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How "Costly" is Healthcare for the Elderly?

Ruchika Majumdar
Scripps College

HOW "COSTLY" IS HEALTHCARE FOR THE ELDERLY?

by

RUCHIKA MAJUMDAR

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PROFESSOR SEAN FLYNN

PROFESSOR NAYANA BOSE

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ABSTRACT

This study focuses on the possible ways to improve healthcare services around the world, which increase the life expectancy for aging people. Utilizing a cost-effective analysis, the relationship between various healthcare expenditures and conditional life expectancy for people aged 60 and above was examined. A linear regression model was used to analyze data from 122 WHO (World Health Organization) countries obtained from the year 2000. The model included additional health-adjusted life years (HALE) at age 60 as the dependent variable and healthcare cost indicators as the independent variables. Regression results revealed that cost of healthcare was overall significant in contributing to HALE at age 60. The independent cost variables that were individually significant in the model consisted of government expenditure, private healthcare expenditure, out-of-pocket expenditure, and social security funding. While public healthcare costs such as government expenditure and social security funding positively impacted HALE, private healthcare expenditure negatively impacted HALE years at age 60. This finding suggests that countries with higher private healthcare expenditure than public healthcare expenditure decreased their chances of improving life expectancy for senior citizens. Through a cost-effective lens, in order to increase the quality and quantity of healthy life years for the elderly, countries should focus on instating policies that fund more public healthcare services.

INTRODUCTION

Healthcare is amongst the most pressing issues regarding the economy and public welfare today. The World Economic Forum ranks healthcare in their top ten biggest global challenges of 2016 stating that the number of people in the world is set to rise to 9.7 billion people by 2050 and countries need to begin adjusting their healthcare systems for this immediately.[1] On top of that, recent spreads of deadly diseases such as HIV (human immunodeficiency virus) /AIDS (acquired immune deficiency syndrome) and Ebola in mainly developing countries have made the initiative to improve healthcare services even more crucial.

[1] Rosamond Hutt, "What Are the 10 Biggest Global Challenges?," World Economic Forum, last modified January 21, 2016, https://www.weforum.org/agenda/2016/01/what-are-the-10-biggest-global-challenges/.

The reason why health epidemics still pose as a great threat is because people around the world still don't have access to immediate or basic health services. Even today in a developed country like the United States, that spends the most money on public health care compared to other countries, 27 million US citizens still live uninsured.[2] Recently, countries have been implementing policies on healthcare that aim to ameliorate the use of government healthcare budgets, the coverage of more health services, and the accessibility of healthcare insurance. For example, in 2008, the government of Ghana instated a mandatory "free maternal healthcare" policy, which strived to facilitate access to free and quality maternal healthcare services such as antenatal, delivery, and postnatal care.[3] In essence, it has become important goal for nations around the world to recognize successful health systems that can reach out to more people and offer useful services that improve the quality of health.

As mentioned earlier, the world is on the brink of a major population growth. Of that population growth, the age group scientists expect to see rapidly increase in the years to come consist of older aged people. Researchers at the World Health Organization (WHO) predict that the number of people aged 65 or older will begin to outnumber children aged 5 and below.[4] Driven by falling fertility rates and remarkable increases in life expectancy, populations 65 and older will grow from an estimated 524 million in 2010 to nearly 1.5

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[2] Garfield, Rachel and Anthony Damico. "The Coverage Gap: Uninsured Poor Adults in States That Do Not Expand Medicaid." *The Henry J. Kaiser Family Foundation.* Jan. 21, 2016. http://kff.org/health-reform/issue-brief/the-coverage-gap-uninsured-poor-adults-in-states-that-do-not-expand-medicaid-an-update/

[3] Ghana Business News, "Ghana's Free Maternal Healthcare Policy Not Working – Research," Ghana Business News, last modified April 23, 2016, https://www.ghanabusinessnews.com/2016/04/23/ghanas-free-maternal-healthcare-policy-not-working-research/.

