DETERMINANTS OF HEALTH EXPENDITURES IN OECD COUNTRIES

The Honors Program
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ABSTRACT

Around the world, governments are coping with spiraling health care spending. This spurs the need for further insight in the determinants of such expenditures. This study investigates the determinants of health care expenditures for a sample of thirty five countries in the Organization for Economic Cooperation and Development (OECD) from 2000 to 2013 in order to understand the impact of different factors on health care spending growth. Besides Gross Domestic Product (GDP), the study accounts for many different driving forces such as demographics, medical progress, health system characteristics, public financing, and other non-medical determinants of health spending such as alcohol and tobacco consumption. Fixed and random-effects panel data models were used to examine the factors influencing health care expenditures and their results are compared.

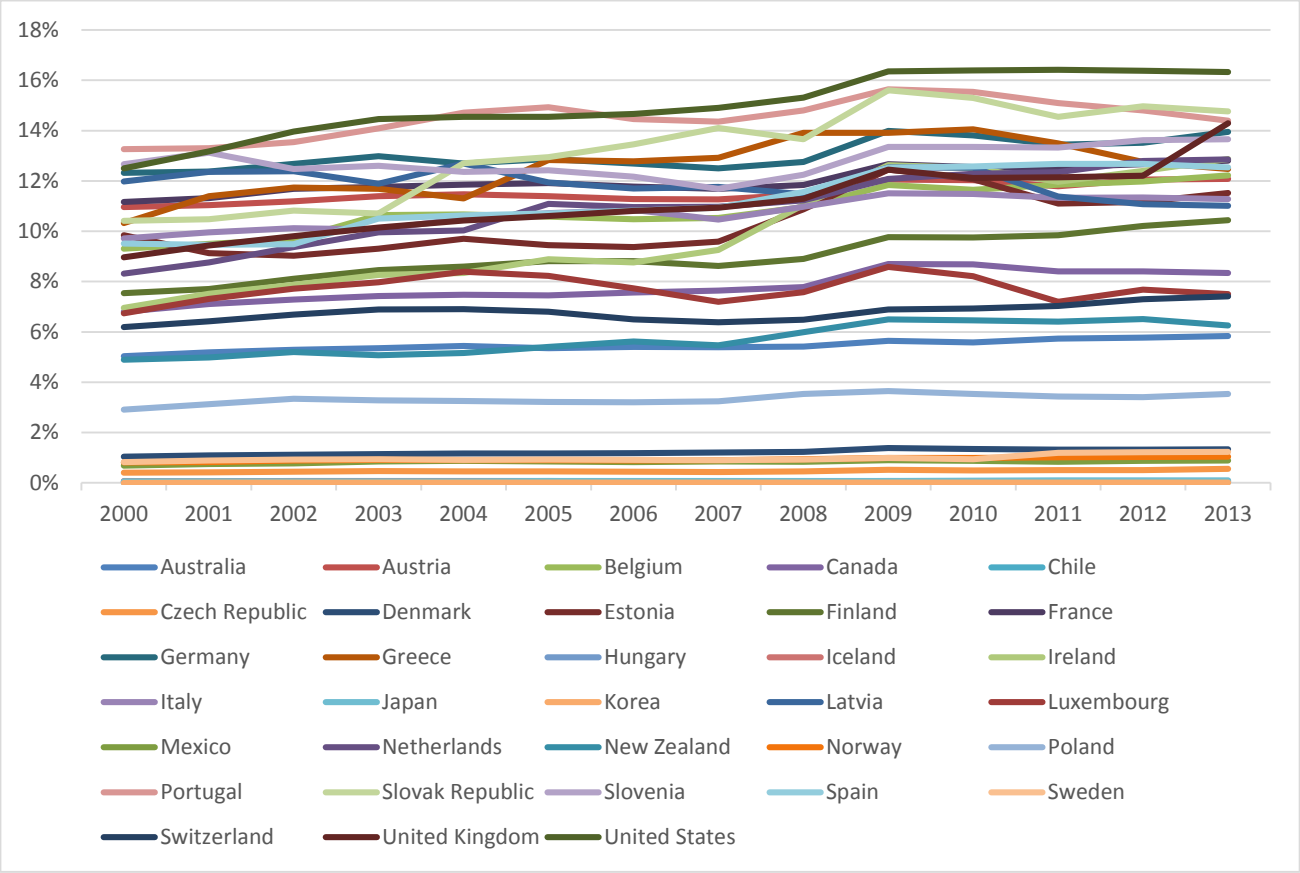
JEL Classification: I10, I11, I12, I14, I18

Keywords: Income Elasticity; Health, Physician, Mortality, Public Health; OECD Countries

1.0 INTRODUCTION

Over the last few decades, health care expenditures[1] have been rising faster than overall economic growth in most developed countries and almost all countries have seen their health care spending increase as a proportion of Gross Domestic Product (GDP) over time (**Figure 1**). Especially in the U.S., total expenditures on health as a percent of GDP has risen from 12.51% in 2000 to 16.39% in 2010. However, the growth has come to a halt in the wake of the 2008 financial crisis. On average, health spending as a share of GDP rose from 6.43% in 2000 to 7.99% in 2011 in OECD (Organization for Economic Cooperation and Development) countries ("OECD Health Statistics", 2016).

Figure 1: Total Expenditures on Health as Percent of GDP



Source: OECD Health Data 2016

1 In this paper, health (care) expenditures and health (care) spending are used as synonyms.

There are a great number of factors contributing to the increase in health spending levels in all developed countries. Those determinants of health expenditures include GDP growth, life expectancy, infant mortality, medical progress, technological improvement, public financing, population aging, alcohol consumption, tobacco consumption, and so on. While the majority of the research on health care expenditures has mentioned those factors, the method of study is still limited. Cross-sectional data could lead to potential bias of the measures of outcome with regards to capturing time-related problems. Moreover, cross-sectional studies have also raised some statistical and methodological problems when trying to figure out whether health care is a necessity or a luxury good. In those studies that utilize the time series technique, the problem of stationary and non-stationary variables are not always satisfactorily determined, therefore leading to the issue of deterministic trend, outliers, and heteroskedasticity. Moreover, there are few studies that cover the most recent period.

This paper makes progress in several aspects. First, it covers the current health care expenditures in the recent period from 2000 to 2013. Second, it avoids the inconvenience and weaknesses of time series and cross-sectional data by using panel data to analyze the dynamic relationship between health spending and various independent variables. This research will test the hypothesis that several important factors such as GDP per capita, life expectancy, public financing, and population aging, etc. would have a great impact on health care expenditures in OECD countries in the past few years.

From a policy perspective, this study is important as the determinants of health expenditures receive a lot of attention from policy makers, researchers, and politicians as the rapid growth of health expenditures has become a grave concern for both households and governments. The ultimate goal of this study is to observe different comparable variables and their significance in determining the level of health care expenditures in 35 OECD countries from 2000 to 2013.

The rest of the paper is organized as follows: section 2 discusses the current health care trends. Next, section 3 presents a literature review and the fourth one describes the database and empirical methodology. Section 5 explains the empirical findings, followed by conclusions in section 6. Finally, this paper ends with the appendices and references.

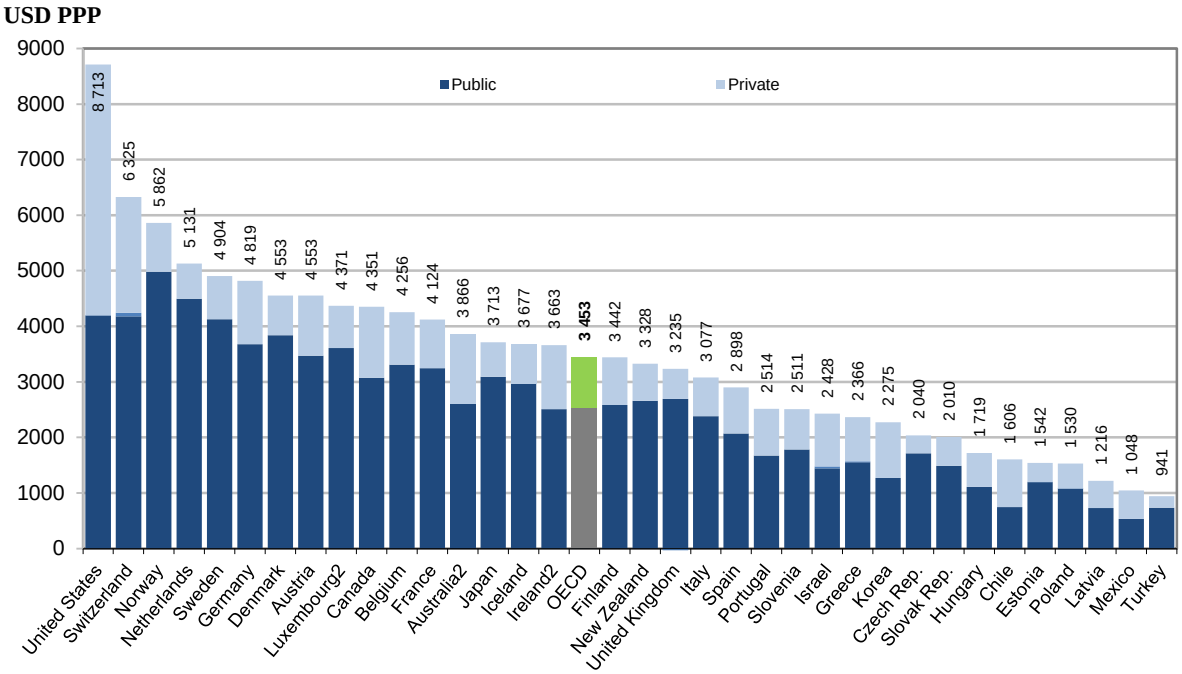
2.0 CURRENT TRENDS

2.1 Current Trend in Health Care Expenditures

In 2013, the United States outspent all other OECD countries by a wide margin, with an equivalent of $8,713 per person annually (**Figure 2**). This number is more than twice the OECD's average of $3,453 and nearly 40% higher than that of Switzerland, the second biggest spender, with $6,325. Compared with Turkey, the lowest spender among OECD countries, the United States spent more than nine times on health care for each US resident. Compared with some G7 countries, the U.S. spent around twice as much as other countries like Germany, France, and Canada did.

