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ABSTRACT

The determinants of public health care expenditure are examined in two of the most decentralized countries in the world (Canada and Spain) for two partly overlapping time-spans of data availability: Canada, 1981 to 2013 and Spain, 2002 to 2013. While Canada generally spends more per capita on health care than Spain, over time Spain's macro level health indicator performance has surpassed Canada's. Using regression analysis, we find the key determinants of public health care spending include time trend, income, physician numbers and regional fixed effects. Physician numbers are a significant driver of real per capita public health expenditures in Canada but not Spain despite the greater per capita number of physicians in Spain. Differences in the growth and performance of real per capita income explain much of the gap between public health spending between these two countries with some contribution from differences in per capita physician numbers. The differential health indicator outcomes raise the question of what Canada might do to be more efficient.

JEL Classification: H51, I1, I18, I3

Keywords: Health care expenditure, Canada, Spain, panel data, income elasticity

Key Points:

Canada's health spending is less sensitive to income than Spain's.

Physician numbers are a more important driver of health expenditures in Canada but not in Spain.

Aging is not a major driver of spending in either Canada or Spain

I. Introduction

Canada and Spain are developed economies with modern public health care systems and substantial differences in the per capita level of health care spending as well as the health outcomes (1,2,3,4). Canada spends more per capita on health and yet in terms of basic macro level health indicator performance, Spain has gradually overtaken Canada. The share of health spending accounted for by the public sector is equivalent in Canada and Spain at approximately 70 per cent. Therefore, we examine the determinants of public sector health expenditure in Canada and Spain to see the differences in the contributions of key health expenditure drivers that might explain some of this differential expenditure performance.

Both Canada and Spain are highly decentralized countries though Canada is a federation while Spain remains a unitary state. Canada and Spain differ in terms of economic characteristics, geographic span and age composition. According to data from the IMF World Economic Outlook Database, in 2017, per capita GDP in Canada was USD 44,773 while Spain's was lower at USD 28,212. Canada's unemployment rate in 2017 was 6.5 percent compared to 17 percent for Spain. Part of this differential economic performance can be attributed to the fact that Spain was hit much harder than Canada by the 2008-09 global economic crisis and its recovery has been much slower [5,6].

Furthermore, Spain's population is larger at 46.333 million compared to 36.638 million for Canada [7] and is also more densely populated given its much smaller geographic area compared to Canada. As well, in 2016 Spain has a more aged population with 19 percent of its population over age 65 compared to 17 percent for Canada.[1] Needless to say, these differences could also be factors explaining differences in their per capita public health spending which in 2015 according to the OECD was $3,262 in Canada and $2204 in Spain (US PPP dollars) [8].

[1] See https://data.worldbank.org/indicator/SP.POP.65UP.TO.ZS

When it comes to health spending and delivery, both countries have relatively decentralized regional health care expenditure and delivery systems but with differences in funding models and aspects of service provision like accessibility to private services. Another interesting difference between Canada and Spain in terms of their health systems is with respect to physician intensity – that is, Canada has fewer physicians per capita than Spain, despite the economic crisis and austerity policies in the European Union (5,6).

The remainder of the paper is structured as follows. We first briefly describe the features of the Canadian and Spanish health care systems in Section II. Next, section III surveys the related literature on health care expenditure determinants and its dynamics. Section IV provides an overview of the empirical model and a brief description of the data. Section V presents the results derived from the model. The final section summarizes and concludes.

II. Health Systems and Health Care in Decentralized Countries: The Case of Canada and Spain

Health care in Canada is both publically and privately financed. However, it should be noted that public finance does not entail direct provision of health services by government. Canadian physicians, for example, are almost completely publicly financed, but physicians are considered private contractors who bill the public health funder with their compensation still based mainly on fee for service.[2] Nevertheless, about 30 percent of health expenditure in Canada is privately funded and the remainder publically funded with the proportion varying both by province and by expenditure category with public shares the largest in hospital and physician services [9].[3]

As a result of its federal nature, Canada does not have one public health care system, but 14 publicly funded systems, given there are ten provinces, three territories and a federal government.[4] In Canada, both the federal and provincial governments finance public health spending but it is provincial governments who administer publicly funded health care making the system quite decentralized with some variation in service provision. At the same time, within each province it is a single payer system and as a result the actual delivery of public health care is actually quite centralized within each respective jurisdiction.

Provincial and territorial government health expenditures are for insured health services and extended health care and are financed by own source revenues as well

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[2] While Canadian physicians are still overwhelmingly on Fee for Service with prices for services negotiated between provincial medical association and provincial government health ministries, recent years have seen the introduction of new approaches. Enhanced Fee for Service combines fee for service with bonuses or block grants to achieve some type of performance target. There is also what is known as Alternative Payment Programs which provides bonuses or other financial incentives for practicing in certain regions or meeting other performance criteria. Capitation has also become of increasing importance in recent years.

[3] It should be noted that the provisions of the Canada Health Act are a reason for these large shares in physician and hospital spending.

[4] It should also be noted that direct health expenditures by the Canadian federal government are relatively small and directed towards First Nations and the Armed Forces.

as federal government transfers to the provinces. Federal transfers for provincial-territorial government health spending are made according to the legislation of the 1984 Canada Health Act, which specifies the general criteria which provinces and territories are expected to meet to receive full federal health transfers.[5] In 2015-2016, the total value of the Canada Health Transfer to the provincial and territorial governments was $CAD 34 billion dollars and is expected to increase to $CAD 37.2 billion by 2017-2018.[6] Federal transfers provide about 20 to 25 percent of provincial government health expenditures though the growth rate of these transfers will decline after 2017.[7]

According to the Canadian Institute for Health Information, total health expenditures in Canada was forecast to reach $CAD 242 billion in 2017 up from $CAD 233 billion the year previous. Provincial-territorial health spending is forecast to be $CAD 157 billion in 2017 up from $152 billion in 2016. Average provincial-territorial government real per capita health spending (in 1997 dollars) has risen from $CAD 1,203 in 1975 and projected at $CAD 2,483 in 2016 though this spending has been declining since 2010 when it stood at $CAD 2,577. One view (10: xvii-xviii) notes that: "… Canada - like most advanced industrial countries - appears to have entered a new phase of dampened [health spending] growth since the fiscal crisis and recession of 2008-09." Health spending in Canada both total and public sector has also been declining as a share of GDP over the last few years [9].

The public share of health spending in Spain is equivalent to Canada at approximately 71 percent according to the most recent OECD Health Statistics numbers but is down from an early 1980s peak of over 80 percent. The Spanish health care system has seen a change from a Social Security model to a National

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[5] Briefly, the key criteria of the Canada Health Act include that provincial health systems must be publically administered, be comprehensive in their coverage of insured services, must be universal in their coverage, must have portable benefits and must provide for reasonable access to insured services.

[6] Department of Finance. Federal Support to Provinces and Territories. http://www.fin.gc.ca/fedprov/mtp-eng.asp.

[7] The 6 percent escalator of the 2004 Health Accord is being replaced by a formula based on the growth rate of real GDP subject to a 3 percent floor.

Health System (NHS, from the 1986 Health Act). This has been accompanied by a set of reforms that introduced quasi-market mechanisms into the health system.