[4] *Global Health and Aging* (World Health Organization, 2011), http://www.who.int/ageing/publications/global_health.pdf.

billion in 2050, with most of the increase in developing countries. Furthermore, the WHO anticipates the aging population to also become more racially and ethnically diverse, which will present challenges to policy makers in programs such as social security and public healthcare.[5]

With a diverse older population soon to be the majority, it is now even more necessary to ensure that their health and safety are in good condition. Additionally, it is important to take care of older people from an economical standpoint. Currently, a new trend of older people postponing their retirement and working longer has begun to develop in many countries, resulting in increased labor productivity in markets.[6] Another trend that has persisted in the economy is older citizens up to the age of 75 are becoming the breadwinners in families for childcare, financial assistance, and tax payments.[7] From a more social standpoint, it is recognized how elders in society have had the most life experience in understanding worldly affairs such as relational, political, and cultural change. They then pass down their expertise and knowledge to future generations in an effort to maintain the heritage and cultural values of their respective communities in countries all over the world.[8] Therefore, bettering healthcare to increase life expectancies for older populations is not only a basic human right, but also a beneficial tool in improving many social and economic aspects of countries. Keeping this in mind, I will attempt to construct a study that focuses on

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[5] *Global Health and Aging* (World Health Organization, 2011), http://www.who.int/ageing/publications/global_health.pdf.

[6] "Ageing Societies: The Benefits, and the Costs, of Living Longer," International Labour Organization, last modified December 1, 2009, http://www.ilo.org/global/publications/world-of-work-magazine/articles/WCM_041965/lang--en/index.htm.

[7] Judith Healy, "The Benefits of an Ageing Population," Australian National University, last modified March 2004, http://www.tai.org.au/documents/dp_fulltext/DP63.pdf.

[8] Judith Healy, "The Benefits of an Ageing Population," Australian National University, last modified March 2004, http://www.tai.org.au/documents/dp_fulltext/DP63.pdf.

which types of healthcare services provide better health outcomes for this population. The specific research question I will examine is: which different healthcare cost indicators affect the conditional life expectancy (or the life expectancy assuming survival regardless of disease/illness conditions) for older populations aged 60 and above around the world?

In this study, I intend to first begin by providing a descriptive overview of the previous studies that make use of existing approaches, which analyze the relationship between cost and healthcare as well as the relationship between the elderly and health outcomes. Afterwards, I will develop an empirical model that is appropriate in answering the research question and will also test the proposed economic theory about quality versus quantity of added years of life expectancy for older populations over 60. The empirical model will consist of a regression that examines the effect of multiple types of healthcare expenditures on health-adjusted life years, or HALE, at age 60. A cost-effective approach will then be used to analyze the results of cost on conditional life expectancy in terms of quantity and quality of health for older populations.

LITERATURE REVIEW

What does a cost-effective analysis of a healthcare system look like?

While major health organizations such as the OECD and the WHO have been ranking healthcare systems around the world with indicators based on quality, cost, efficiency, and health outcomes, recent studies in health have developed a new tool to analyze healthcare systems with cost effectiveness. By definition, a "cost-effective analysis" is a method for assessing gains in health relative to the costs of different health interventions (Jamison 2006). A "cost-effective" analysis on healthcare compares the quality of health outcomes in relation

to cost. Based on this, a cost effective analysis can also determine whether or not healthcare systems are "efficient," or more specifically if certain healthcare systems produce better quality health outcomes with low costs compared to others. Even this is hard to identify, as there are many theoretical questions that lie in cost-effective analyses such as, what is gain in healthcare? How do we measure it? What is quality of healthcare? What are the different costs of health interventions? I will attempt to explore the different ways through which economists have approached cost-effective analyses in healthcare.