Figure 2 also shows how public and private sources are allocated in each country. Public health care expenditures in the United States still remain the highest among all OECD countries. Meanwhile, the U.S. private sector plays an even bigger role in financing its health care system.

Figure 2: Health Expenditure per Capita, 2013



Note: Expenditure excludes investments, unless otherwise stated.

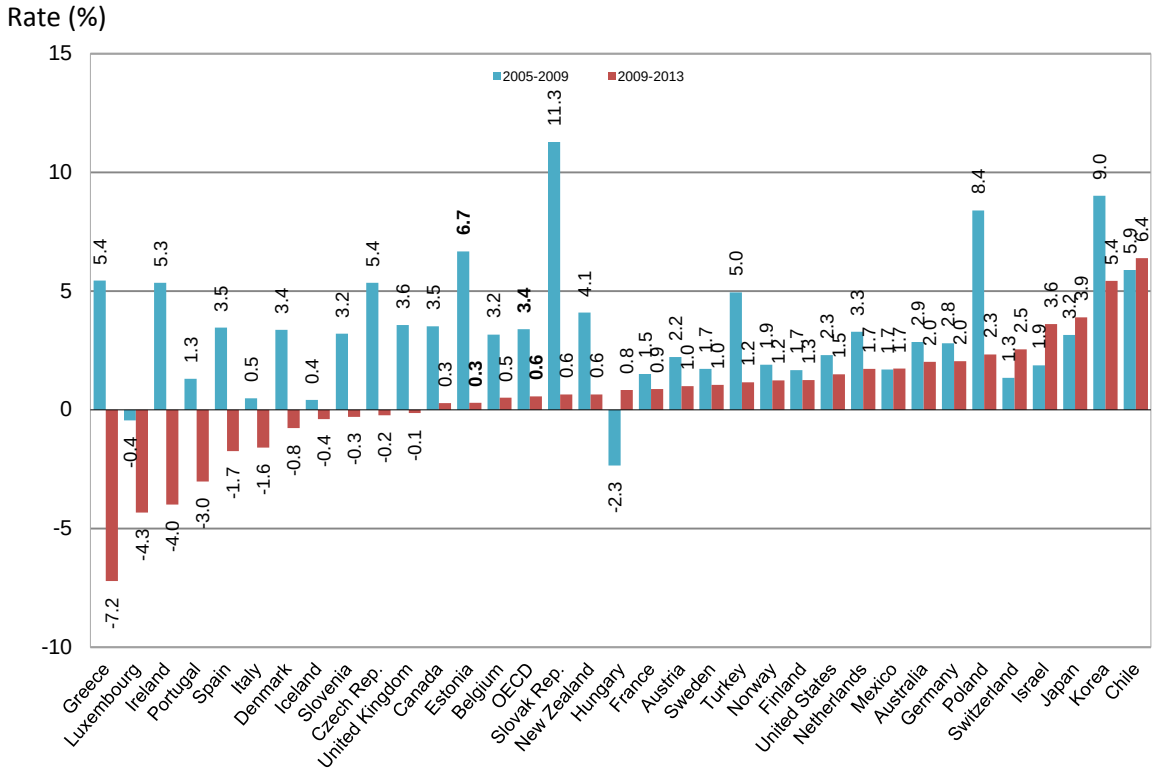
1. Includes investments.

2. Data refers to 2012.

Source: OECD Health Statistics 2015; WHO Global Health Expenditure Database.

There have been some significant changes in the annual growth rates in per capita health expenditures before and after the financial crisis. In the Slovak Republic, the annual health care growth rate has decreased by 10.7% (11.3% vs. 0.6%) after the crisis. In Greece and Ireland, annual growth rates have been reversed significantly. Only six countries including Japan, Hungary, Switzerland, Israel, Chile, and Mexico have recorded a higher level of growth even after the recession.

Figure 3: Annual Average Growth Rate in Health Expenditure per Capita, from 2005 to 2013

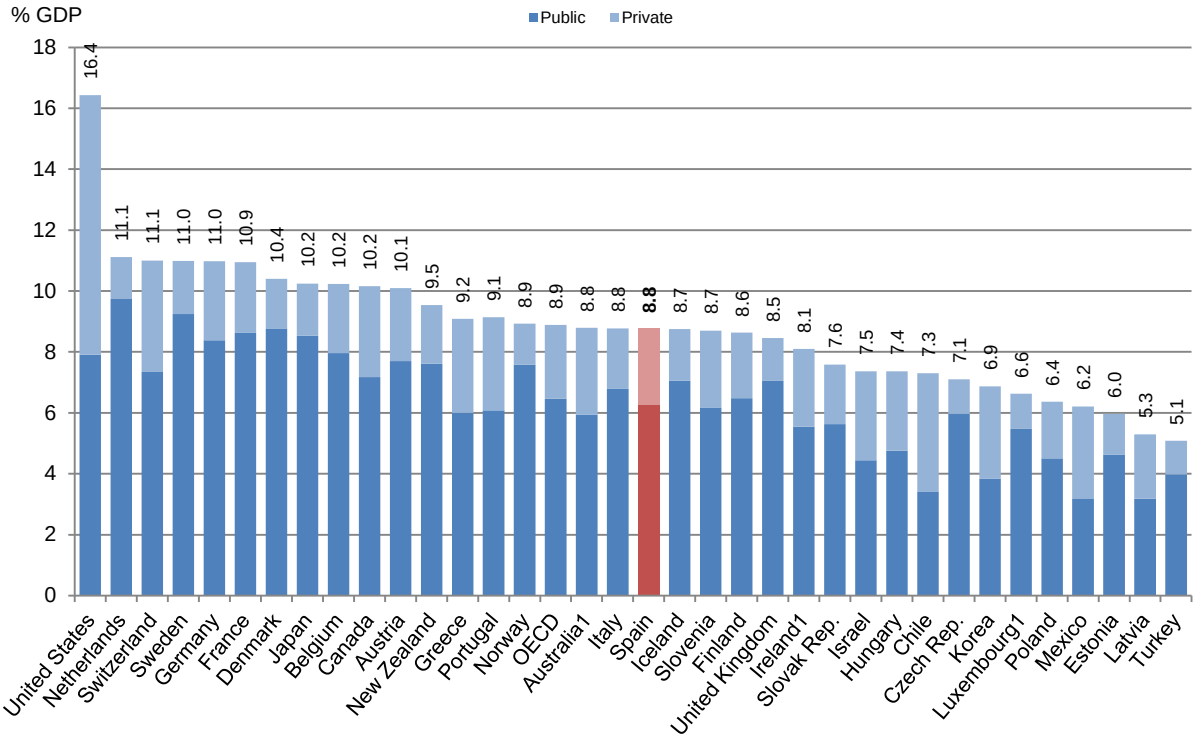


Since 2000, health care spending growth has always been higher than GDP growth across many OECD countries ("*Health at a Glance 2015: OECD Indicator*", 2015). Nevertheless, as a result of the financial crisis in 2008, there was a reduction in health spending to GDP ratio in those countries.

Health care expenditures accounted for 8.9% of GDP on average among all OECD

countries in 2013 (**Figure 4**), which stayed the same compared to 2012 and up from 8.8% in 2011. In 2013, the United States remained the highest spender on health care with 16.4% of GDP, outspending more than five percentage points compared to the second biggest spender groups which include the Netherlands, Switzerland, Sweden, Germany, and France. Overall, almost half of the OECD countries spent about 9% of GDP on health care. Meanwhile, Latvia and Turkey spent the least with around 5% of GDP on health services.

Figure 4: Health Expenditure as a Share of GDP, 2013



Note: Expenditure excludes investments, unless otherwise stated.