The Spanish NHS is based on the principle of universalism (basic coverage for all residents). General Practitioner (GP) and paediatricians (primary care) are the first contact point of patients with NHS. Their choice is possible (if the physician's list has not reached the maximum number of allowed patients), but access to specialist care services (secondary care) is restricted by gate-keeping system. Once the GP has authorized the visit or procedure, patients are free to choose any provider among those accredited by the NHS inside their origin region and a special health care fund exists for displaced patients. Moreover, because of waiting lists, as in other European countries (e.g. Italy, Greece, Portugal, etc.), some individuals consult private specialists at their own expense in order to complement public health insurance.

Health care is decentralised to regions with financing via regional and shared taxes and block-grants from the central government. Pharmaceutical co-payments are used as additional source of financing and to discourage inappropriate use. Inpatient care and primary care are free at the point of health utilization. In emergency cases, direct and free access is allowed for all health care services, regions and population groups. Like other OECD countries, health care decentralization in terms of regional systems has been seen as a way to improve responsiveness and efficiency. As a result of these processes, Spain –much like Canada -- does not really have one public health care system, but 17 publicly funded systems, given that there are 17 autonomous communities (regions) along with a federal government. At the same time, much like the Canadian system within each region there is a single payer system for public health spending.

Regional governments in Spain organize their own health care services as recently demonstrated [4,11,12] and as a result, there are differences across regions mainly in complementary supply and coverage of (and access to) some health care programs. For example, in the case of dental care in Spain, most of the assistance is carried out through private systems with public sector performance limited to diagnosis and pain relief through dental extraction for adults, and preventive programs of conservative dentistry for children and adolescents.

Comparisons of performance and spending across the Canadian and Spanish health care systems are provided in Figures 1-4. Figure 1 plots per capita total and public health spending in US $ PPP (Purchasing Power Parity) for Canada and Spain for the period 1960 to 2015 using OECD data.[8] Per capita health spending has grown in both countries over time, but growth rates have declined over time with Spain hit harder after the 2008-09 recession.

There has been a persistent gap in health spending between the two countries. In 1965, total per capita health spending (US $PPP) was $163 in Canada and $39 in Spain while public health spending was $86 and $15 respectively. By 2015, total per capita health spending (US $PPP) was $4,608 in Canada and $3,153 in Spain while public per capita health spending was $3,262 and $2,204 respectively. With respect to public health care spending, in 2015 Canada spent approximately 48 percent more than Spain.

Despite the considerably larger per capita amounts being spent by Canada relative to Spain, it is interesting that physician density is now greater in Spain as illustrated in Figure 2. By 2014, there were 2.6 physicians per 1,000 of population in Canada as opposed to 3.8 in Spain – Spain having 46 percent more physicians per 1,000 of population.

Also, as illustrated in both Figures 3 and 4, over time, the performance of the Spanish health care system in terms of basic health indicators improved faster than Canada's and indeed overtaken the Canadian system. Life expectancy has grown,

[8] OECD Health Statistics 2015 and 2016 [8]

and infant mortality fallen in both Canada and Spain over the last half century. However, whereas Spanish life expectancy at birth was below that of Canadians in the 1960s, by 2011 it was 1.3 percent higher (82.6 versus 81.5 years).[9] Meanwhile, while infant mortality in Spain was 60 percent higher in Spain relative to Canada in 1960 (at 43.7 versus 27.3 deaths per 1,000 live births), by 2012, it was actually 35 percent lower in Spain (at 3.1 versus 4.8 deaths per 1,000 births).[10]

Given the Canada spends considerably more per capita on health care than Spain but with similar public shares, undertanding the source of expenditure differences is of interest given that higher spending and lower heath indicator outcomes in Canada suggest differences in the cost-effectiveness of the two systems. Spain spends less per capita and yet appears to have better performance. Our next step is to compare the deteminants of public health expenditure across the two countries to see what the sources of the expenditure differential might be.

[9] These life expectancy numbers are from OECD Health Statistics 2017. It should be noted that in developed countries, values for life expectancy tend to be similar and as a result small differences in actual values can generate large differences in rankings.

[10] These numbers are again taken from OECD Health Statistics 2017 but it should be noted that the definition of infant mortality depends on the definition of live births and that can vary internationally.

Figure 1

Per Capita Health Spending in Canada & Spain, 1960-2015 (US PPP$; OECD Health Statistics 2017)

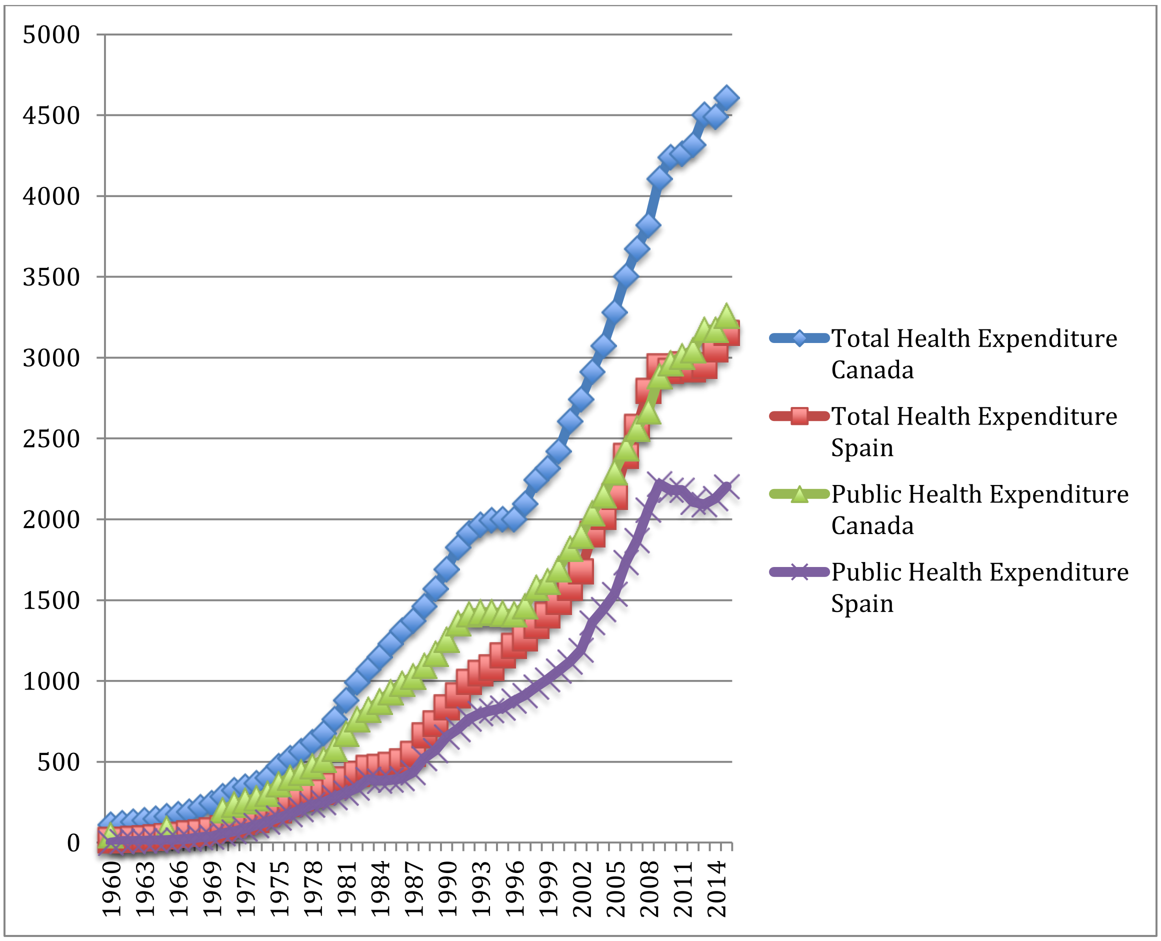


Figure 2

Physicians, Density per 1,000 Population (Source: OECD Health Statistics 2017)