Cost-effective incentives in healthcare systems can be first understood through the relationship between cost and quality. In a study measuring the Dutch healthcare system's performance in patients with diabetes, multi-dimensional quality and cost indicators were used to test whether or not the patients could get the same quality care with lower and higher costs. Researchers used a combined cost-consequence analysis (CCA) to gain more insight on the Dutch healthcare system's performance. A cost-consequence analysis is a type of health economic evaluation in which all direct and indirect costs of healthcare are listed separately from each other and then are compared to different health outcomes. Results from this study indicated that predicated quality of diabetes care was achieved with lower instead of higher costs (Portrait, Galien, and Berg 2015). Therefore, it can be seen how getting similar quality healthcare with lower costs is the first approach economists go about addressing cost-effectiveness – by talking about cost efficiency and quality.

Another approach that uses cost effective analysis to examine the relationship of efficiency and cost in healthcare was conducted economist Michael D. Rosko in 2001. Rosko (2001) in his study uses a stochastic frontier model to estimate inefficiency scores in 1,631 US hospitals during the period 1990 – 1996. Stochastic frontier regression (SFR) is an

econometric technique which accounts for random shocks or error in periods of time when estimating the efficiency at the observed level of outputs and inputs. The results of from this study suggested that US hospitals' inefficiency scores were negatively associated with health medical organization (HMO) penetration, or the proportion of HMO enrolment per county (Rosko 2001). In other words, there was an inverse relationship between HMO penetration and inefficiency, indicating that the growth of managed care actually decreased the hospital efficiency levels.

Cost-effective analyses so far have broadly been used to measure relationships between cost, quality, and efficiency in health care. However, cost-effective analyses also can be used to reveal hidden or overlooked costs, termed as "unrelated costs," and how they affect healthcare systems. In a study titled "Future Costs, Fixed Healthcare Budgets, and the Decision Rules of Cost-Effectiveness Analysis," Van Baal, Meltzer, and Brouwer (2014) examine the unseen costs of life-saving medical technologies and medical interventions administered to cancer patients. Because these technologies and services are mainly used for treatment to side effects of cancer, they do not get counted in overall future costs of cancer treatment. Therefore, this study questions whether or not it is beneficial to include future costs of both related and unrelated medical care costs in economic evaluations of a healthcare system's performance. Through a theoretical lens, these economists suggest that both the costs and benefits of unrelated as well as related medical care together is a cost-effective approach that health insurers need to take. They believe this because with a picture of all the costs that are used towards health treatments, policy makers receive a more informative take on how to make a more efficient use of their designated healthcare budget (Van Baal, Meltzer, and Brouwer 2014).

How does cost-effective analyses affect overall health outcomes?

One of the most renown and oldest paradigms for analyzing the quality of healthcare, the Donabedian model, deals with evaluating the medical care process at the level of physician-patient interaction. In this model, Donabedian (1966) discusses how there are three key approaches that can be used to analyze the quality of a healthcare system – process, structure, and outcome. Focusing specifically on the outcome approach, the Donabedian model suggests how outcomes of medical care have been frequently used as measurable indicator for quality because they have "end points" or concrete factual data that are quantifiable (Donabedian 1966). However, this approach also mentions how even though outcome measurements are quantifiable in measuring quality, they can also be irrelevant without a chosen criterion. In this case, that criterion is cost effectiveness, as this study will question whether or not multiple cost indicators are effective in contributing to health outcomes for the elderly.

The following literature demonstrates how a cost-effective analysis can be performed using Donabedian's outcome approach to measure quality of healthcare. Examining the 1985 Medicare Provider Analysis File (MEDPAR), author Steven T. Fleming uses cost-effective analysis to measure US hospital quality in terms of outcomes such as risk-adjusted mortality and readmission indices. Risk-adjusted mortality rates are mortality rates from the RAMI (Risk-Adjusted Mortality Index) that are adjusted for predicted risk of death. Readmission indices for this study measure the number of scheduled and unscheduled readmission of patients from the RARI (Risk-Adjusted Readmission Index) that occur 31 days following a patient's discharge. Fleming (1991) discovered in his work that the behavior of hospitals in response to cost constraints and behavioral consequences on medical outcomes, depended on

where they were put on a cubic cost function in terms of quality measured by the Medicare Provider and Analysis Review (MedPAR) (Fleming 1991). The analysis of the results found that when the level of quality in hospitals was low, a cost reduction was associated with poorer health outcomes and vice versa (Fleming 1991).