1. Includes investments.

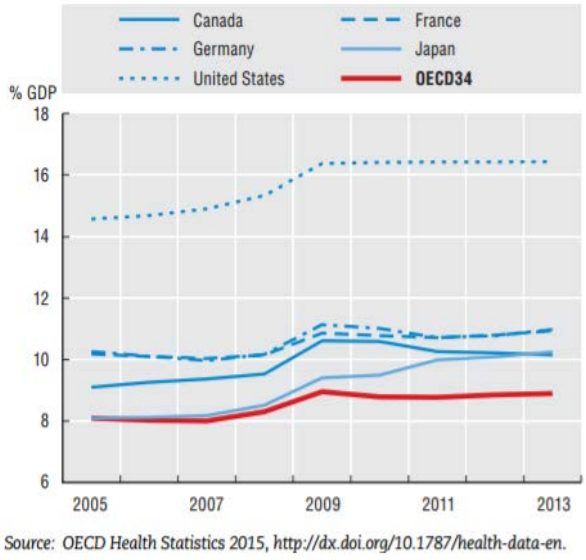
2. Data refers to 2012.

Source: OECD Health Statistics 2015; WHO Global Health Expenditure Database.

It is clear that health expenditure growth has been aligned to the economic growth in many OECD countries over the past decade. Government deficits and the economic crisis are some of the reasons for the drop in health care spending (especially in the public sector) after 2008 (**Figure 5** and **6**). Health spending to GDP ratio in the United States has

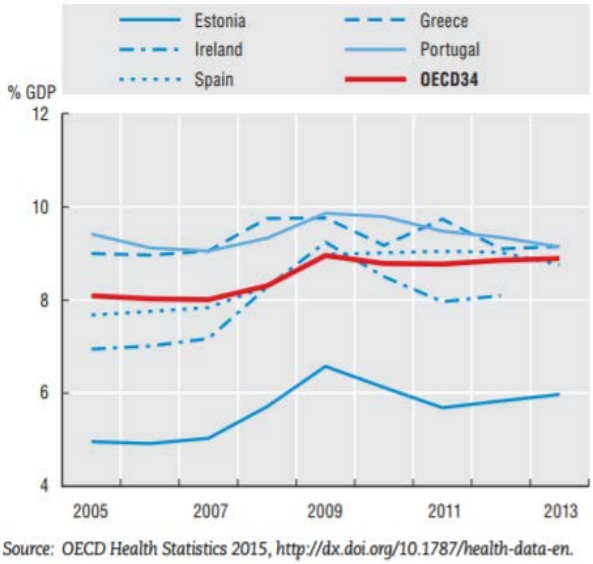
remained the same since 2009 in contrast to a steady increase of 2 percentage points in the period from 2005 to 2009 (**Figure 5**). Canada's ratio reached its peak in 2009 and since then its health spending to GDP ratio flat-lined. Japan, on the other hand, has always shown a steady increase in the level of health expenditure even amid the slowdown of economic growth in 2009. This constant rise is the result of a deliberate policy to foster public health care in Japan (*"Health at a Glance 2015: OECD Indicator"*, 2015). Meanwhile, France and Germany have experienced a steady level of health expenditure as a share of GDP as a result of their stable economy. Other European countries, such as Ireland and Portugal saw a substantial decline in their health spending to GDP ratio after 2009 (**Figure 6**). Greece, with its fluctuation in the level of GDP growth and its significant cuts to health spending over the years, shows some substantial ups and downs in health spending to GDP ratio.

Figure 5: Health Expenditure as a Share of GDP, Selected G7 Countries, 2005-2013



Source: OECD Health Statistics 2015, http://dx.doi.org/10.1787/health-data-en.

Figure 6: Health Expenditure as a Share of GDP, Selected European Countries, 2005-2013



Source: OECD Health Statistics 2015, http://dx.doi.org/10.1787/health-data-en.

2.2 Current Trends in Determinants of Health Care Expenditures

Across OECD countries, people are living longer than ever before, with life expectancy now exceeding 80 years on average, thanks to improvements in living conditions, educational attainments, and most importantly, improvement in health care ("Health at a Glance 2015: OECD Indicator", 2015). In most countries, universal health coverage provides financial protection against the rising cost of illness and promotes access to health care for the whole population. The quality of health care is also significantly improved throughout the years, as shown in the reduction of deaths in heart attacks or improved treatments for serious diseases and cancer. Nevertheless, the improvements come with cost. Higher health care spending is not a problem if benefits outweigh the costs but there is ample evidence of inefficiency and ineffectiveness in health care systems.

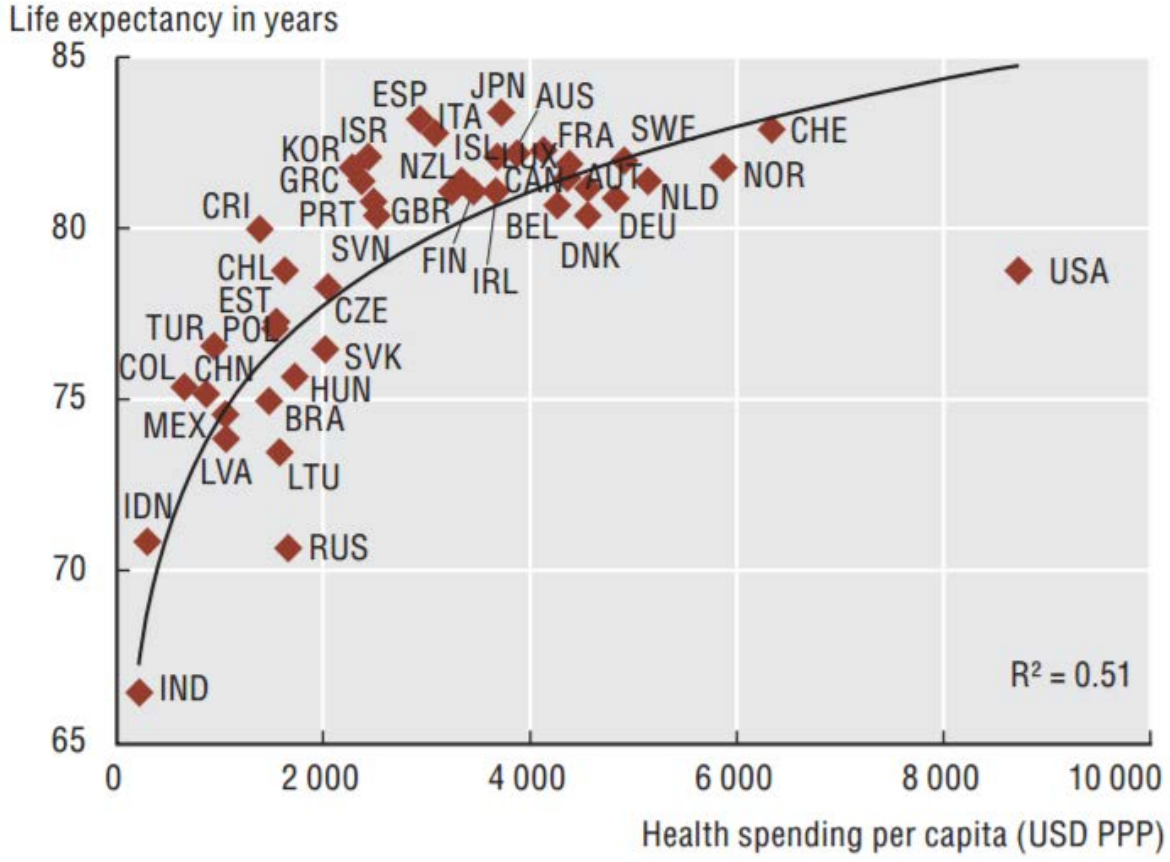
Health Status

Life expectancy continues to increase steadily in OECD countries, rising on average by 3 - 4 months each year. In 2013, life expectancy at birth reached 80.5 years of age on average. Japan, Spain, Switzerland, Italy and France are those countries that have the highest life expectancy at birth, although France does not perform very well in terms of life expectancy at birth for men, showing higher mortality rates among younger and middle-aged men. On the other hand, Mexico, Hungary, the Slovak Republic and Turkey have the lowest life expectancy at birth, even though Turkey has achieved huge gains in longevity over the past few decades and is quickly moving towards the OECD average

Although higher health spending per capita is generally associated with higher life expectancy, this relationship is less prominent in countries at the highest levels of health

spending per capita. Japan, Spain and Korea stand out as having relatively high life expectancies, and the United States relatively low life expectancies, given their levels of health spending (see **Figure 7**). Life expectancy in the United States is lower than in most other OECD countries because of higher mortality rates from various health-related behaviors such as higher obesity rates, higher consumption of drugs, and higher deaths from road traffic accidents and homicides, adverse socio-economic conditions, and poor access of care for certain population groups.