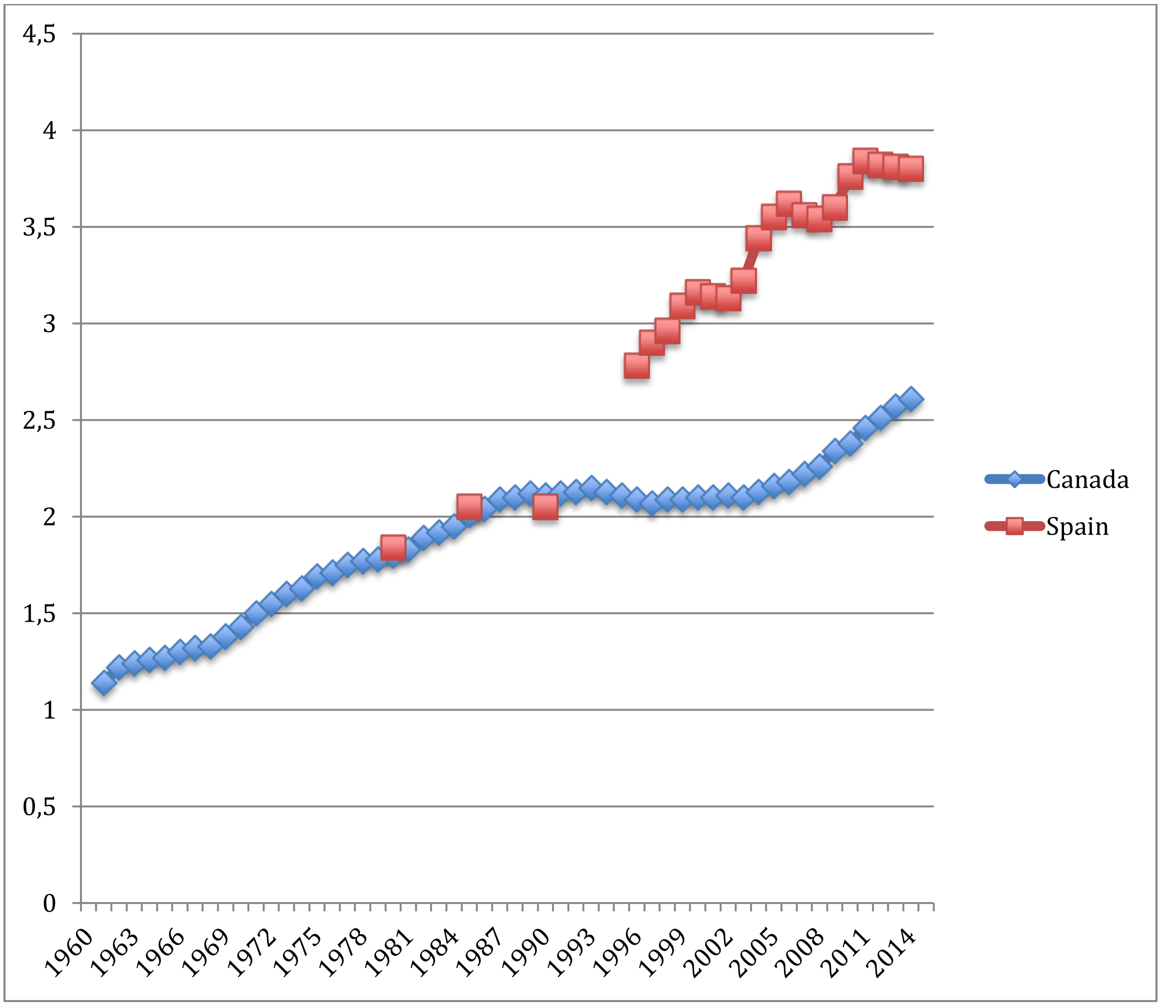


Figure 3

Life Expectancy at Birth, Years, Total Population (Source: OECD Health Statistics 2017)

