27	0.40	***−4.43***	***−2.21***
Canada Health and Social Transfer	***−86.83***	***−4.53***	10.30	1.75	***−12.39***	***−2.47***	−0.51	−0.53	***−13.03***	***−4.20***
Canada Health Transfer/Canada Social Transfer separate	***−59.07***	***−2.38***	10.91	1.47	−11.07	−1.73	−0.49	−0.40	−6.53	−1.66
Medical School Enrollment Restrictions	−13.67	−1.61	***−5.71***	***−2.01***	***−4.84***	***−1.97***	***−1.02***	***−2.20***	***−6.57***	***−4.72***
Newfoundland & Labrador × Year	***23.08***	***7.06***	***12.23***	***6.41***	***7.44***	***4.76***	***0.79***	***2.91***	***4.61***	***6.64***
Prince Edward Island × Year	***13.58***	***6.55***	***3.44***	***3.49***	***5.48***	***5.99***	***0.58***	***3.57***	***4.66***	***12.26***
Nova Scotia × Year	***16.99***	***5.66***	***8.92***	***6.01***	***5.65***	***3.82***	***0.93***	***3.96***	***5.73***	***8.43***
New Brunswick × Year	***20.77***	***7.33***	***4.74***	***3.10***	***7.12***	***4.96***	***1.35***	***5.40***	***4.16***	***6.55***
Quebec × Year	3.31	0.82	***6.13***	***2.72***	3.96	1.82	***0.96***	***2.46***	***5.49***	***6.54***
Ontario × Year	1.84	0.28	−0.56	−0.17	***10.85***	***2.49***	0.93	1.29	***3.61***	***3.03***
Manitoba × Year	***15.67***	***5.96***	***6.07***	***4.93***	***6.54***	***5.09***	***1.35***	***6.02***	***4.90***	***7.98***
Saskatchewan × Year	***8.55***	***2.86***	***7.86***	***4.64***	***5.84***	***4.44***	***1.20***	***4.46***	***3.55***	***4.39***
Alberta × Year	***8.42***	***2.29***	−0.03	−0.02	***6.98***	***3.15***	0.51	1.13	***4.25***	***6.19***
British Columbia × Year	***12.24***	***3.15***	1.45	0.54	0.15	0.05	***0.91***	***2.18***	***2.32***	***2.91***
Constant	96.69	0.29	−36.29	−0.20	343.43	1.44	4.64	0.12	***−170.67***	***−2.77***
Wald chi^2 statistic	3734.76		1894.62		3065.31		1267.96		12,685.09	

	VI		VII		VIII		IX	
	Capital		Public health		Administration		All other health	
	Coeff	z	Coeff	z	Coeff	z	Coeff	z
Family physicians per 10,000 population	1.60	0.52	0.53	0.44	−0.36	−0.87	0.55	0.76
Specialist physicians per 10,000 population	−3.35	−0.76	−0.54	−0.32	−0.08	−0.15	0.29	0.31
Real per capita GDP	***0.00***	***3.41***	***0.00***	***4.90***	0.00	0.05	***0.00***	***3.59***

Table 4 (*Continued*)