Figure 7: Life Expectancy at Birth and Health Spending Per Capita, 2013



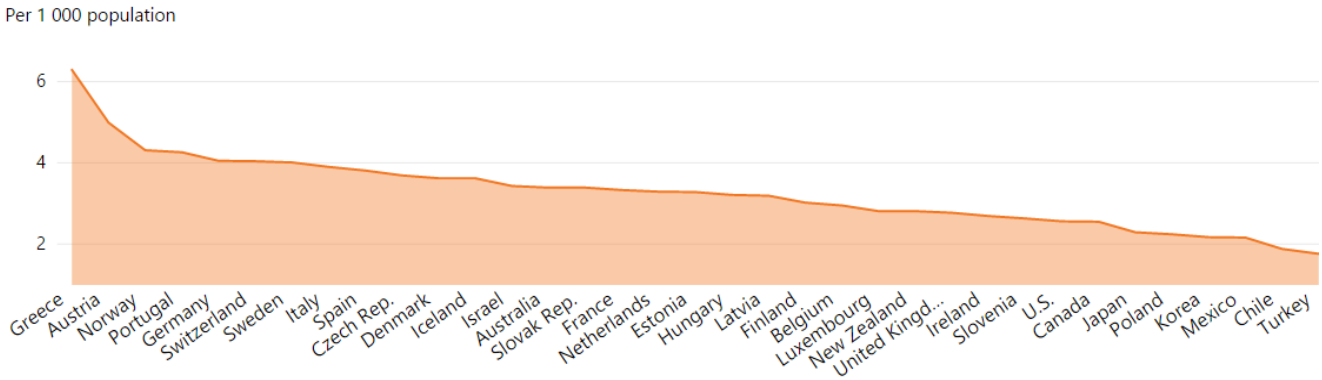
Source: OECD Health Statistics 2015

Health Resources

Higher spending on health care expenditure does not always associate with higher spending on health resources in terms of physical and technical equipment in health systems. The number of doctors and nurses has never been higher in OECD countries and varies widely across OECD countries. According to **Figure 8**, Greece, Austria, and Norway have the highest number of physicians per 1000 population in 2013.

The significant increase in the number of doctors is due to a higher number of foreign-trained doctors working in OECD countries in response to short-term needs and a surge in student intakes in medical programs. Turkey, Korea, Mexico and the United Kingdom are those countries with the highest rate of increase in the number of physicians

Figure 8: Physicians per 1000 Population, 2013

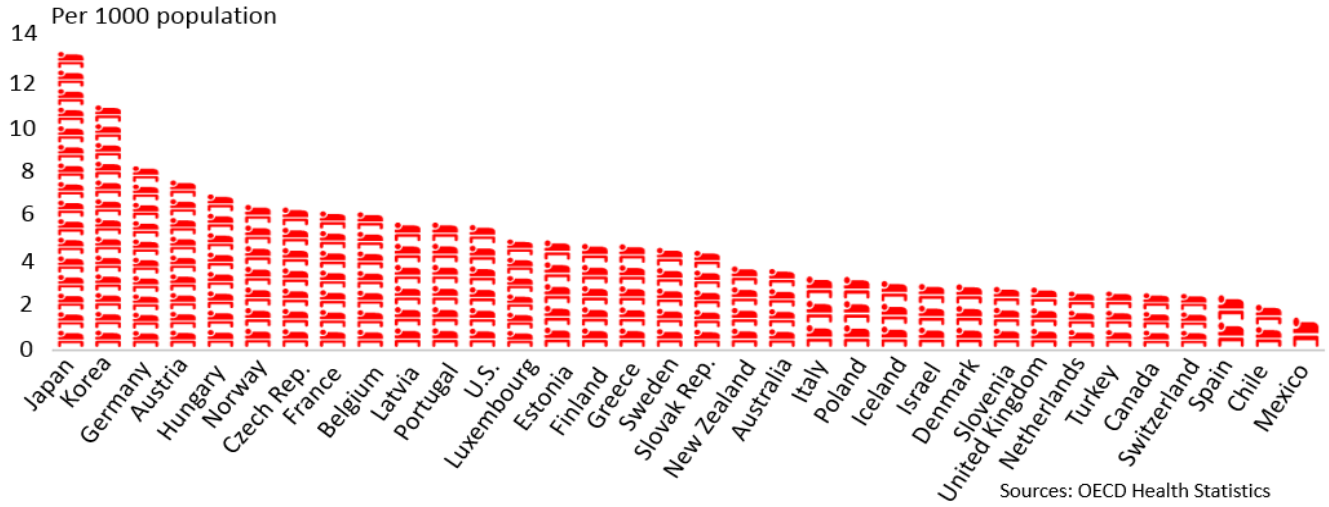


Sources: OECD Health Statistics

The number of hospital beds provides the access to health care and therefore measures the resources available for delivering health services. Among OECD countries, Japan and Korea have the highest number of hospital beds with more than 11 beds per 1000 population, as seen in **Figure 9**. These two countries have the "social admissions" in which a significant part of hospital beds is devoted to long-term care. From 2000 to 2013, the

number of hospital beds in 35 OECD countries has been decreasing as a result of the medical progress which allows day surgeon and avoid the need for hospitalization.

Figure 9: Hospital Beds per 1000 population, 2013

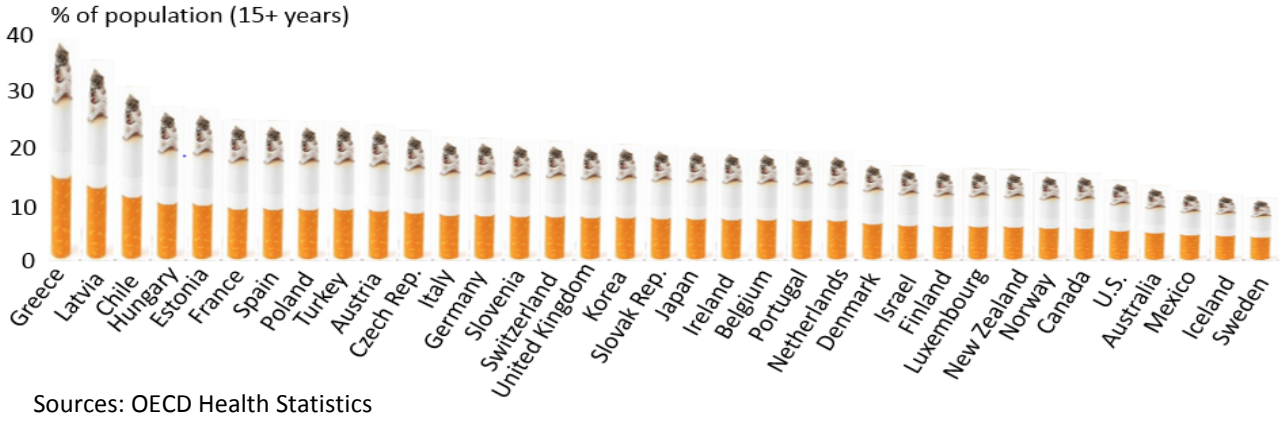


Risk Factors of Health

Most OECD countries do not perform well for at least one of the risk factors affecting health such as tobacco or alcohol consumption. This underlines the importance of raising awareness among people within the society and of putting higher priority on disease prevention and health promotion to reduce risk factors to health.

The proportion of daily smoking in adult varies greatly among OECD countries. According to **Figure 10**, more than half of OECD countries had less than 20% of the population smoking daily in 2013. Smoking rates are lowest in Sweden, Iceland, Mexico, and Australia while smoking prevalence is highest in Greece, Latvia, and Chile. Smoking rates across most OECD countries have been diminishing over the years in response to rising rates of tobacco-related diseases and public awareness campaigns.

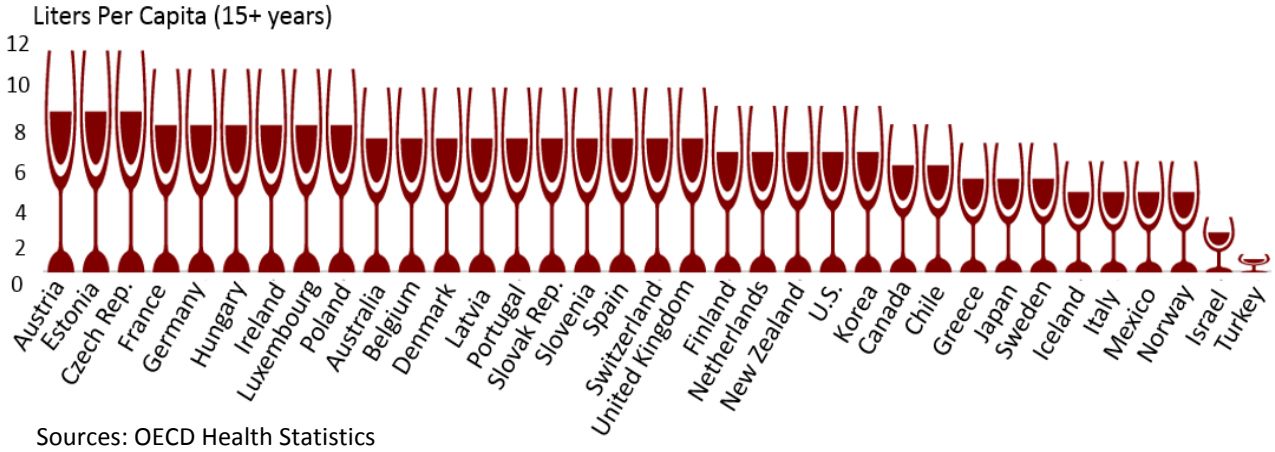
Figure 10: Daily Smoking in Adults, 2013



Sources: OECD Health Statistics

On average, alcohol consumption was at 8.9 liters per adult across OECD countries in 2013. The highest consumption of alcohol was recorded in Austria, Estonia, and Czech Republic with 11.5 liters per adult annually (**Figure 11**). Low alcohol consumption was recorded in Turkey and Israel, where religious and cultural traditions restrict the use of alcohol in some population groups.