Another study conducted some years later on 137 Department of Veteran Affairs hospitals from 1988-1993, used Fleming's work to conduct a similar cost-effective analysis. Using Fleming's cubic cost function that accounted for the risk-adjusted measures of mortality and readmission, researchers Carey and Burgess (1999) also found in their study that in veteran hospitals, cost and health outcomes were positively related. However, they also recognized that Fleming's cubic cost function was inaccurate because it failed to account for factors which could have affected mortality and readmission rates such as severity of illnesses (Carey and Burgess 1999). Therefore, Carey and Burgess conclude that further research must be done to not only improve upon the cubic cost function, but also simultaneously accurately adjust for severity of patients' illnesses in a model that utilizes mortality and readmission rates.

What does better health outcomes for the elderly consist of?

We have talked about what cost-effective analyses healthcare consist of and how they affect health outcomes. However, these studies have pertained to general patient and hospital data without any specific focus on age, gender, or race (which previous literature has controlled for). For this paper, I attempt to focus on the older age category of patients. Hence, it is necessary to recognize previous studies conducted on this population regarding which health outcomes, apart from life expectancy, have been used to measure cost effectiveness in healthcare.

One article titled *Health Insurance, Medical Care, and Health Outcomes: A Model of Elderly Health Dynamics*, utilizes prescription drug coverage, measured as a percent of Medicare coverage dedicated to paying for prescribed drugs, as a measurable health outcome of the US's elderly population (Yang, Gilleskie, and Norton 2007). This study examined the effect of Medicare prescription drug coverage on the overall rate of expenditure on medicine for older populations. Results revealed that prescribed drug coverage increased the overall drug rate by 7% to 25% over a five-year period and decreased mortality rates for the elderly as well. Another article accounts for time as a cost factor used to determine health outcomes for the elderly. This study aimed to explore the effect of the cost of time on physical exercise, which measured the health-related quality of life for seniors. With data from a 4-year randomized controlled trial, Eastern Finnish men and women aged 57-78 were surveyed with a questionnaire regarding the cost and time they put into physical exercise. The outcome of this survey illustrated that motivation and the labor market position are important factors in determining the cost of physical exercise in terms of time. Furthermore, an increase in time spent on physical exercise for senior citizens had positive effects on their health outcomes such as it improved physical and mental components of health (Kollner, Valtonen, Komulainen, Hassinen, and Rauramaa 2012).

Another study, which looks at the impact of health insurance public policy called China's New Cooperative Medical Scheme (NCMS) for senior citizens, used three different types of health outcome measures – mortality within three years, self-reported health (or survey-reported health), and measured health through hospital physical examinations. Launched in 2003, the NCMS is a public healthcare insurance system instated in rural areas of China. This study attempts to assess the effect of NCMS on specifically senior citizens in

rural areas of China. Results of this study revealed that rural senior citizens classified as low-income benefitted more than rural senior citizens classified as high-income (Cheng, Liu, Zhang, Shen, and Zeng 2014). Additionally, this study reports that in rural counties in China, NCMS had no significant effect on healthcare-uninsured seniors in terms of mortality rates, but did moderately reduce the mortality rates for healthcare-insured seniors (Cheng, Liu, Zhang, Shen, and Zeng 2014).

There are a plethora of studies that have tried to answer the question of what constitutes better health outcomes for older populations across the globe apart from ones cited. With this paper, my goal is to contribute a different cost-effective approach in determining the quality of health outcomes for the elderly. The "different" cost-effective approach I use specifically examines the quality of conditional life expectancy for older populations. This approach will include the types of healthcare costs that affect the conditional life expectancy of the elderly and whether or not they improve the quality of health per year as well.