	VI		VII		VIII		IX	
	Capital		Public health		Administration		All other health	
	Coeff	*z*	Coeff	*z*	Coeff	*z*	Coeff	*z*
Real per capita Federal Cash Transfer Revenues	−0.01	−1.44	0.00	1.64	***0.00***	***2.52***	***0.00***	***−3.24***
Real per capita provincial government own-source revenues	0.00	−1.30	0.00	−1.30	***0.00***	***2.41***	***0.00***	***−2.79***
Real per capita provincial government debt interest	−0.01	−0.54	***−0.03***	***−4.30***	0.00	−0.98	***−0.01***	***−3.66***
Proportion of population aged 65–69	1525.69	1.37	***−2258.82***	***−4.17***	−19.60	0.09	452.99	1.32
Proportion of population aged 70–74	1836.34	1.11	256.63	0.33	−299.50	1.08	774.85	−1.62
Proportion of population aged 75–79	1673.51	0.86	108.72	0.12	110.40	0.34	***1644.30***	***2.93***
Proportion of population aged 80–84	***8854.11***	***3.13***	***−3738.89***	***−2.82***	757.08	1.73	−327.53	−0.42
Proportion of population aged 85 and over	4214.28	1.18	***6164.72***	***3.77***	−580.74	1.06	***4295.23***	***4.56***
Newfoundland & Labrador	728.04	3.10	***486.80***	***3.61***	63.40	1.87	106.34	1.16
Prince Edward Island	***564.44***	***2.43***	***553.85***	***4.09***	***73.81***	***2.12***	37.15	0.40
Nova Scotia	***575.25***	***2.66***	***491.91***	***3.93***	***62.70***	***1.96***	33.64	0.39
New Brunswick	***639.62***	***2.84***	***495.86***	***3.84***	***64.96***	***1.99***	30.93	0.35
Quebec	***203.66***	***3.17***	***162.99***	***4.61***	***35.42***	***3.74***	20.05	0.77.
Manitoba	***454.31***	***2.19***	***481.95***	***3.99***	***73.09***	***2.40***	33.98	0.41
Saskatchewan	***486.11***	***2.31***	***486.14***	***3.99***	***76.77***	***2.51***	29.03	0.35
Alberta	***552.85***	***2.84***	***416.20***	***3.75***	52.69	1.90	63.85	0.81
British Columbia	***401.07***	***2.40***	***367.89***	***3.80***	***70.95***	***2.89***	18.71	0.28
Provincial Population	***0.07***	***2.46***	***0.06***	***3.51***	***0.01***	***2.45***	0.01	0.68
Private sector proportion of health spending	−356.66	−5.31	42.38	1.44	−10.07	−1.18	4.35	0.25
Canada Health Act	−3.87	−0.74	−0.62	−0.30	−0.87	0.89	0.02	0.02
Established Program Financing	−4.60	−0.87	3.89	1.82	−1.13	−1.15	−0.13	−0.10
Canada Health and Social Transfer	−11.65	−1.53	3.80	1.27	−1.84	−1.29	−2.09	−1.09
Canada Health Transfer/Canada Social Transfer separate	−5.67	−0.58	***11.89***	***3.02***	−1.24	−0.68	−4.62	−1.88
Medical School Enrollment Restrictions	***−15.43***	***−4.41***	***−4.60***	***−3.09***	***−3.02***	***−4.63***	−0.15	−0.16
Newfoundland 6 Labrador × Year	***−7.08***	***−2.91***	***2.89***	***2.74***	***0.82***	***3.19***	−0.90	−1.25
Prince Edward Island × Year	−1.05	−0.59	1.10	1.60	***1.94***	***5.86***	***1.62***	***4.08***
Nova Scotia × Year	***−3.89***	***−1.96***	−0.41	−0.45	***1.40***	***3.99***	***1.64***	***2.54***
New Brunswick × Year	***−6.25***	***2.78***	1.15	1.27	***0.75***	***3.06***	***3.38***	***5.22***
Quebec × Year	***−6.65***	***−2.26***	−0.65	−0.46	−0.49	−1.27	0.62	0.63
Ontario × Year	***−11.76***	***−2.30***	−3.58	−1.26	***−1.46***	***−2.06***	0.77	0.41
Manitoba × Year	−0.90	−0.50	***1.99***	***2.57***	0.19	0.69	***4.49***	***7.95***
Saskatchewan × Year	−3.59	−1.57	***4.58***	***5.14***	−0.30	1.24	***3.26***	***5.35***
Alberta × Year	−5.21	−1.93	1.24	0.95	0.36	1.10	1.61	1.42
British Columbia × Year	***−6.01***	***−2.09***	0.48	0.32	−0.47	−1.07	***4.35***	***3.80***
Constant	***−767.11***	***−2.77***	−478.74	−3.10	−55.23	−1.42	−102.71	−0.97
Wald chi^2 statistic	478.71		4256.83		833.38		6058.47	