Figure 11: Alcohol Consumption among Adults, 2013



Sources: OECD Health Statistics

3.0 LITERATURE REVIEW

Previous literature reviews have examined various determinants of aggregate health care expenditures. They mention the effects of aggregate income, institutional, and socio-demographic factors on health care such as per capita GDP, public financing, proportion of the population aged 65 and older, and medical progress. By using household or macroeconomic data, those studies rely on different research methods such as cross-sectional, panel, cointegration, and unit root methods, therefore obtaining different regression results.

Most studies show that income (using per capita GDP as a proxy) is the most important determinant of aggregate health care expenditures. Since the 1970s, Kleiman (1974) and Newhouse (1977) have identified the key role of income in explaining the differences of health care expenditures between countries. Earlier studies focus on income elasticity of health care and its impact on policy as well as the distribution of health care resources. Most cross-sectional regressions of aggregate health expenditure per capita on GDP per capita show that the coefficient estimate of GDP per capita is equal to or greater than one (Kleiman, 1974; Newhouse, 1977; Leu, 1986; Getzen, 2000), implying that health care is a luxury. Gerdtham (1992) conducted a study employing 1987 data from 19 OECD countries. He found per capita income to be one of the most significant determinants of per capita health expenditures[2]. The coefficient estimates for per capita income was -1.33, suggesting that there is income elasticity.

Nevertheless, one would intuitively expect income elasticities to be less than unity, inferring that health care is seen more as a necessity than a luxury. Much of the later studies have raised statistical and methodological issues with these cross-sectional approaches by indicating that health care is not a luxury good, as the inferences in the stationary tests have suggested (Hansen & King, 1996; Blomqvist & Carter, 1997; McCoskey & Selden, 1998; Gertham & Lothgren, 2000; Dreger & Reimers, 2005). More recently, a study by Baltagi and Moscone (2010) indicated that health care elasticity, with respect to income was about

[2] The coefficient estimates for urbanization, share of public health expenditure, share of inpatient care expenditure, and a fee-for-service fixed effect are also statistically significant.

0.87 in 20 OECD countries over the period 1971-2004. This analysis investigated the non-stationary and cointegration properties in health care spending, income per capita, and their long-run relationship. Possible reasons for the differences in income elasticity obtained in previous studies could be attributed to omitted variables bias, small data sets, the issue of non-stationary variable in health data and income, or the regional dimension of health care expenditures within a country. The disagreement over the nature of health care therefore has led to the controversy over health care policy implications. Advocates of health care being a necessity believe that the government should support the health care system. On the other hand, people who agree that health care is a luxury believe that government intervention is unnecessary and that the health care market should be left alone (Culyer, 1988).

However, numerous studies in the past possess some obvious limitations. First, those studies rely on cross-country data from a single year, therefore making it impossible to control for unobserved time – specific shocks that simultaneously affect all countries. Second, the data size for those studies is very small which preclude any benefits from asymptotic properties and further confound empirical estimates of income elasticity. Third, omitted variables bias could be a possible reason for the large income elasticities obtained in previous studies (Sen, 2005). Coefficient estimates of per capita income is biased upwards because of the absence of any controls for unobserved determinants of per capita health expenditures, which are time-invariant and time-varying within countries. Therefore, coefficient estimates of the impact of per capita income will be inflated by an inability to disentangle actual movements in per capita income from year-specific shocks that are common across countries.

Another important point that has be taken into consideration in many past studies is the reverse effects of health care expenditures on GDP (Erdil & Yetkiner, 2009). When treating health as part of human capital together with education, an increase in health care expenditures must ultimately lead to a higher GDP. Also, increases in health spending associated with effective health intervention increases labor supply and productivity, eventually leading to a higher GDP. This reverse causation makes it difficult to designate a clear impact of one variable to the other. There might be an endogeneity problem caused by the simultaneous causal relationship between GDP and health care spending. Several studies that applied the Granger-causality test (Granger, 1969) showed significant bi-directional

Granger-causality for high income countries. A study by Erdil and Yetkiner (2009) suggested that a one-way causality run from health care expenditures to GDP in high income countries. However, the results have been mixed. Another study by Hartwig (2008) showed no evidence that health spending causes per-capita GDP growth in 21 OECD countries with a positive sign.

Besides income, other important factors such as non-income determinants such as demographics, technological progress, and health system characteristics are also taken into consideration in previous literature. First, the age structure of the population has been seen as a significant variable in explaining per capita health spending across countries in several studies (Leu, 1986; Culyer, 1988). Indicators such as the percentage of population ages 65 and over and the percentage of population ages 15 and under have been included in regression models. According to Murthy (1994) and most of the studies, the share of the elderly has a positive correlation with future health care expenditure growth. As the elderly are usually cared for the remainder of their lives, health care expenses increase as well. For example, in Korea, the "social admissions", a significant part of health care expenditure, is devoted to long term care. Therefore, an increase in the percentage of elderly people results in a more than proportionate increase in health care costs. Other studies also argue that health care costs often remain constant throughout the senior years and only increase with proximity to death (Sen, 2005). In both cases, an aging population is expected to impose a significant burden on health care spending. However, little evidence exists on a significant level of these variables (Leu, 1986; Hititis and Posnett, 1922; Di Matteo and Di Matteo, 1998; Grossman, 1972). Age distribution shows a relatively modest impact on health cost compared to the income effect. On the other hand, Barros (1998) discovered that the effect of aging populations are unable to explain growth rates in health care expenditure. The percentage of elderly people might be negatively correlated with health expenditures. Obviously, there have been some mixed results associated with the aging population as a factor of health care spending.

Very few literature reviews from the past have considered technological progress as a covariate since the work by Newhouse in 1992 (Newhouse, 1992) which saw technological advances as an important driver of health care expenditures. This is due to a lack of reliable data on technological advances and the difficulty of finding a proxy for

changes in technology. In those small number of papers that mention technological progress, several proxies such as the number of specific medical equipment and surgical procedures have been considered (Baker & Wheeler, 2000; Weil, 1995; Mohan & Mirmirani, 2005). R&D spending in the health care sector is also chosen as a proxy for technological change (Okunade & Murthy, 2002). This study shows that real aggregate health care expenditure per capita does respond to R&D expenditure. As R&D spending continues to rise at historical rates and real income rises, health insurance is likely to be more expensive and therefore drive up health care expenditure. Furthermore, life expectancy and infant mortality are also common variables that have been widely used for both technological change and medical progress. The baby boomers are expected to cause a significant increase in health care costs in many OECD nations. As the baby boomers begin to grow older and life expectancy rates increase, leading to a surge in health expenditures. Moreover, as infant mortality has a high correlation with the aging population, infant mortality rates become a significant factor affecting health care expenditure, granted that the population is healthier. Thus, life expectancy and infant mortality are two exogenous variables that are major determinants in the level and growth of health spending, according to Dreger and Reimers (2005). Additionally, most of these studies use a time trend or a set of time fixed effects as technological progress changes over time that would help in the absence of a suitable measure. There are also studies that incorporate different proxies to come up with a better method of accounting for technological advancement.

Structural characteristics of the health care system such as health financing, the number of physicians, and the number of hospital beds per capita are also included in previous studies. The role of government in health care financing has evoked some controversy over the past few decades. In terms of financing structures, Leu (1986) argued that the share of public health financing had a positive effect on total health expenditures. In other words, he stated that health care expenditure should increase with the share of public finance, under the assumption that this share reduced the price to consumers. Culyer (1988) continued this line of reasoning by explaining that Leu's hypothesis came from a passive response of the financing agent who adjusts the supply of finance to the quantities and prices of health care. He stressed the degree of open-endedness of financing which plays a bigger role in health care growth rates and a lack of business restrictions in health care. While

open-ended financing systems are characterized by multiple finance resources such as different insurance companies and by fee-for-service remuneration, close systems are characterized by one or few finance agents, global or national budget for hospitals, and prospective payments such as capitation for outpatient services. Even though the impacts of the share of public financing and provision on health care expenditure cannot be determined a priori, countries with more closed financing systems are anticipated to have lower expenditure. By contrast, Gerdtham et al. (1992) reported that the impact of public financing in health care cannot be determined as countries with a larger share of public financing do not seem to be characterized by higher health care expenditure. Thus, public health care has mixed results on total health care expenditures in previous studies.

Another institutional feature of health systems that may influence health care expenditures is the fee-for service system which imposes a higher cost on health spending than other capitation schemes (Gerdtham et al., 1992). Under a fee-for-service system, physicians may adjust their work load in response to changes in the environment so that their target income is maintained (Evans, 1974). Hence, a shift from financing hospitals through budgets to fee-for-services or patient-based payment mechanisms is associated with increases in both public and private components of health care expenditure.