THEORY & MODEL

Using a classical linear regression model, I will attempt to test the economic theory of "quality versus quantity" and analyze it in terms of life expectancy for senior populations. The "quality versus quantity" economic theory was developed in an article called *Interaction between Quantity and Quality of Children* by economists Gary S. Becker and Gregg Lewis at the University of Chicago back in 1974. Becker and Lewis (1974) argued that the relationship between quantity of children per household and quality of children per household was closely related. For the purposes of this study, "quality" of children can be

defined as the rate of consumption for each child and "quantity" of children can be defined as the number of children per household. More importantly, Becker and Lewis (1974) used "shadow prices," or estimates of the cost of one child per household with respect to household income level. They concluded that theoretically quality affected the price of children more than the quantity, as households with higher income levels with less children cost more to take care of than lower-income households with more children (Becker and Lewis 1974). Higher-income households have higher-quality children that consumed more than lower-quality children from lower-income households, hence why children of higher-income households had higher prices.

I attempt to investigate if Becker and Lewis's findings are consistent with the empirical cost-effective model on healthcare being tested in this paper. I will see whether or not a close relationship between quantity and quality of life expectancy for older populations exists as it does for children. More specifically, this model will investigate which cost indicators of healthcare affect the quality of health added to the lives of the elderly.

In the linear multi-regression model, the dependent variable, or Y_i, will be HALE at age 60 (measured as a number of additional years to age 60). The cost indicators that will be chosen as the explanatory, independent variables for this regression include: external resources on health, general government health expenditure, out-of-pocket expenditure, private health expenditure, private insurance, social security funds, total health expenditure (THE), total health expenditure per capita (THE per capita), and developed or developing nation as a dummy variable (where developed nations =1 and developing nations =0).

Hence, the regression model is generally identified as:

$\mathbf{Y_i = \beta_0 + \beta_1 X_{i1} + \ldots + \beta_p X_{ip} + \varepsilon_i}$

where Y_i is the dependent variable, X_{ip} is the number of independent variables, βs are the coefficients for each independent variable, and ε_i is the error term (which is equal to 0). When we input health life expectancy at age 60 as Y_i, or the dependent variable, and all the other variables as independent X-variables, the regression equation becomes:

$\mathbf{HALE = \beta_0 + \beta_1 EXT.RES + \beta_2 GGE + \beta_3 PVT.H + \beta_4 OOP + \beta_5 PVT.I + \beta_6 SSF + \beta_7 THE + \beta_8 THE\ P.C. + \beta_9 DEV.NAT}$

In this regression equation, the abbreviations for each variable are:

HALE = health life expectancy at age 60 (measured as number of additional years to age 60)

EXT.RES = external resources (measured as a % of total healthcare expenditure)

GGE = general government expenditure (measured as a % of total healthcare expenditure)

OOP = out-of-pocket expenditure (measured in US$ per capita)

PVT.H = private healthcare expenditure (measured as a % of total healthcare expenditure)

PVT.I = private insurance expenditure (measured % of private healthcare expenditure)

SSF = social security funding (measured as a percent of general government expenditure)

THE = total healthcare expenditure (measured as a % of gross domestic product or GDP)

THE P.C. = total healthcare expenditure per capita (measured in US$ per capita)

DEV.NAT = developed/developing nation (measured as two possible outcomes, 1 and 0)

Each variable in this equation has an in depth description and explanation to why it has been included in the model that can be seen in Appendix A at the end of this study. Also, Appendix A includes more information on the unit of measure for each independent variable in the model.

DATA

Most of the data (with the exception of the variable DEV.NAT) for the regression model has been obtained from the World Health Organization (WHO) database. Established in 1948, the WHO is a specialized agency of the United Nations concerned with international public health policies. Furthermore, the WHO uses its Global Health Observatory data to serve as a gateway to health-related statistics for more than 1000 indicators for 194 member-countries around the world. For the purposes of the regression model stated previously, the data obtained was mostly cross-sectional specifically for year 2000. Cross sectional data can be recognized as a type of data collected by observing many subjects (such as individuals, firms, countries, or regions) in one specific time period.