[a] Bold italics denotes significant at 5 percent level.

least restrictive, which includes the most confounding factors including province-year interactions (VI). LOWESS profiles for real per capita provincial government health expenditures versus regression fitted values from these specifications are plotted in Fig. 4 and the results suggest that specification VI, which uses an interactive province-year specification rather than year alone as in specification V, provides the best fit. However, the impact of the physician variables in the sixth specification while positive, is much reduced in magnitude of effect and the coefficients are not statistically significant. As a result, the expenditure category results are presented for both the fifth and sixth specifications in Tables 3 and 4[40]

[40] It should also be noted that additional specifications for were run both total health spending and the separate expenditure categories that included a lagged dependent variable. The results generally rendered the physician variables as well as most of the other variables statistically insignificant with the lagged variable becoming positive and very significant – a not uncommon result. Including both a lagged dependent variable and fixed effects complicates the estimation of the model. The lagged dependent variable is controlling for the unobserved effects of a variable

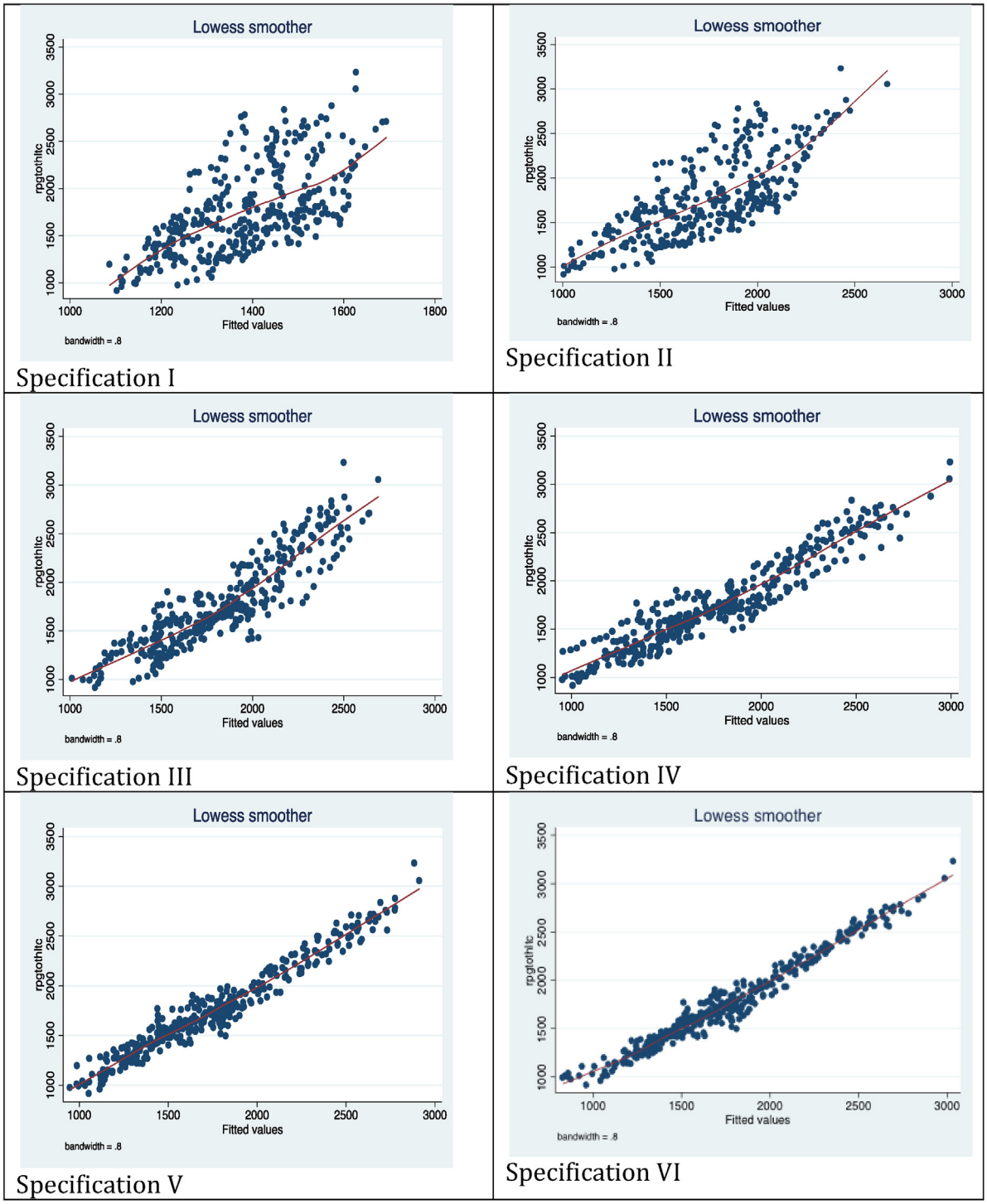
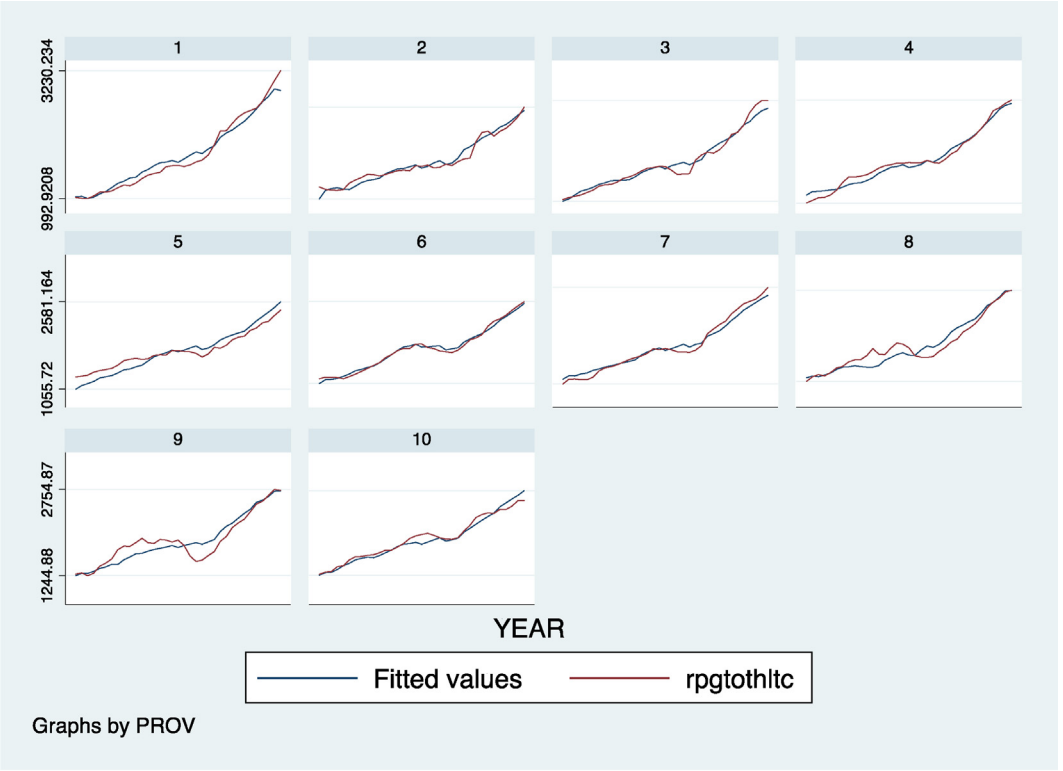


Fig. 4. LOWESS profiles for real per capita provincial government health expenditures versus regression fitted values from specifications.

that follows a time related process. Fixed effects variables are controlling for what is also unobservable but remains constant in its effect over time. In theory, it makes perfect sense to control for both but in practice the conditions for consistent estimation of the regression coefficients in a specification with both fixed effects and a lagged dependent variable are more demanding given the residual is correlated with the lagged dependent variable. Generally, it is preferable to use a lagged dependent variable as an alternative to a fixed effects specification and estimate them separately and use the results to provide bounds on the causal effect of the variables of interest. (for a discussion, see Angrist and Pischke (2009: 243–247) [63]).