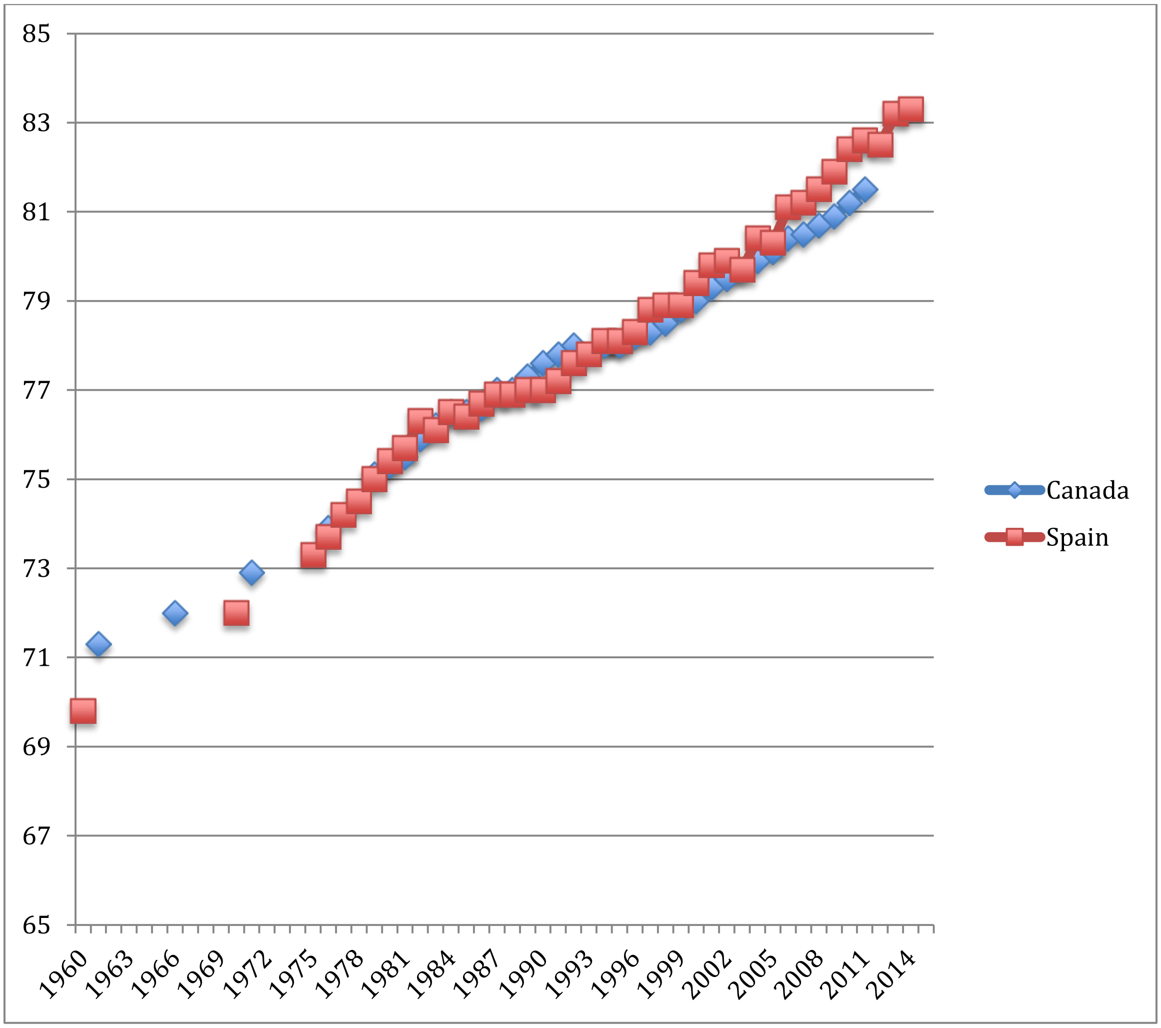
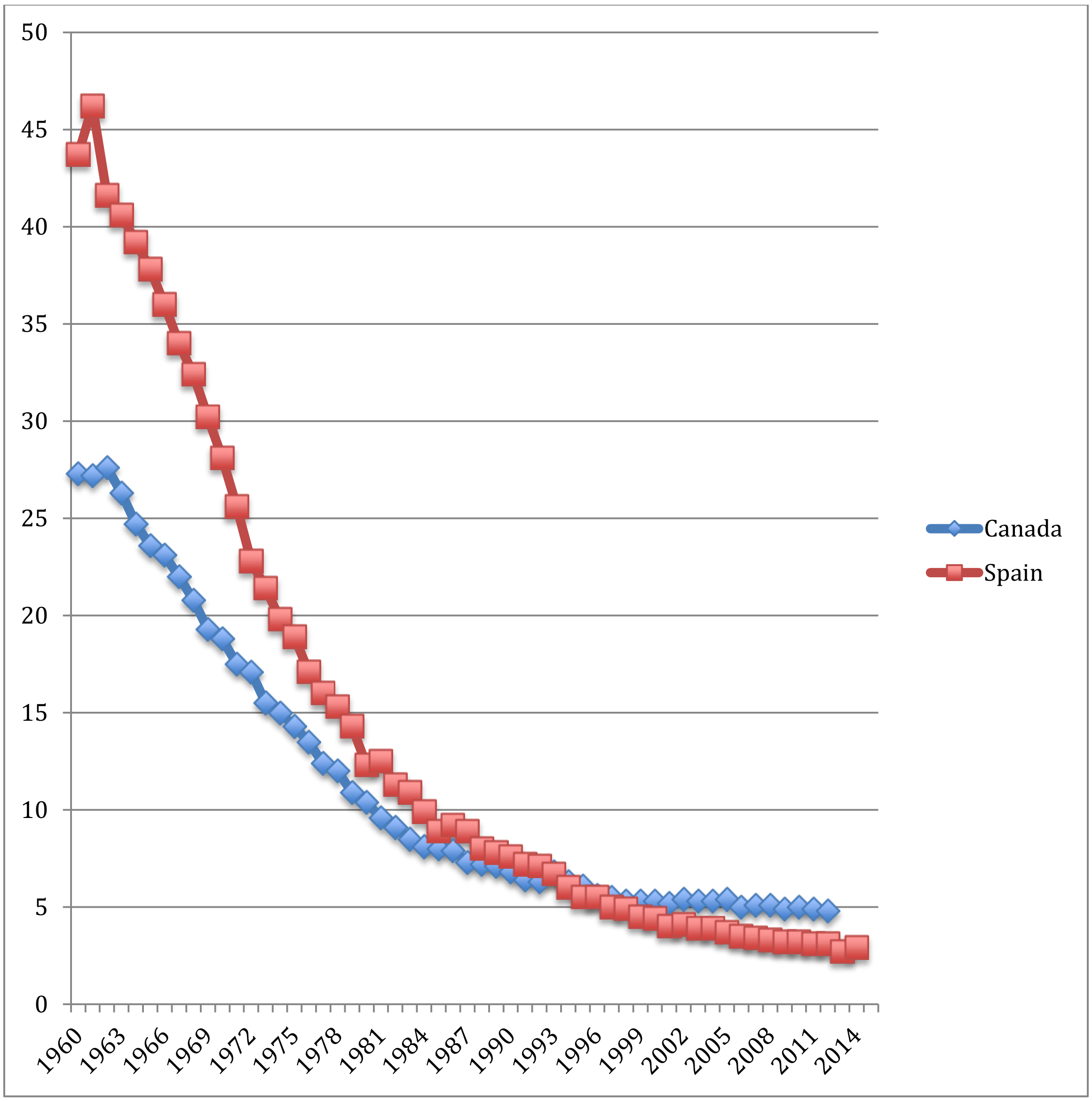


Figure 4

Infant Mortality, Deaths Per 10000 Live Births (Source: OECD Health Statistics 2017)



III. Health Expenditure Determinants

The health expenditure determinants literature identifies key drivers as physician numbers, population growth, population aging, income, inflation, and enrichment factors such as technological extension. Studies have used international, national and regional level data to examine the determinants of health expenditures with simple bivariate cross-sectional techniques, multivariate regression, pooled time series regressions, error-correction approaches as well as non-parametric techniques [1,2,3,4,13,14,15,17]. Moreover, recently micro-data has also been utilized in an effort to determine expenditure determinants at an individual rather than aggregate level. All of these studies use a "determinants" approach in which per capita health care expenditures are regressed on variables believed to affect health expenditures.

Income is seen as the key factor in explaining health care spending and health spending's sensitivity to income – the elasticity of health expenditure – crucial in determining whether health spending is a necessity or a luxury. High income elasticities are seen as an indicator of health spending as a luxury good even though common perceptions maintain that health care is a necessity [18]. Yet, the view of health as a 'luxury" may be the result of econometric specifications[11] with Sen [19] emphasizing omitted variable bias, unobserved country and year specific effects as the main factors. Getzen [20] argues the data source can be a source of the differences with individual income elasticities closer to zero and national health expenditure income elasticities being often larger than one.

Leu using 19 OECD countries found income elasticities ranging from 1.18 to 1.36 [21]. Parkin, McGuire and Yule [22] used similar methods and data found income elasticities of between 1.12 to 1.18 while Brown [23] obtained an income elasticity of 1.39. Gerdtham et al [14] used a cross-section of 19 OECD countries and also

[11] Culyer [18] (p.46) argues that the missing variable is probably "too subtle to be readily quantified." It may be in the public budgeting mechanism used to fund health care.

reported a large income elasticity of 1.33 while Gbsesmete and Gerdtham [24] used a cross-sectional sample of 30 African countries and reported an income elasticity slightly less than 1.