However, due to an unexpectedly large amount of missing data for particular countries, two of the countries' data (Afghanistan and Cote d'Ivoire) have been taken from 2002, making the entire model technically pooled cross-sectional data, or data that has randomly sampled observations of subjects at different time periods. Because this model has HALE at age 60 as the dependent variable, the only year in the WHO database that contained this information was 2000. Furthermore, even though there are 194 member countries, only 122 out of those 194 countries contained data for all of the healthcare cost indicators. Therefore, because this model uses the number of countries as the number of observations, the total number of observations for this regression model was equivalent to 122. Reasons for the missing 72 member-countries' data include blanks for some of the independent variables. The WHO records blanks in the data under the following conditions: no applicability, financial constraints, lack of resources, or no registration of the unit. The data for the dummy variable, developed/developing nation (DEV. NAT), has been obtained from the

Development Policy and Analysis Division (DPAD) of the Department of Economic and Social Affairs in the United Nations Secretariat. The United Nations Secretariat is one of the six major branches of the United Nations (UN). The UN is the largest and most familiar intergovernmental organization that promotes international cooperation and maintains international order amongst 193 member-countries.[9] The summary statistics of each variable in the regression model can be seen below in Figure 1.

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
HALE (# years)	122	13.50164	2.273425	7.5	18.2
EXT.RES (%)	122	7.172755	10.65738	0	71.11573
GGE (%)	122	53.87585	20.39795	7.094141	94.27777
OOP (US$ per capita)	122	87.22806	150.3502	1.561323	1167.61
PVT.H (%)	122	46.31678	20.49953	5.722225	96.90898
PVT.I (%)	122	10.16374	14.66201	0	77.27142
SSF (%)	122	21.60984	32.08491	0	99.00284
THE (%)	122	5.712966	2.124009	1.836784	13.63
THE P.C. (US$ per capita)	122	416.9336	794.0728	3.194748	4788.312
DEV. NAT	122	0.172131	0.3790511	0	1

Figure 1: This table displays the summary statistics for each variable (dependent and independent) in the regression model described in the previous section. Units of measurement for each variable are in parenthesis next to the abbreviations. DEV.NAT has no units of measure next to it since it is a dummy variable with only two possible outcomes. **Note:** Please refer to Appendix A for more information on units of measure.

Figure 1 reveals that the range of the dependent variable, HALE, is quite short from 7.5 – 18.2 years, implying that there is only 10.2 years of variation amongst all 122 countries. Also, it can be seen how some of the minimum values for quantitative variables such as EXT.RES, PVT.H, and SSF are "0." This signifies that some countries do not have this type

[9] National Geographic, "International Organization," National Geographic, https://www.nationalgeographic.org/encyclopedia/international-organization/.

of cost indicator implemented or do not have a policy that include these types of funding. For example, 51 countries out of the 122 did not have a recognized social security funds program for senior citizens. Therefore, the WHO records these values as 0% of general government expenditure (does the same for the other cost indicators in the model represented in percentages too). Also note that the minimum and maximum values of the DEV.NAT variable is 0 and 1 respectively because it is a dummy variable.

Before analyzing the data, another important aspect to test for is if the independent variables in the regression model are collinear with each other or not. When independent variables are collinear to each other in a model, it makes one independent variable's data dependent on another independent variable. In order to use a linear regression, estimators in the model must be independent of one another so that the error in each variable is random and minimized. With high or perfect multicollinearity between variables, this assumption is violated. Highly correlated variables have many potential consequences in a regression model such as producing misleading hypothesis testing results, giving insignificant coefficient signs or magnitudes, and generating larger standard errors for each variable. Therefore, the collinearity between variables have been outlined in Figure 2 and Figure 3, which look at the correlation coefficients and variance inflation factors (VIF) respectively.