Newfoundland & Labrador-1
Prince Edward Island-2
Nova Scotia-3
New Brunswick=4
Quebec-5
Ontario-6
Manitoba-7
Saskatchewan-8
Alberta-9
British Columbia-10

Fig. 5. Actual real per capita provincial government health expenditures (rpgtothltc) vs fitted by province (Prov) for 1975–2009 from regression results Table 2, specification V.

Key positive and significant determinants (at the 5 percent level) of real per capita provincial government total health expenditures for specifications V and VI generally include real per capita GDP, time trend, and the proportions of population aged 65–69 and 85 years and over. Key negative and significant determinants include the real per capita amount of provincial debt interest, the proportion of population aged 75–79, the onset of the Canada Health and Social Transfer and the private share of health spending. Fig. 5 illustrates the high degree of fit of these results across the ten provinces for specification 5. These determinants are also of significance across the other health expenditure categories and are consistent with other studies of the determinants of health expenditures.

In specification V, the number of family and specialist physicians per 10,000 of population is an important positive and significant driver of provincial government health spending for total spending, hospital and physician spending. In specification VI, it is positive and significant for specialist physicians in the case of hospitals and for both family and specialist physicians in the case of physician expenditures. With some exceptions, physician numbers are generally not statistically significant factors for the other expenditure categories. However, it should be noted that the number of specialists per 10,000 of population is negatively and significantly related to capital spending in specification V while both specialist and family physicians are negatively to drug expenditures in specification VI. This

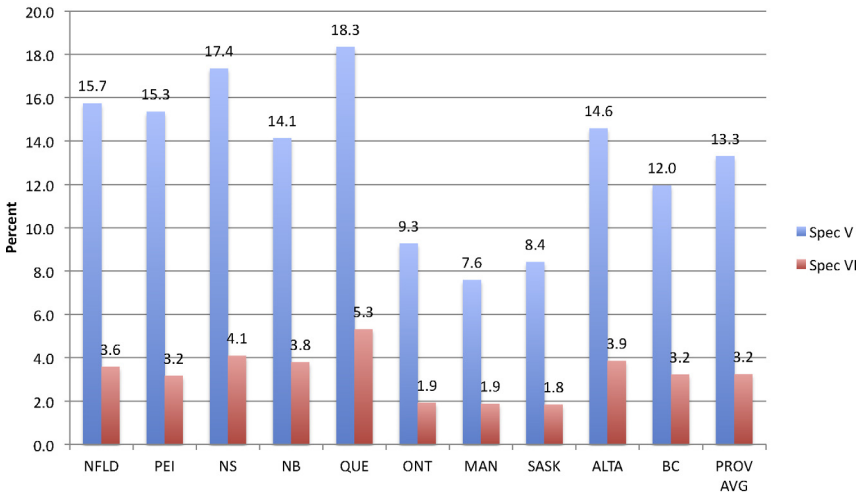


Fig. 6. Percent contribution of physician numbers to real per capita provincial government total health expenditures: 1975–2009.

suggests that there may be some degree of substitutability between specialist physicians and capital and drug expenditures.

Specialists are the more important positive driver when real per capita total provincial government expenditures are considered in specification V. Adding one family physician per 10,000 of population adds 18 dollars in real per capita total health spending while one specialist physician is associated with an increase of almost 40 dollars in real per capita spending. The real per capita amounts are smaller when it comes to the separate categories of hospital and physician expenditure but the relatively greater impact of specialist physicians is replicated. Moreover, while the physician variables are not a significant determinant of real per capita total provincial government health spending in specification VI, they are still positive and significant drivers of both hospital and physician spending.