Studies using pooled time-series cross-sectional data for either countries or regions find income or GDP a significant determinant of health spending but usually with lower income elasticity estimates. Hitiris and Posnett [16] used 560 pooled time-series and cross-section observations from 20 OECD countries over the period 1960-87 and found an income elasticity close to one. Barros [17] used data for 24 OECD countries for the period 1960 to 1992 and also found an income elasticity close to one. Gerdtham, et al. (15) used a pooled time-series cross-section analysis for 22 countries over the period 1970-1991 and found the income elasticity of health expenditure to be in the 0.7-0.8 range. An exception to these income inelastic results done using data for 10 OECD countries from 1960-1991 found the income elasticity of health expenditure ranged from 1.14 to 1.17 [25].

In a national-level pooled time-series cross-section Canadian provincial study, Di Matteo and Di Matteo (1) found an income elasticity of 0.77. Di Matteo (26,27) using non-parametric approaches for Canadian, OECD and US data finds that income elasticities are higher at low-income levels and decline with rising income. As well, income elasticity does vary by level of analysis with international income elasticities being larger than national or regional studies. Bilgel and Tran in their examination of Canadian provincial level find that the long run income elasticity of health expenditure is substantially lower than one [28].

López-Casasnovas and Saez [29] using data for 110 regions in eight OECD countries and a multilevel hierarchical model concluded that the degree of fiscal decentralization within countries in estimating income elasticity of health expenditure could be important although in a framework of more regional decentralization, public policies aimed at increasing choice and competition also may tend to rise national health care expenditure. A panel of US state level data controlling for the proportion of the population over the age of 65, urbanization and hospital beds [30] found the cross-section income elasticity of health care around 0.7. Hartwig and Sturm [31] using 33 OECD countries over the period 1970 to 2010 find GDP growth a robust and statistically significant determinant of health care expenditure growth. Ang [32] examines health care expenditure in Australia during the period 1960–2003 and finds the income elasticity for health care is found to be greater than one, suggesting that health care is a luxury good.

The time-series literature has been criticized on the basis of the issue of stationarity and a co-integration approach applied.[12] In a national-level study, Murthy and Ukpolo [41] applied co-integration techniques to time-series data for the United States over the period 1960-87 and found the income elasticity of health care spending not significantly different from one. Ariste and Carr [42] used error correction and co-integration techniques on Canadian provincial health expenditure data (1966-1998) and found an income elasticity of 0.88. Murthy and Okunade [43] apply a Autoregressive Distributed Lag Cointegration (ARDL) approach to US annual time series data from 1960 to 2012 and find an income elasticity estimate of around 0.92 and that medical technology advances play a major role in the long run rise of the U.S. health expenditure.

Time series tests for stationarity can often yield inconclusive results and this has sometimes been the case in health expenditure determinants studies. Gerdtham and Jonsson [13: 48] note methodological differences are the most likely reason for diffrences in results and the reliability of the tests is an issue. Nonetheless, even with this caveat it remains that the results from the time series stationarity health

[12] A stationary time series is one whose mean and variance do not change with time. If variables in a regression are non-stationary, then the implication is that the regression may be spurious. If the error term is stationary, then the two variables are co-integrated with the error term representing 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 [33,34,35, 36] For studies of health expenditure determinants using this approach, see [37, 38, 39]. Stationarity may not be as serious a problem in panel data when panel level tests are employed and therefore "researchers studying national health expenditures need not be as concerned as previously thought about the presence of unit roots in the data." [40: 375].

spending literature like the main body of literature find income elasticities of health care spending not significantly different from one. Recent work also concludes that meaningful results are possible in regular panel regression approaches if allowance is made for structural changes. (44: 322).

Despite the focus on income as a health expenditure driver and the income elasticity of health spending, other factors have also come to assume a greater role in these studies. Newhouse (45,46) regressed per capita medical expenditures on GDP per capita for 13 countries circa 1970 finding "over 90 percent of the variance in per capita medical expenditure in these countries can be explained by variation in per capita GDP" and that health care spending was income elastic with the elasticity ranging from 1.15 to 1.31. (45: 117). However, in later work, Newhouse argued health care spending was a normal good but income inelastic leading Newhouse to conjecture that a larger portion of the increase in health expenditures is due to other factors such as technological and demographic change including population aging [47].

A variety of technological innovations have been held responsible for rising health expenditures including new medical techniques, treatments and pharmaceutical innovations. For example, pharmaceuticals are substituted for other health services, including institutionalisation (with the introduction of anti-psychotics) and surgery (anti-ulcer drugs), and perhaps even the amount of time physicians spend with their patients [48]. Popular discussion has viewed aging populations – in particular the proportion aged greater than 65 - as a major cost driver whereas academic studies often noted the impact of aging is overstated [49,50]. Along with age alone are the intertwined effects of changing health expectations and demands across population cohorts, the impact of new technologies, and age related changes on health service costs such as the higher costs in the final days of life as proximity to death nears [51,52].[13]

Indeed, the proportion of population aged 65 and over is a positive and significant driver of Canadian provincial government health spending when simple regression specifications are used but its effect becomes negative when more complex age specifications and time trend are included [27]. Reinhardt (53) notes that population aging is a minor cause of the annual growth in health care spending given rising incomes, expensive new health technology and labor costs that can raise per unit health care costs. Morgan and Cunningham (54) found the effects of population aging small contributing less than 1% per year to spending with changes in age-specific mortality rates reducing hospital expenditure by –0.3% per year.

As for micro and individual level regression studies, Brinda et al, (55) use a sample of 2,414 people aged 65 years and older from the WHO's Study on Global Aging for India and find Out-of-pocket health expenditures were higher among participants with disabilities and lower income. Gopffarth et al., (56) use 2011 year data on expenditure, utilization of health services and state of health in Germany's statutory health insurance system by county. They conclude that regional variation in German health expenditures can be explained to a large degree by variations in health and demography across counties.

Finally, besides rising trends in health expenditure – and explanations for its particular growth differences across countries– during the last years had been concerned with the sustainability of national health-care systems and the decomposition of the drivers [57,58]. This issue had become interesting to economic researchers, and so a growing literature has recently risen [59,60,61].

[13] For Canada a CIHI analysis of cost drivers focusing on the period 1998 to 2008 found that total public-sector spending on health care increased at an average annual rate of 7.4% with population growth contributing an average of 1% per year to the increase in health expenditures, while population aging contributed only 0.8%, making demographic factors relatively modest contributors at 1.8%. See [10: xix].

Summarizing the key variables and their effects on health care expenditures, Martin et al. [62] review the literature on health care expenditure determinants for the period 1998 to 2007 and find no clear patterns of results. Of the studies they surveyed, about 20 percent found income to be the principal determinant while 30 percent of studies highlighted population aging though another 30 percent highlighted the proximity to death. Of these studies, only just over half calculate an income elasticity of health care spending and of those about one-fifth of them find an income elasticity greater than 1. Martin et al., [62: 1] conclude that there is no consensus with respect to the variables to be used or the econometric specification employed when it comes to estimating health expenditure determinants in the OECD countries. Moreover, the evidence that population ageing is a major contributor is not definitive and other factors such as technological change, proximity to death and decentralization of service provision are seen as of increasing importance.