As mentioned above, the use of physicians or general practitioners as gatekeepers of the health care system seems to result in higher health expenditure. When the stock of physicians increases and the work load decreases, physicians tend to induce the patients to use more services at higher prices (Gerdtham et al., 1992). Moreover, according to Sen (2005), an increase in salaried physicians can lead to higher per capita health expenditures. However, he also mentions that an increase in the number of physicians might not have much impact on health costs under a fee-for-service system if there is a flux of patients from existing to new practitioners. However, per capita health expenditures will definitely rise if there is an increase in the number of visits for existing physicians.

Last but not least, another proxy for health resources is the number of hospital beds per 1000 of population. This exogenous variable captures trends in patient care access in health care. Even though there are not a lot of studies in the past that use this variable as a structural characteristic of the health care supply, there exists evidence on restrictions on

hospital bed supply as a component of reducing health expenditures (Vandersteegen, 2014).

Less frequently adopted determinants of health care expenditures are population density (Hellinger & Encinosa, 2006), urbanization (Gerdtham et al., 1992), the price of health care (Roberts, 1999), and international aid (Liang & Mirelman, 2014). Furthermore, Gerdtham et al. (1992) also includes institutional factors in their analysis.

4.0 DATA AND EMPIRICAL METHODOLOGY

4.1 Data and Variables

This study uses data from OECD Health Statistics 2016 to collect panel data from 2000 to 2013 for a sample of 35 OECD countries[3]. The data set is investigated by estimating heterogeneous panel model with cross sectional data and comparing its three regression outcomes that include Ordinary Least Square (OLS), Fixed Effects Model (FEM), and Random Effects Model (REM). Data were obtained from the World Bank Data Indicators and OECD Health Database. Independent variables consist of eight variables obtained from various sources. The list of variables, definitions, and data sources are shown in **Appendix A**, while **Appendix B** provides more details on the variable description, expected signs and justification for usage. Summary statistics for the data are provided in **Table 1**.

[3] Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.

Table 1. Summary Statistics (N = 490)

Variable	Obs.	Mean	Standard Deviation	Minimum	Maximum
Health expenditures per Capita (US$)	490	2914.7810	1523.5760	575.1512	8157.4230
Health Expenditures per Capita as a Share of GDP per capita	490	0.0847	0.0196	0.0490	0.1641
GDP per Capita (US$)	490	36508.27	21333.87	6926.75	110001.10
Public Financing (%)	490	71.9351	11.2549	35.9796	89.9983
Number of Physicians per 1000 population	490	2.9831	0.9025	0.8960	6.6167
Number of Hospital Beds per 1000 population	490	5.2567	2.4211	1.57	14.69
Alcohol Consumption (Liters per Capita)	490	9.4739	2.7571	1.20	14.80
Tobacco Consumption (Grams per Person)	490	14.4851	3.3745	6.30	22.00
Life Expectancy (years)	490	78.6545	2.9444	70.10	83.40
Population > 65 years old (% of total population)	490	14.6407	3.6280	5.0087	25.0093

4.2 Empirical Models

Following the model provided by Vandersteegen (2014), this study adapted and modified the model by using some variables from the original regression model and getting rid of the medical malpractice variable. I have added other variables such as public financing and several non-medical determinants of health care such as alcohol and tobacco consumption.

Information is available for the period 2000 – 2013 for all 35 OECD countries, which yields 490 observations. The data set consists of i = 1,…,N cross sections (number of groups), and several points of time series for each group t = 1,…,T(i), or a cross section of N time series each of length T(i). Panel data analysis is divided into fixed effects and random effects models. FEM looks at the impact of country effects while REM investigates time effects. In other words, FEM explores the relationship between outcome variables within a country. In this model, each country has its own individual characteristics that may or may not influence the predictor variables (for example, government schemes and compulsory contribution health care financing schemes in a particular country could have some effect on health care spending). On the other hand, the rationale behind REM is that it considers the individual effects as a random component of the error term and that variation across entities is assumed to be uncorrelated with the predictor or independent variables included in the model.

> "The crucial distinction between fixed and random effects is whether the unobserved individual effect embodies elements that are correlated with the regressors in the model, not whether these effects are stochastic or not." (Greene, 2008)

The two models are planned in the following way:

(A) $\ln PCHCE_{it} = \alpha + \beta'$ (lnPCGDP, PUBFIN, PHYS, BED, ALC, TOB, LIFE, POP65) + $u_{it} + \varepsilon_{it}$

(B) $(PCHCE / PCGDP)_{it} = \alpha + \beta'$ (PUBFIN, PHYS, BED, ALC, TOB, LIFE, POP65) + $u_{it} + \varepsilon_{it}$

where i = 1,…,N indicates country

t = 1,…,T(i) indicates year

β_i is a vector of coefficients for the vector of the variables

u_{it} is a classical disturbance term with $E[u_{it}] = 0$, $var[u_{it}] = \sigma^2_{\mu}$

ε_{it} is an error term.

In the regression stated above, two endogenous variables are *PCHCE* and (*PCHCE/PCGDP*). While *PCHCE* controls for per capita total (public and private) health expenditure, which is measured at purchasing power parity values in US$, (*PCHCE / PCGDP*) is per capita health care expenditures as a share of per capita gross domestic product in US$.

Taking into account the availability and quality of data for the OECD countries and the findings from past studies, this paper selects several independent variables for the regression. *PCGDP* represents Gross Domestic Product (GDP) per capita measured at purchasing power parity values in US$. GDP is an aggregate measure of production equal to the sum of the gross values added of all resident institutional units engaged in production. Other independent variables used in the regression include: proportion of total health care expenditures that is publicly financed (*PUBFIN*), which also accounts for a country's socio-political environment, number of physicians per 1000 inhabitants (*PHYS*), number of hospital beds per 1000 population (*BED*), alcohol consumption in liters per person (age 15+) (*ALC*), tobacco consumption in grams per person (age 15+) (*TOB*), life expectancy in years (*LIFE*) as a proxy for medical progress, and population age structure (proportion of the population aged 65 or more) (*POP65*). Per capita health care expenditures and per capita GDP are in logs. Variables are in constant prices.

OLS regression is also used to estimate the two models. However, differences in variances may interfere with the OLS regression method and a robust estimator will be included in the estimations to account for heteroskedasticity. Standard errors are found in parentheses estimated coefficients and are White-corrected for heteroskedasticity. All regressions are estimated using STATA.

5.0 EMPIRICAL RESULTS

This section presents the results of the regressions, descriptions and explanations for their significance. The primary goal of this study is to identify the determinants of health care expenditures in the OECD countries. This paper looks at the dynamic relationship among different dimensions of health status, from public financing, demographic references, non-medical determinants of health, to health care resources on health care expenditures over the period from 2000 to 2013. For each of the exogenous variables, the interaction is assessed twice to see whether those variables yield the same result in both models.

All FEM and REM regressions are ran with the same variables as in OLS regressions. The Hausman Test was used to see whether FEM and REM would be the more accurate to use with this panel, which will be discussed in the next section. In **Table 2**, **Table 3**, **Table 4**, and **Table 5**, regression results of the OLS and FEM of health spending for 35 OECD countries are reported. This study runs different regressions for each model A and B (all regressions are labeled from 1 to 6).

Based on the regression results, all OLS, FEM, and REM regressions consistently point to the same direction. Overall, almost all coefficients of our control variables have the expected sign and are statistically significant except for three variables which are alcohol consumption, tobacco consumption, and number of hospital beds.

To control for heterogeneity or unobserved effects, Hausman test analysis is carried out. A Hausman test can be run to determine whether Fixed Effects or Random Effects model is the most suitable for this study. It is assumed that if the cross-section specific, error component, and the regressors are uncorrelated, the random effects model is preferred; otherwise, the fixed effects model is more appropriate. The hypotheses of the Hausman are as follows:

H_0: Random Effects Model

H_a: Fixed Effects Model

The Hausman test is performed on six regressions as seen in **Table 2** and **Table 3**. All six regressions suggest that H_O should be rejected and therefore a FEM produces better coefficient estimates. Thus, the FEM turned out to be the best specification.

MODEL A

Using FEM for all three regressions of Model A (regression 1, 2, and 3) in **Table 2**, this study points out several factors that help explain the cost of health care, such as GDP per capita, public financing, life expectancy, and population aged 65 and older. The estimated coefficients results were expected for three out of eight variables and quite similar to those reported in other studies. While regression 1 looks at the effect of all variables on per capita health expenditures, the remaining regressions 2 and 3 allow for other sensitivity checks. Specially, regressions 2 and 3 consist of empirical estimates in regression 1 but remove the number of physicians and hospital beds and those non-medical determinants of health care such as alcohol and tobacco consumption. Furthermore, 82% (adjusted R-square) of the variation in natural log of per capita health expenditures are explained by the variation in the model.

The results across all three regressions 1, 2, and 3 are very similar. All of these regressions indicate that per capita GDP is statistically significant at 1% and the coefficient estimates for this variable consistently are less than one (0.978 (regression 1), 0.964 (regression 2), and 0.924 (regression 3)). In regression 1, for every additional one percent increase in log of GDP per capita, there is 0.978% increase in health expenditure per capita. A t-test performed on these three regressions fails to reject the null (H_0: $\beta_1 = 1$; H_a: $\beta_1 > 1$) and therefore suggests that health care is not a luxury good, since it is not statistically significantly greater than 1. This result backs up the study by Baltagi & Moscone (2010) which demonstrates that health care is a necessity rather than a luxury, with an elasticity much smaller than that estimated in previous studies.