Based on the value of these coefficients and the actual increases in real per capita provincial government health spending, it is possible to calculate the percent contribution of physicians to provincial government health spending over the period 1975–2009. Between 1975 and 2009, real per capita total provincial government health expenditures rose from an average across the ten provinces of 1149 dollars in 1975 to 2718 dollars in 2009 – an increase of 1568 dollars. Based on the coefficients for specification V, the average amount of the increase due to the increase per 10,000 of population of family physicians was $62.75 while that of specialists was $145.80 for a total of $208.55 due to physicians. This represents 13.3 percent of the increase. Based on the coefficients for specification VI which were not significant at the 5 percent level, the average amount of the increase due to the increase per 10,000 of population of family physicians was $27.58 while that of specialists was $23.29 for a total of $50.87 due to physicians and an average contribution of 3.2 percent of the increase. As Fig. 6 also illustrates, this contribution varies across the provinces ranging from a low of 7.6 percent for Manitoba to a high of 18.3 percent for Quebec for specification V. For specification VI, the range is from a low of 1.9 percent for Ontario and Manitoba to a high of 5.3 percent for Quebec.

The contributions are larger for the separate categories of physician and hospital expenditure. Fig. 7 plots the results for hospitals while Fig. 8 plots the results for physicians. For specification V, the contribution of physician numbers to real per capita provincial government hospital spending averages 17.4 percent and ranges from a low of 10.7 percent in Manitoba to a high of 44.9 percent in Quebec. For specification VI, the range is from a low of 7.8 percent in Manitoba to a high of 30.5 percent in Quebec. Meanwhile, the contribution of physician numbers to physician spending (Fig. 8) averaged 23.4 percent across the provinces and ranged from a low of 11.5 percent in Ontario to a high of 62.5 percent in British Columbia for specification V and ranged from a low of 10.5 percent for Ontario to a high of 65.8 percent for British Columbia using specification VI.

These results suggest that after controlling for income, time trend, an aging population and other confounding variables, physician supply deepening – that is an increase in the number of physicians per 10,000 of population – is indeed associated with increases in real per capita health expenditures. This supports the conventional wisdom that expansion in the supply of physicians and physician capacity can in of itself be a driver of health system expenditures. However, the average contribution of physician numbers to the increase in overall real per capita health spending is relatively modest ranging from 3.2 to 13.3 percent of the increase. This means that other factors account for 86.7–96.8 percent of the increase in spending.

However, for the physician and hospital expenditure categories the contribution is larger and also varies more across provinces. For example, physician numbers contributed approximately 31–45 percent of the increase in real per capita hospital spending in Quebec over the 1975–2009 period. As for real per capita physician spending, physician numbers contributed approximately 63–66 percent of the increase in British Columbia and over 30 percent in Newfoundland and Labrador, Nova Scotia and