IV. Models and Data

Data is available for 17 Spanish regions 2002 to 2013 [63] and for 10 Canadian provinces for the period 1981 to 2013 and used to run separate pooled time series cross-section regressions. The time span for both countries is determined by the ready availability of consistent regional data series not just for health expenditure (which in Canada at the provincial level actually goes back to 1975) but also other economic and demographic variables such as GDP (which for Canada are more consistently and readily available back to the early 1980s). For Spain, regional government is a relatively recent innovation and there have been institutional changes to the health care system and data series have not yet been substantially extended backwards in time. Due to the nature and availability of the data collected, identically specified regressions for both were not possible but it was possible to include income, time trend, demographics, physician numbers and regional fixed effects in both regressions.

Canada and Spain

A pooled time-series cross-section regression[14] model is estimated for provincial and/or regional government health expenditure category taking the form:

$$(1)\ H_{it} = f(z_{1it}, z_{2it}, \ldots z_{nit})$$

where H_{it} is real per capita government health expenditures of the i-th province/region at period t, and z_1 to z_n represent a vector of social, demographic, economic and policy variables of the i-th province/region at time t which are determinants of H_{it}. These determinants are essentially expenditure-drivers and the literature has identified these key drivers to broadly include population growth,

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

population aging, income growth, inflation and enrichment factors such as technological change as accounted for by either time trend or residual effects [64].[15]

Specifically, the determinants of real per capita government health spending are defined as physicians per 1,000 of population[16], real per capita GDP, the proportion of population aged 65 years and over, real per capita federal cash transfers (for Canada only,[17] a variable designed to capture federal transfer regime switches (for Canada only) [18] and time trend. Inflation is accounted for in all these regressions by using real expenditure data (in 1997 dollars for Canada and 2010 euros for Spain). Finally, province/region 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.

The inclusion of physician numbers is to take into consideration their impact on spending given their role as gatekeepers to the services of the health care system

[15] A time trend (YEAR) is often used to account for technological change's impact. If new techniques generate cheaper health procedures, there could be expenditure reductions associated with technological change. Cutler et al. 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 new treatments, technological change can be associated with rising health expenditures [65].

[16] The variable for physician numbers is the number of physicians per 1,000 people. The intent is not to capture the effect of the total number of physicians on government health spending but the effect of physician deepening. In other words, what is of interest is not extensive but intensive growth in physicians. See Di Matteo [3].

[17] At present, Canadian 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 2015-16 of 68 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 34 billion in 2015-16 – an annual growth rate of nearly six percent. It accounts for about half of federal cash transfers to the provinces.

[18] In 1977, Established Program Financing (EPF) 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.

and not as a test for supplier induced demand.[19] The effect of supplier-induced demand can be more spending on physician services as a result of either increased volume or a higher equilibrium fee for services. However, in the absence of specific data on physician fees and changes in fee schedules over time, physicians per capita in our regressions is not the best test for the effects of supplier induced demand and at best represents an attempt to capture the role of physician density as a gatekeeper to the access of health care services and determinant of expenditures.[20]

The variables are defined for Canada in Table 1-a and the data for these regression variables were obtained from the National Health Expenditure database constructed by the Canadian Institute for Health Information[21] and also from CANSIM-Statistics Canada and the Federal Fiscal Reference Tables (See Appendix I for a summary).

In the same manner, the variables are defined for Spain in Table 1-b and the data for these regression variables were obtained from the BBVA Foundation and Ivie (Instituto Valenciano de Investigaciones Económicas) (2015) and also from Spanish National Institute of Statistics (See Appendix I for a summary).

Canadian and Spanish regression results are presented in Table 2 using Generalized Least Squares (GLS) estimates for log-log specifications excluding and including

[19] Supplier induced demand may occur when health care providers use their superior knowledge to take advantage of the information gap between health care professionals and their patients and influence demand for the purposes of economic self-interest. The classic expositions by Shain and Roemer (were applied to hospital spending [66,67]. 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.

[20] The literature on supplier induced demand is quite substantial and not conclusive and the issue is still subject to considerable debate. See [68, 69, 70, 71, 72, 73, 74, 75, 76].

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

time trend.[22] As well, GLS estimates are presented in an effort to deal with any autocorrelation or heteroscedasticity that might affect OLS estimates.[23] The GLS estimates assumed heteroscedastic panels with a common AR(1) correlation for all panels. Estimates were done using STATA 15 and similar testing was done on the data.

For example, Levin-Lin-Chu and Fisher Type[24] unit root tests for panel data were conducted for the variables in the data sets and the variables exhibited a high degree of stationarity[25] with the null hypothesis of a unit root being rejected for many of the variables. In addition, when a correlation matrix was done for the variables in the final models, many of the correlation coefficients were below 0.5 suggesting that the impact of multi-collinearity was limited in the estimates.

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[22] These estimates are pooled time series cross sections using Generalized Least Squares (GLS), assuming heteroskedastic panels with cross-sectional correlation and common ar (1). As well, linear and log-linear specifications were also estimated, and their results parallel the log-log ones.

[23] Inspection of plots of residuals against the regression variables did not show heteroscedastic patterns. Box-Cox testing found a linear specification to be more suitable than log-linear. However, the linear and log-linear results paralleled the log-log ones in terms of both magnitude and significance and log-log results presented in order to show elasticities. As well, a Ramsay-Rest test on the variables used in the Box-Cox test that the model has no omitted variables did not support the presence of omitted variables. Nonetheless, the omission of explanatory variables or the use of an incorrect functional form can also lead to the conclusion that autocorrelation or heteroscedasticity is present. A common practice is to use a generalized least squares technique (GLS) to construct additional estimates. [77]

[24] 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. This data set has a small number of panels (10) and a fixed number of time periods. The Levin-Liu-Chu tests were done with trend assumed. The Fisher-Type tests assumed the dfuller option, drift and two lags and were done both with and without the demean option. 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”. [78].

[25] A stationary time-series is one whose mean and variance do not change with time. If variables in a regression are non-stationary, then the implication is that the regression may be spurious. Tests for stationarity are available but their power can be limited by both the quality and the time span of the data. See [34,36]. Some research has suggested that stationarity may not be as serious a problem in panel data when panel level tests are employed. See [39, 40]

V. Results and discussion

Much in line with results from other studies, the results for Canada and Spain show that physicians per 1,000 population, real per capita GDP and time trend were all positive drivers of real per capita government health expenditures. Real per capita GDP and time trend were statistically significant positive drivers for both countries whereas physician numbers were only significant for Canada. With respect to time trend, after controlling for confounding factors, each year saw an average annual increase of 1.6 percent for Canada and 3.2 percent for Spain.

As well, real per capita public health spending was quite income inelastic for both countries in the estimates without time trend but once time trend was included Spain's health spending became more income elastic. Overall, Spain exhibited greater income elasticity of health spending than Canada. Canada's income elasticity of health spending ranged from 0.28 to 0.52 whereas Spain's ranged from 0.84 to 1.2. Spain's higher income elasticity means that its public health spending would be much more sensitive to income. Even when federal cash transfers, which are a form of income, are considered with respect to Canada the elasticity is quite small though the coefficients are significant.