In all three regressions 1, 2, and 3, the coefficient estimates of life expectancy (LIFE) and the percentage of elderly people (POP65) are positive and statistically significant at alpha levels of 1% and 5%, respectively. There is a strong relationship between these factors and per capita health expenditures. In regression 1, for every

additional year of life expectancy, per capita total health expenditures increases by 3.42%, holding everything else constant. For every additional percentage point of population aged 65 and older, per capita total health expenditures increases by 2.98%, ceteris paribus. From the demand side perspective, total health care expenditures will increase as there is an increasing older population. On average, an older population will require more resources and greater demand for health care. Therefore, higher life expectancy and the aging population have a great influence on health expenditures.

The empirical estimate of public financing is insignificant in influencing health expenditures in OECD countries, suggesting that a higher or lower portion of government schemes and compulsory contributory health care financing schemes has no effect on reducing the level of health care spending. This finding contradicts Leu's finding (1986) that share of public health had a positive effect on total health care expenditures and backs up Gerdtham's study (1992) which shows that the impact of public financing in health care cannot be determined.

Regression 2 attempts to control for the non-medical determinants of per capita health expenditures which are alcohol consumption (ALC) and tobacco consumption (TOB). Both of the coefficient estimates for these two variables is statistically insignificant in all regressions, indicating that alcohol and tobacco consumption do not have an impact on the level of health care spending in 35 OECD countries from 2000 to 2013.

Regression 3 controls for the impact of health care resources on health spending throughout the years. The number of physicians per 1000 population (PHYS) as a proxy for health related human capital does not show any effect on health spending in OECD countries, as reflected in the coefficient estimate for physician variable. Our regression results indicate that the number of physicians variable is also insignificant ($t = 1.40$ in regression 1 and $t = 1.34$ in regression 3). Thus, the empirical finding indicates that there is no evidence of physician supply as influencing health care costs.

Similarly, the number of hospital beds per 1000 population (BED) is statistically insignificant, indicating that the number of hospital beds is not one of the determinants of per capita health expenditures. Even though this variable captures trends in patient care access, which has a similar purpose as the number of physicians (PHYS), there is no

evidence of the number of hospital beds as a factor that helps reduce health services costs. The increase in the number of hospital beds does not necessarily imply an increase in the average length of hospital stay and therefore does not have any impact on total per capita health expenditures. In contrast to general expectation of hospital services, the number of hospital beds is not an important cost factor determining the provision of health services.

Even though the main objective of this paper is to examine the determinants of health care expenditures upon the exogenous variables, a cause-and-effect relationship that runs from the explanatory variables to the dependent variable is not always the case. For example, in regressions 1, 2, and 3, GDP per capita can influence the level of health expenditures per capita, but at the same time, a higher level of health expenditures per capita can also have a great impact on GDP per capita. As a result, a two-way relationship between GDP and health expenditures exists. To reduce endogeneity in the models, this research paper runs the second set of regressions for Model B in which the dependent variable is per capita health expenditure as a share of per capita income.

MODEL B

As a sensitivity check, three regressions of model B get rid of per capita income (PCGDP) as an exogenous variable but still control for all other relevant variables that help explain the level of per capita health expenditures as a share of per capita GDP. Parameter estimates indicate that these three regressions show similar results to those three regressions 1, 2, and 3 in model A. As discussed earlier, all three regressions 4, 5, and 6 involve FEM regression, according to Hausman test. Regressions 5 and 6 are variations of regression 4, providing an interaction between different explanatory variables. These two regressions consist of sensitivity analyses pertaining to different estimation procedures.

According to the empirical finding, there are two variables affecting per capita health expenditure as a portion of per capita GDP in those OECD countries. First, the coefficient estimate of life expectancy (LIFE) is statistically significant at 1% level. This variable also shows a positive correlation with health expenditure per capita as a percent of GDP per capita. For every year increase in life expectancy, health expenditures per capita as a portion of GDP per capita increases by 0.003 percentage point, holding everything

else constant. Another widely perceived determinant of health expenditure is the ageing population. The population age structure which is expressed by the share of old people (above 65 years) over the active or total population (POP65) is significant at 5% level and positively correlated with trends in health expenditures. Every additional percentage point of population above 65 years of age lead to the 0.002 percentage point increase in health expenditure per capita as a share of GDP per capita. A reason for this could be the growing of baby boomers in many Western nations that eventually leads to an ageing population and the increase in life expectancy rates. Thus, a significant increase in public health care expenses as a share of GDP is unavoidable, as the elderly are usually cared for the remainder of their lives. Therefore, an increase in the percentage of elderly people results in an unproportioned increase in health care costs, as suggested in a study by Sen (2005).

In terms of financing in health care, the coefficient estimate for public financing is insignificant ($t = -0.44$ for regression 4, $t = -0.40$ for regression 5, and $t = -0.41$ for regression 6) to have any impact on health care spending as a portion of GDP in all of the regressions. As suggested in a study by Gerdtham et al. (1992), public financing in health care does not have any effect on total health care expenditure as a portion of GDP.

Similarly, both the number of physicians (PHYS) and the number of hospital beds (BED) are insignificant in determining health care expenditures as a share of GDP, as suggested by the coefficient estimates for these two exogenous variables. As in model A, these two variables do not have a big effect on health care even though it is one of the important factors capturing patient health care access.

Regression 5 focuses on the consequences of including non-medical variables such as alcohol consumption (ALC) and tobacco consumption (TOB). From the empirical models, one can see that the magnitude and precision of the coefficient estimates of alcohol consumption (ALC) and tobacco consumption (TOB) remain unchanged with the exclusion of other health resources variables (number of physicians per 1000 population (PHYS) and number of hospital beds (BED)) in regression 4. Statistically there was no significance for the coefficient estimates of these two variables, indicating that alcohol and tobacco consumption do not have an impact on health expenditures over years in OECD countries.

Lastly, the OLS model was also employed to act as a sensitivity test. These estimates are contained in **Table 4** and **Table 5**. In model A, the coefficient estimate of per capita GDP (PCGDP) in OLS regression is quite similar to the corresponding FEM estimate and is statistically significant. Specifically, the coefficient estimate is significantly lower than one. Besides life expectancy (LIFE) and population over 65 years old (POP65) which show the same results as in FEM models, public financing (PUBFIN) and the number of hospital beds per 1000 of population (BED) are also statistically significant at 1% level in OLS model and both have negative correlation with health care expenditure. The number of physicians per 1000 of population (PHYS) and alcohol consumption (ALC) is also at 1% level of significance and have a positive correlation with health care spending. The only variable that indicates the same result is tobacco consumption (TOB) which is insignificant in neither the OLS model or FEM method. The important point is that the OLS models differ significantly from the FEM models by making a numerous number of variables become significant.

Table 5 shows OLS regression for model B. One could notice a difference between OLS and FEM method in **Table 3** as public financing (PUBFIN), physicians per 1000 (PHYS), and alcohol consumption (ALC) now become significant at 1% level in OLS model.

Regardless of the number of studies in literature who have used the OLS method, placing emphasis on results from OLS coefficient estimates could be a misguided strategy because it might yield simultaneity bias. Specifically, some of the exogenous variables specified on the right hand side of model A and B such as per capita GDP might be jointly correlated with per capita health expenditures, which would result in a correlation with the error term and inconsistent estimates. Thus, OLS coefficient estimates of these variables are clearly biased.

OLS estimation yields biased and inconsistent parameters in the presence of such correlation. Therefore, the estimation technique that best fit the data was chosen based on Hausman's Chi-squared statistics, the FEM model.

6.0 FINAL REMARKS

Using panel data with 35 OECD countries from 2000 to 2013, this paper investigates the determinants of health expenditures. Instead of depending on cross-section regression methods, this study employs fixed-effects panel data model based on the estimation technique obtained from the Hausman Test.

The empirical findings presented in this paper provide empirical evidence that per capita GDP plays a key role in explaining the cost of health care in OECD countries and that the coefficient estimate of GDP per capita is smaller than one. This backs up the intuitive expectation of income elasticity to be less than unity, indicating that health care is more as a necessity than a luxury. Thus, health care expenditures are not highly income sensitive and therefore backs up existing studies which suggest that heath care expenses are unresponsive to changes in individual or household income.

As for non-income determinants, estimates from our regression models provide evidence that the other key driving force of both health expenditure and health expenditure as a share of GDP is medical progress, which are reflected in two variables, life expectancy and population aged 65 years and older.

Besides, health resources such as the number of physicians per 1000 of population or the number of hospital beds per 1000 of population, non-medical determinants of health care such as alcohol and tobacco consumption, and public financing do not show any impact on the level of health spending.

In terms of policy implications, the empirical findings highlights that health care is not a luxury good and therefore, government should provide more support to the health care system. Because of the income inelasticity of health care, in the market, health expenditure is not a luxury good although the study cannot prove that it is therefore a necessary good. Thus, those who suggest that health expenditure should have limited to none government intervention would be going against common practice for goods that are not luxury goods. Everyone is entitled to health care without a choice and therefore health care should be given to people from government as many of them are unable to afford the cost of health

care. The finding of a small income elasticity of health care expenditures implies that social reforms aiming at cutting benefits in health care would not help reduce health care expenditure in OECD countries. The small income elasticity of health care expenditures found in this study demonstrates that individuals being covered by public health would reduce the total health care expenditures.