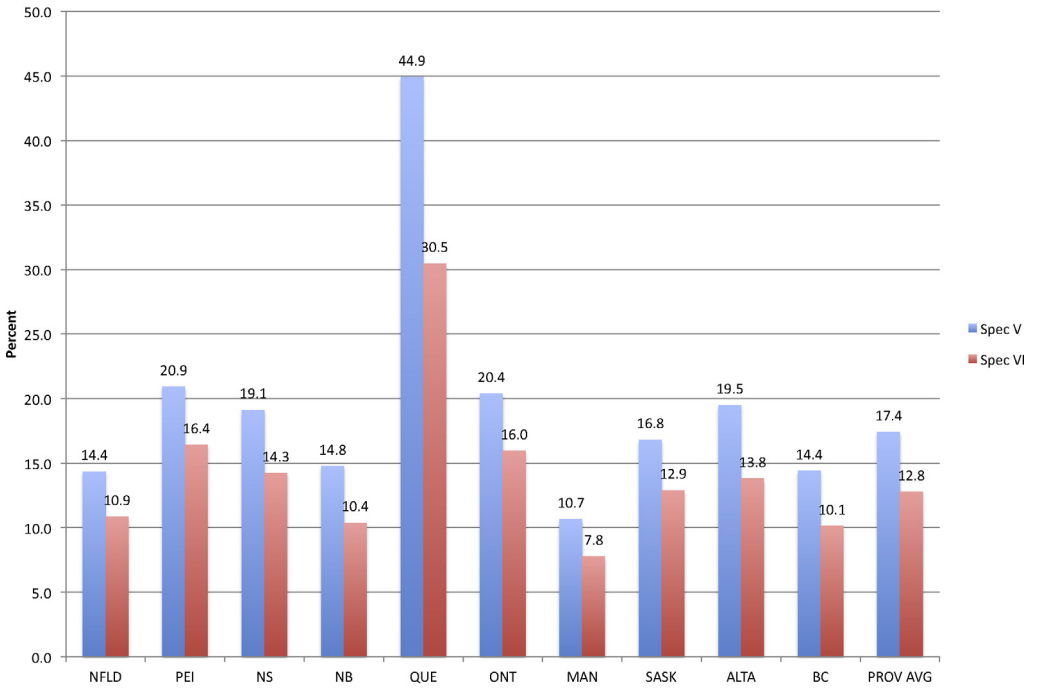


Fig. 7. Percent contribution of physician numbers to real per capita provincial government hospital expenditures, 1975–2009.

Quebec respectively. In these jurisdictions, physician numbers have been a more potent driver of these specific expenditure categories.

At the same time, for those provinces with the largest contributions to hospital and physician spending by physician numbers – British Columbia for physician spending and Quebec for hospital spending – it should be noted those two provinces over the period 1975–2009 also had the lowest increases in real per capita provincial government health expenditures.