Average real per capita income in this data set was $37,771 for Canada and 24,023 Euros for Spain. Again, using the results from the regressions including time trend, a one percent increase in real per capita GDP – an increase of about $378 would increase real per capita government health spending in Canada by approximately 0.28 percent for an increase of about $5.50 in real per capita provincial government health spending. On the other hand, for Spain, an increase in real per capita income of 1 percent – or about 240 Euros – would increase real per capita government health spending by 1.19 percent or approximately 26 Euros.

It should be noted that between 2002 and 2013, average real per capita income in the Spanish data set actually declined by 7 percent primarily as a result of the impact of the global financial crisis Great Recession while for Canada – which weathered the crisis well relative to other G7 countries - it grew 14 percent. Over the period 2002 to 2013, the increase in real per capita GDP alone would have resulted in an increase in average provincial government health spending in Canada of 4 percent compared to a decline in Spain of 8 percent. Thus, one reason for the difference between Canadian and Spanish per capita public health spending is directly tied to the differential performance of income combined with the higher income elasticity of Spanish health spending.

As for the aging variables, for Canada, the proportion of population aged 65 years and over was not a positive driver of health spending once time trend was controlled for.[26] However, it was negative and significant for Spain both with and without the time trend. These results are in keep with recent revisionist literature on the impact of age on health spending and it supports the case for a more complicated impact of aging on health care spending than popularly assumed. While aging is still 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.[27]

Furthermore, for Canada, health spending is quite inelastic with respect to the proportion aged 65 and over and with an increase in the proportion from 10.1 percent to 15.8 percent between 1981 and 2013, the predicted decline in spending attributable to population aging would have been quite small. It should be noted that using the regression without a time trend, health spending is positively affected by an aging population but still quite inelastic with respect to the proportion aged 65 years and over and as a result in that specification barely a fifth of the increase in real per capita spending would be attributable to aging – with physicians and

[26] It should be noted that this result held when a more complicated age structure was used for Canada breaking the data up into age groups 0-24, 25 to 44, 45 to 64 and 65 and over. However, what was positive and significant in this case was the proportion of population aged 45 to 64.
[27] For other discussions of this, see [79,80,81].

income being larger in their impact. In the case of Spain, spending is more elastic with respect to an aging population, but the proportion aged 65 and over did not increase substantially between 2002 and 2013 – going only from 17 to 18 percent – and therefore again would not have been as significant a factor in affecting Spanish public health expenditures.

The lack of importance of the proportion of the population aged 65 years and over is also a function of the fact that aging may be correlated with variables such as income as well as the time trend and the true impact of aging is intertwined with these variables. Moreover, the observation needs to be made that while populations are aging, both Canada and Spain have seen a slowdown in the growth rate of real per capita public health spending with Spain witnessing as actual decline since 2008. Given the relatively short time span of the Spanish data from 2002 to 2013 which is marked by an aging population, falling real per capita GDP and public health spending after 2008, any negative correlation between aging and health spending is not surprising and may be an artefact of the shorter time span and its unique events.

The province/regional variables show that in both countries there is some statistically significant regional variation in spending with the variations more pronounced in Spain. When time trend is included for Canada, compared to Ontario (the omitted province), real per capita spending is 4 percent less in Quebec and 11.5 percent less in Alberta but 10.5, 8.4 and 8.1 percent more in Prince Edward Island, Saskatchewan and British Columbia respectively. For Spain, compared to Madrid (the omitted region), real per capita spending is significantly higher in all the other regions ranging from only 25 percent higher in Balears to 136 percent more in Extremadura.

With respect to the impact of physicians, total physicians per 1,000 were only statistically most significant (at the 5 percent level) for Canada and not significant for Spain.[28] A 1 percent increase in physicians per 1000 in Canada would increase provincial government health spending by 0.29 to 0.35 percent making spending relatively inelastic to the number of physicians per 1,000. While physician numbers for Spain were not significant, they were even more inelastic than Canada at about 0.02 percent.

In 1981, average physicians per 1,000 in Canada across the ten provinces were 1.41 and rose to 2.21 in 2013 – an increase of 81 percent. In Spain, between 2002 and 2013, the average number of physicians across the 17 regions rose only slightly from 6.26 to 6.27. The average number of physicians per 1000 in these data sets were 1.8 for Canada and 6.3 for Spain. Using the results from the regressions including time trend, adding one physician per 1,000 of population would increase real per capita government health spending in Canada by approximately 16.2 percent or $316. For Spain, adding one physician per 1,000 population would increase real per capita health spending by 0.3 percent or about 41 Euros. Given the average real per capita public health spending in these data sets was $1,953 ($1997) for Canada and 1375 Euros (2010 Euros) for Spain, physician numbers in Canada are a more important contributor to spending.

[28] Given the availability of a breakdown into GPs and Specialists, the model was also run for Canada using these two variables rather than total physicians and it was found that it was Specialists per 1,000 that was positive and statistically significant. This of course raises the possibility that specialist numbers in particular may be a proxy for hospital costs since in Canada only care delivered in hospitals or by physicians is publicly paid for creating an incentive for people to be treated in hospitals.

Table 1-a: Regression Variables, Canada

Dependent Variables

Real per capita provincial government total health expenditures in 1997 dollars deflated using the Government current expenditure implicit Price Index. Source: Canadian Institute for Health Information, NHEX.

Independent Variables

Number of total physicians per 1000 population.

Real per capita gross domestic product in 2007 dollars. Deflated using the GDP Deflator, 2007=100.

Real per capita federal cash transfer revenues. In 1997 dollars, deflated using the Government Current Expenditure Implicit Price Index.

Proportion of population aged 65 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.

Canada Health and Social Transfer. 1 if combined Canada Health and Social Transfer in effect (1996-2004), 0 otherwise.

Year (defined as a time indicator variable running from 1 to 33)

Table 1-b: Regression Variables, Spain

Dependent Variables
Real per capita provincial government total health expenditures in Euros deflated. Source: BBVA Foundation and Ivie (Instituto Valenciano de Investigaciones Económicas) (2015).
Independent Variables
Number of total physicians per 1000 population. Source: Spanish Institute of Statistics
Real per capita gross domestic product in 2010 euros. Source: Spanish Institute of Statistics
Proportion of population aged 65 or greater.
1 if Andalucia, 0 otherwise. 1 if Aragón, 0 otherwise 1 if Asturias, 0 otherwise. 1 if Balears Islands, 0 otherwise. 1 if Canarias, 0 otherwise. 1 if Cantabria, 0 otherwise. 1 if Castilla and Leon, 0 otherwise. 1 if Castilla-La Mancha, 0 otherwise. 1 if Cataluña, 0 otherwise. 1 if Region of Valencia, 0 otherwise. 1 if Extremadura, 0 otherwise 1 if Galicia, 0 otherwise. 1 if Madrid, 0 otherwise 1 if Murcia, 0 otherwise. 1 if Navarra, 0 otherwise 1 if Basque Country, 0 otherwise. 1 if La Rioja, 0 otherwise
Year (defined as a time indicator variable)

Table 2: Regression Results, Canada & Spain

Estimation Technique: Cross-sectional time series FGLS, heteroskedastic, common AR(1)

a) Canada

Dependent Variable
Log of Real Per Capita provincial government health expenditures (dollars)