	HALE	EXT. RES	GGE	OOP	PVT. H	PVT. I	SSF	THE	THE P.C.	DEV. NAT
HALE	1.000									
EXT. RES	-0.496	1.000								
GGE	0.442	-0.095	1.000							
OOP	0.583	-0.303	0.180	1.000						
PVT. H	-0.426	0.088	-0.994	-0.175	1.000					
PVT. I	0.366	-0.289	0.151	0.324	-0.135	1.000				
SSF	0.472	-0.289	0.215	0.302	-0.216	0.207	1.000			
THE	0.375	-0.154	0.140	0.525	-0.136	0.305	0.425	1.000		
THE P.C.	0.609	-0.282	0.313	0.087	-0.312	0.420	0.562	0.360	1.000	
DEV. NAT	0.587	-0.288	0.402	0.654	-0.404	0.210	0.403	0.462	0.757	1.000

Figure 2: This table displays a correlation coefficient matrix for variables (dependent and independent) in pairs. The correlation coefficients, or r-values, in the table are meant to represent the collinearity between the variable on the first row with each other variable on the first column. For example, the r-value between variables HALE and EXT.RES in the first column is -0.496. Note that the r-value will be 1.000 if the variable on the horizontal row is being paired with itself on the column. R-values that are higher than .8 indicate high collinearity between two variables. **Note:** Please refer to Theory & Model section for variable abbreviations.

Variable	VIF
PVT.H	97.25
GGE	96.74
THE P.C.	7.10
OOP	4.81
DEV. NAT	2.81
THE	1.65
PVT.I	1.41
SSF	1.38
EXT. RES	1.24
Mean VIF	**23.82**

Figure 3: This table displays the variation inflation factor (VIF) calculations for variables (dependent and independent) in the regression from the previous section. VIF statistics represent each variable's collinearity to the regression model overall. Represented in descending order from highest to lowest in value, VIF calculations greater than 10 signal a variable has high collinearity in the regression model. The same applies for the mean VIF of the model, as it must be below 10 in order to have no high multicollinearity. **Note**: Please refer to Theory & Model section for variable abbreviations.

In Figure 2, we see alarmingly large correlation coefficient shared between general government expenditure (GGE) and private healthcare expenditure (PVT.H) of -0.994, which indicates both are highly collinear to each other. In Figure 3, we see the VIF statistics for both to be high as GGE is 96.74 and PVT.H is 97.25, signifying that there is high multicollinearity in the regression model overall. Referring to the definition of total healthcare expenditure (THE),[10] it can be seen why this is the case. Both GGE and PVT.H are the two major components that make the sum of THE and therefore the values for each can be predicted if the other is present. All the other paired variables maintain relatively low r-values and VIF statistics, therefore passing as not collinear to each other and to the regression model overall.

To address the highly collinearity of GGE and PVT.H, I divided the model into two separate regressions which has one of the two variables defined as:

MODEL 1 (GGE included): $\mathbf{HALE = \beta_0 + \beta_1\ EXT.\ RES + \beta_2\ GGE + \beta_3\ OOP + \beta_4\ PVT.I + \beta_5\ SSF + \beta_6\ THE + \beta_7\ THE\ P.C. + \beta_8\ DEV.\ NAT}$

MODEL 2 (PVT. H included): $\mathbf{HALE = \beta_0 + \beta_1\ EXT.\ RES + \beta_2\ PVT.H + \beta_3\ OOP + \beta_4\ PVT.I + \beta_5\ SSF + \beta_6\ THE + \beta_7\ THE\ P.C. + \beta_8\ DEV.\ NAT}$