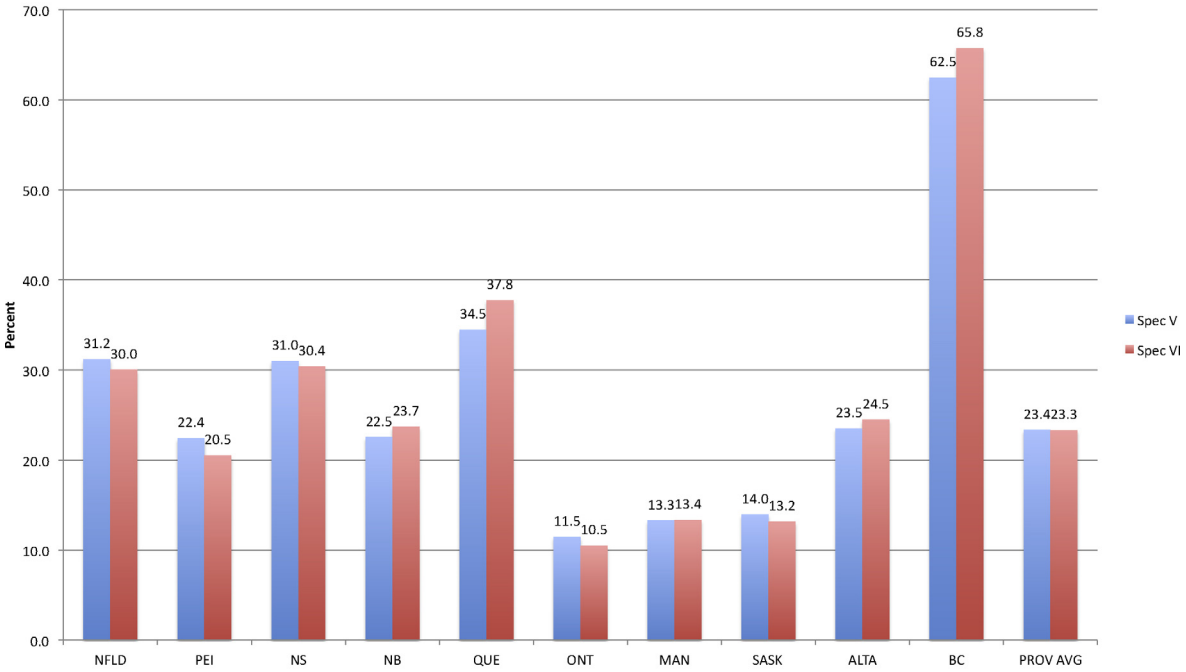


Fig. 8. Percent contribution of physician numbers to real per capita provincial government physician expenditures, 1975–2009.

3. Conclusions

Since 1975, increases in Canadian physician numbers have been accompanied by increases in provincial government health expenditures. Increases in the number of physicians can potentially increase health expenditure as physicians have the power to induce demand for their services. Regression estimates in this paper show that after including confounding factors such as income, time trend, and aging, the deepening of physician supply – that is an increase in the number of physicians per 10,000 of population – is indeed positively correlated with increases in real per capita health expenditures. Moreover, specialists have a greater impact than family physicians.

However, the contribution of physician numbers to the increase in overall real per capita provincial government health spending is relatively modest ranging from 3.2 to 13.3 percent of the increase. This means that factors other than physician numbers account for 86.7–96.8 percent of the increase in spending. However, physician numbers alone are a more important driver of expenditures when the hospital and physician categories are examined and particularly for Quebec and British Columbia.

While every provincial government in Canada has tried to hold down physician fees and cap payments,[41] current public policy in Canada has renewed its focus on physicians and physician costs as important factors in reducing the growth of public health care spending. Canada's largest province, Ontario, in particular has decided to tackle its multi-billion dollar provincial deficit in part by imposing fee cuts and freezes for Ontario physicians. The Ontario decision to tackle physician fees is understandable given that physicians in Ontario account about one-quarter of government health spending – the highest share in the country. Yet, physician numbers alone only account for at best 11.5 percent of the increase in government physician spending in Ontario. The remainder is therefore a combination of the number of services provided and fees for the services provided – a mixture of both price and quantity.[42]

Despite the recent increases in physician numbers, the impact of their numbers for most provinces is modest shifting the focus for savings to the fees and payment methods and ultimately may spread to the services provided as well as workload. Physician workloads appear to have declined but their incomes have not. In an era of tight budgets, having more physicians working fewer hours and charging higher prices will increasingly be seen as a luxury.

Yet, even though physicians have become a renewed target for health care restraint, provincial governments are likely aware that the drivers of public health care spending are a complex interaction between physician decision-making, diagnostic and drug technologies, population growth, aging, the cost and deployment of human resources, provincial health system institutions and the role of demand side economic variables such as incomes.

Focusing on physicians represents a solution partly driven by political reasons given the high profile that physicians have within the public health care system. The relatively small contribution of physician numbers as an expenditure driver suggests the focus will need to be more on fees, service volumes and utilization. Yet, given the importance of physician numbers as a driver in hospital and physician expenditure categories particularly in Quebec and British Columbia, a renewed health policy focus in these provinces on physician numbers is also distinct possibility. There cannot be a one-size-fits-all approach to physician expenditure cost control in the Canadian public health care system. By extension, international health expenditure control policy will also require a diversity of solutions.

While physician numbers are an expenditure driver, they are most important as a driver of physician expenditures–less so as a driver of hospital expenditures or total health expenditures. This suggests that their gatekeeper role may not be a dominant as one might think and that approaches to restrain health expenditures and rising health costs that emphasize physicians should more carefully rethink what the cost drivers might be.

[41] See Evans (1998: 758) [4].

[42] Total physician expenditure = Number of Physicians × Number of Services × Price per Service.

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