	Log-Log A		Log-Log B	
	Coefficient	z	Coefficient	Z
Log of Total Physicians per 1,000	0.3508	4.67	0.2926	4.33
Log Real Per Capita GDP	0.5254	9.37	0.2765	4.80
Log Real Per Capita Federal Transfers	0.0614	3.92	0.0466	3.29
Log of Proportion Aged 65 and Over	0.3493	3.99	-0.2561	-2.71
Newfoundland & Labrador	0.0239	0.66	-0.0351	-0.99
Prince Edward Island	0.1281	2.41	0.1050	2.23
Nova Scotia	-0.0413	-1.05	-0.0270	-0.76
New Brunswick	0.0804	2.04	0.0546	1.58
Quebec	-0.0092	-0.32	-0.0395	-1.55
Manitoba	0.0445	1.29	0.0773	2.86
Saskatchewan	-0.0037	-0.10	0.0842	2.56
Alberta	-0.0615	-1.11	-0.1150	-2.35
British Columbia	0.0335	1.37	0.0807	3.82
Canada Health & Social Transfer	0.0124	1.12	-0.0245	-2.31
Time Trend			0.0156	9.99
Constant	2.0999	3.00	3.3443	5.20
Observations	330		330	
Wald chi^2	1153		1555	

b) Spain

Dependent Variable
Log of Real Per Capita regional government total health expenditures (euros)

	Log-Log A		Log-Log B	
	Coefficient	z	Coefficent	Z
Log of Total Physicians per 1,000	0.0163	0.30	0.0187	0.50
Log of Real Per Capita GDP	0.8385	5.00	1.1999	11.70
Log of Proportion Aged 65 and Over	-0.8081	-2.10	-1.2722	-5.38
Andalucia	0.4825	4.21	0.6903	10.82
Aragon	0.6168	4.73	0.8436	10.79
Asturias	0.9222	5.93	1.2559	13.48
Balears	0.1916	2.01	0.2526	4.91
Canarias	0.3552	2.62	0.4477	5.83
Cantabria	0.7207	6.69	0.9649	14.72
Castilla and Leon	0.8029	4.93	1.1403	11.65
Castilla-La Mancha	0.7226	6.39	1.0145	14.55
Cataluna	0.3145	3.86	0.4198	10.08
Valencia	0.4852	5.00	0.6838	12.94
Extremadura	0.9855	7.76	1.3616	18.01
Galicia	0.8379	5.75	1.1860	13.52
Murcia	0.5096	4.19	0.6605	9.93
Navarra	0.4329	4.60	0.5468	10.53
Basque	0.4988	4.22	0.6317	9.76
La Rioja	0.5659	4.86	0.7591	11.03
Time Trend			0.0315	17.71
Constant	0.4799	0.20	-2.2277	-1.51
Observations	204		204	
Wald chi^2	98		637	

VI. Conclusion

Canada spends considerably more per capita on health than Spain while basic health outcome indicators suggest that the performance of Spain's health care system has improved more than Canada's. Canada's health spending is generally more income inelastic than Spain's and its income elasticity of health spending ranged from 0.28 to 0.52 whereas Spain's ranged from 0.84 to 1.2. An important difference between Canada and Spain in terms of their economies is Canada's higher per capita GDP which can partially explain the gap in spending. Moreover, given that Canada's real per capita GDP has grown since 2002 while Spain's has declined, is an important factor explaining the difference in real per capita health spending between the two countries.

Another difference is in physician intensity – that is, Canada has fewer physicians per capita than Spain but here we find that physician numbers are a more statistically significant driver of real per capita provincial government health expenditures in Canada but not in Spain despite the fact that the per capita number of physicians is greater in Spain. Indeed, physician density has grown in Canada since 2002 while in Spain it has remained stable.

Adding one physician per 1,000 of population would increase real per capita government health spending in Canada by approximately 16.2 percent or $316. For Spain, adding one physician per 1,000 population would increase real per capita health spending by 0.3 percent or about 41 Euros. Between 2002 and 2013, the average regional number of physicians per 1,000 population in Spain has remained flat whereas in Canada it has grown from 1.79 to 2.21.

As for aging, aging per se – that is the effect of seniors – is not a significant positive driver of spending in either Canada or Spain suggesting the impact of age on health spending is a more complicated phenomenon than popular discussion would suggest. The proportion of population aged 65 and over is often negatively correlated with real per capita provincial government spending when variables like time trend and income are included suggesting any positive effects of aging on health spending are intertwined with these variables. Meanwhile, technological change, as measured by time trend appears to be a greater driver of spending for Spain than for Canada with an average annual increase in spending of 3.2 percent annually compared to 1.6 in Canada.

From a policy perspective, there seem to be interesting lessons here for international public health care systems. First, the relative size and strength of expenditure drivers differs between these two countries and explains much of the difference between Canada and Spain when it comes to real per capita health spending. Canada – relative to Spain – has seen greater growth in both physicians per 1,000 population as well as real per capita GDP – both factors of significant importance when it comes to driving health spending. While the effects of time are greater in Spain than Canada in terms of impact on annual spending increases, they have not been sufficient to overcome the gap between Canadian and Spanish real per capita public health spending.

Second, when it comes to health outcomes, more spending per se does not necessarily translate into greater health outcomes at least in terms of the macro level health indicators used here. With respect to public health care spending, Canada spends approximately 48 percent more than Spain and yet by 2012 life expectancy at birth in Spain was 1.3 percent higher and infant mortality 35 percent lower in Spain. This would suggest that given value for money, the Spanish health care system is able to deliver a more cost-effective performance at least when it comes to these basic health indicators.

Notwithstanding the potential impact of other socio-economic determinants on health status, this raises the question of what Canada can do more efficiently in running its public health systems given its provinces are spending substantially more than Spanish regions. One factor here is the response of health spending to physician numbers given that Canadian health spending is more elastic to physician numbers and has seen greater growth in physician numbers in recent years. Indeed, the institutional structure and differences of physician behaviour in these two countries may be factors worth examining more carefully as might be the funding mechanisms of their respective government systems.[29]

Acknowledgements & Declaration

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[29] In the context of Canadian federalism, equalization and transfers, there may indeed be additional interplay with effects on health spending.[82]

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APPENDIX I.

Data Sources: Canada

Real per capita provincial government health expenditures, Canadian Institute for Health Information, National Health Expenditures, 2015
Family Physicians Per 1000 pop, Canadian Institute for Health Information National Physician Database.
Special Physicians Per 1000 pop, Canadian Institute for Health Information National Physician Database.

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Federal Cash Transfers, Federal Fiscal Reference Tables, Finance Canada

Provincial Population, Statistics Canada
Proportion of Population Aged 25 to 44 Years, Statistics Canada
Proportion of Population Aged 45 to 64 Years, Statistics Canada
Proportion of Population Aged 65 to 74 Years, Statistics Canada
Proportion of Population 75 years and Over, Statistics Canada

Government Current Expenditure Implicit Price Index (1997=100), Canadian Institute for Health Information, National Health Expenditures, 2015

Data Sources: Spain

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Number of total physicians per 1000 population. Source: Spanish Institute of Statistics