Additionally, medical progress should receive more attention from scholars and policy makers. In order to raise a healthier standard among the aging group, a proper balance between spending on disease prevention and treatment should be considered as government's goal is to increase life expectancy while aiming for a healthier population. Improving quality of care is also a high priority among OECD countries. As no country consistently performs well on quality of care, there is room for improvements in all countries in terms of health care quality and performance, prevention, and treatment of different health problems.

Several limitations of this study need to be acknowledged. First, this study notices a reverse causality effect between per capita GDP and per capita health care expenditures. High levels of GDP might induce countries to spend more on health care expenditure while at the same time when treating health as a factor of human capital and education, higher levels health care could drive up GDP as well. This causal relationship between GDP and health care spending leads to an endogeneity problem as it is difficult to designate a clear in the impact of these two variables on each other. Therefore, in order to avoid reverse causality in the model, per capita health expenditure as a share of per capita GDP is employed as a dependent variable instead of per capita health expenditure. Second, due to data constraints, some key factors that are not included in the model are technological progress (R&D expenditure or CT scan are often used as a proxy), malpractice, sociopolitical risks, or international aid. Third, only including high income countries restricts the model sizes and make statistical inference somewhat fragile and bias. Expanding the research paper to include both low- and middle- income countries will help improve the quality of data and avoid misspecification in different regression models.

Table 2. Fixed Effects Model (FEM) Regression Equations for Model A

Dependent Variable	Log of Health Expenditure per capita		
Regression	1	2	3
Log of GDP per capita	0.978***	0.964***	0.924***
	(6.56)	(6.66)	(6.63)
Public Financing	-0.00128	-0.0011	-0.00139
	(-0.43)	(-0.38)	(-0.42)
Physicians per 1000	0.0299		0.0289
	1.40		(1.34)
Hospital Beds per 1000	0.00173		0.00129
	(0.11)		(0.08)
Alcohol Consumption	-0.00558	-0.00503	
	(-0.45)	(-0.41)	
Tobacco Consumption	-0.00359	-0.00347	
	(-0.53)	(-0.50)	
Life Expectancy	0.0342***	0.0375***	0.0389***
	(2.81)	(2.83)	(2.88)
Population > 65 years old	0.0298**	0.0313**	0.0313**
	(2.30)	(2.51)	(2.38)
Constant	-5.291***	-5.355***	-5.223***
Obs	490	490	490
Adjusted R^2	0.82	0.82	0.82

Robust standard errors are displayed in parentheses under the coefficient estimates.

, **, * Denote an estimate significantly different from zero at the 10%, 5% or 1% level, respectively.*

Table 3. Fixed Effects Model (FEM) Regression Equations for Model B

Dependent Variable	Health Expenditure per capita as a share of GDP per capita		
Regression	4	5	6
Public Financing	-0.000126 (-0.44)	-0.000109 (-0.40)	-0.000119 (-0.41)
Physicians per 1000	0.00204 (1.20)		0.00212 (1.21)
Hospital Beds per 1000	0.000153 (0.13)		0.0000488 (0.04)
Alcohol Consumption	-0.00034 (-0.34)	-0.000356 (-0.35)	
Tobacco Consumption	-0.000417 (-0.72)	-0.000409 (-0.69)	
Life Expectancy	0.00271*** (3.31)	0.00288*** (3.30)	0.00287*** (3.38)
Population > 65 years old	0.00233** (2.71)	0.00242*** (2.91)	0.00243** (2.72)
Constant	-0.151**	-0.160**	-0.175***
Obs	490	490	490
Adjusted R^2	0.49	0.49	0.49

Robust standard errors are displayed in parentheses under the coefficient estimates.
, **, * Denote an estimate significantly different from zero at the 10%, 5% or 1% level, respectively.*

Table 4. OLS Test Regression Equations for Model A

Dependent Variable	Log of Health Expenditure per capita		
Regression	1	2	3
Log of GDP per capita	0.802***	0.811***	0.834***
	(27.37)	(27.12)	(29.15)
Public Financing	-0.00650***	-0.00676***	-0.00620***
	(-4.71)	(-4.69)	(-4.52)
Physicians per 1000	0.0339***		0.0346***
	(3.71)		(3.53)
Hospital Beds per 1000	-0.0102***		-0.00741**
	(-2.70)		(-2.12)
Alcohol Consumption	0.0213***	0.0195***	
	(7.17)	(6.76)	
Tobacco Consumption	-0.00046	-0.00325	
	(-0.20)	(-1.60)	
Life Expectancy	0.0122**	0.0130**	0.00361
	(2.35)	(2.47)	(0.68)
Population > 65 years old	0.0119***	0.0144***	0.0184***
	(3.81)	(5.31)	(5.98)
Constant	-1.359***	-1.427***	-0.955***
Obs	490	490	490
Adjusted R^2	0.91	0.91	0.91

Robust standard errors are displayed in parentheses under the coefficient estimates.

, **, * Denote an estimate significantly different from zero at the 10%, 5% or 1% level, respectively.*

Table 5. OLS Test Regression Equations for Model B

Dependent Variable	Health Expenditure per capita as a share of GDP per capita		
Regression	4	5	6
Public Financing	-0.000814***	-0.000819***	-0.000769***
	(-7.68)	(-7.43)	(-7.36)
Physicians per 1000	0.00239***		0.00237***
	(2.83)		(2.87)
Hospital Beds per 1000	-0.000517		-0.000504*
	(-1.49)		(-1.69)
Alcohol Consumption	0.00116***	0.00109***	
	(4.02)	(3.93)	
Tobacco Consumption	-0.000198	-0.000335*	
	(-0.90)	(-1.78)	
Life Expectancy	-0.00164***	-0.00151***	-0.00183***
	(-5.23)	(-4.84)	(-5.67)
Population > 65 years old	0.00118***	0.00139***	0.00156***
	(4.02)	(5.43)	(5.35)
Constant	0.243***	0.236***	0.257***
Obs	490	490	490
Adjusted R^2	0.27	0.26	0.25

Robust standard errors are displayed in parentheses under the coefficient estimates.
, **, * Denote an estimate significantly different from zero at the 10%, 5% or 1% level, respectively.*

APPENDIX A: Variable Description and Data Sources

ACRONYM	DESCRIPTION	DATA SOURCE
PCHCE	Per capita health care expenditures, constant prices, constant PPPs, OECD base year, in US$	OECD Health Data Statistics
PCHCE/PCGDP	Per capita health care expenditures as a share of per capita GDP	OECD Health Data Statistics; World Bank
PCGDP	Gross Domestic Product per head, constant prices, constant PPPs, in US$	World Bank
PUBFIN	Proportion of total health spending financed by public expenditures	OECD Health Data Statistics
PHYS	Number of physicians per 1000 population	OECD Health Data Statistics
BED	Number of hospital beds per 1000 population	OECD Health Data Statistics
ALC	Alcohol consumption, liters per capita (age 15+)	OECD Health Data Statistics
TOB	Tobacco consumption in grams per person (age 15+)	OECD Health Data Statistics
LIFE	Life expectancy, years	OECD Health Data Statistics
POP65	Percentage of population above 65 years old	OECD Health Data Statistics

APPENDIX B - Variables and Expected Signs

ACRONYM	DEFINITION	RATIONALE	EXPECTED SIGN
PCHCE	Per capita health care expenditure is the total cost of health care (public and private expenditures)	N/A	N/A
PCHCE/PCGDP	Per capita health care expenditure as a percentage of per capita GDP is the total cost of health care (public and private expenditures) as a percent of per capita GDP	N/A	N/A
PCGDP	GDP per capita is an aggregate measure of production equal to the sum of the gross values added of all resident institutional units engaged in production.	Higher income is associated with higher health expenditures	**+**
PUBFIN	Government schemes and compulsory contribution health care financing schemes as a percentage of total health care spending	Higher percentage of public financing will reduce health expenditures as administration cost is often reduced in a single-payer system	**-**
PHYS	Practicing physicians provide services for individual patients.	Higher physicians' density increases health care expenditures	**+**
BED	Total hospital beds are all hospital beds which are regularly maintained and staffed and immediately available for the care of admitted patients.	Higher number of hospital beds increase the cost of health care	**+**
ALC	Annual consumption of pure alcohol in liters, per person, aged 15 years old and over.	Higher alcohol consumption implies high health risk, thus higher health spending	**+**
TOB	Annual consumption of tobacco items (e.g. cigarettes, cigars) in grams per person aged 15 years old or more.	Higher tobacco consumption leads to poor health, therefore driving up the rate of health spending	**+**

LIFE	Life expectancy at birth and at various ages is the average number of years that a person at that age can be expected to live, assuming that age-specific mortality levels remain constant.	Life expectancy is a proxy of medical progress, thus results in lower health care expenditures	+
POP65	Percentage of total population who are 65 years or older	Higher percentage of population above 65 years old increases health spending	+

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