[10] Refer to Appendix A

RESULTS

HALE (# of years)	MODEL 1	MODEL 2
EXT. RES (%)	-0.0552*** (0.01358)	-0.0553*** (0.01368)
GGE (%)	0.0288*** (0.00732)	-
OOP (US$ per capita)	0.0042** (0.00187)	0.0043** (0.00189)
Pvt. H (%)	-	-0.0271*** (0.00735)
Pvt. I (%)	0.0141 (0.01039)	0.0149 (0.01046)
SSF (%)	0.01481*** (0.00539)	0.01483*** (0.00543)
THE (%)	-0.0285 (0.07606)	-0.02909 (0.07665)
THE P.C. (US$ per capita)	0.0003 (0.00042)	0.00002 (0.00043)
DEV. NAT	0.7469 (0.59570)	0.7786 (0.60035)
CONS	11.5269*** (0.56706)	14.3299*** (0.54076)
	MODEL 1 N = 122 R^2 = 0.6101 F = 22.10***	**MODEL 2** N = 122 R^2 = 0.6042 F = 21.57***

Figure 4: This table displays the regression results for Model 1 and Model 2 holding HALE as the dependent for both. A new abbreviation, CONS, is introduced here as it stands for the constant in the model. Coefficients for each independent variable are on the first line of each row and its standard errors are right below in parenthesis on the second line of each row. In Model 1, PVT.H has a dash because it was omitted; and for Model 2, GGE has a dash because it was omitted. Significance of the coefficients are indicated under the 10% level (*), under the 5% level (**), under the 1% level (***). This regression already accounts for multicollinearity and heteroskedascticity (none were present in the model). **Note:** Please refer to Theory & Model section for variable abbreviations and Appendix A for more information on units of measure.

From the results in Figure 4, which include Model 1 and Model 2, both have an R^2 value that allows us to explain about 60% of the variation in the data. Furthermore, along with a high R^2 value, the F-statistic of both Model 1 and Model 2 are significant as well under the 1% level, indicating that the results of each model hold overall significance. Of the individual variables, the statistically significant variable under the 5% level was out of pocket

expenditure; and under the 1% level were EXT.RES, GGE (in Model 1), PVT.H (in Model 2), SSF, and CONS. The insignificant variables remained the same across both Model 1 and Model 2, as they were PVT.I, THE, THE P.C., and DEV.NAT.

Focusing specifically on Model 1, which included government general expenditure (GGE) instead of private healthcare (PVT.H), the first statistically significant variable is the constant (CONS). The coefficient of the constant being statistically significant indicates that the minimum amount of HALE years for people at age 60 is approximately 11, which is relatively high. The reason why it can be deemed as high is because if we were to look at Figure 1, the mean of HALE was about 13 across all countries and the coefficient of the constant itself is about 11 years. This implies that without any funding or expenditure, seniors will still be given a minimum of 11 years to live after 60 reaching a life expectancy of 71 years, which is only about 2 years less than the average (73 years). The second significant variable is social security funding with a positive coefficient of 0.0148, which means that for every 1% social security funding went up, HALE increased by about 0.0148 of a year. In reality, this is a relatively small magnitude because mathematically even if we were to increase social security funding by 100%, life expectancy would only increase by 1.5 years or about 1 year and 6 months for people at age 60. Similar results were drawn even when looking at the third positive significant variable in Model 1, general government spending (GGE). In spite being significant, if general government spending were to increase also by 100%, its coefficient suggests that HALE would only increase by 2.9 years or about 2 years and 10 months. The fourth positive statistically significant variable in Model 1, which had the greatest impact on HALE with a coefficient of 0.0042, conveys how for every $100 spent out of pocket on healthcare, HALE at age 60 increased by .42 years or almost 5 months.

The fifth statistically significant variable in Model 1, which also had the greatest magnitude, was extra resources (EXT.RES) and it was negative. The coefficient on EXT.RES in Model 1 suggests that for every 1% increase in external resources, HALE years decreased by 0.0552 years. Again to provide a clearer picture of this coefficient's magnitude, mathematically if we were to increase external resources by 100%, then the life expectancy for people 60 and above would decrease by more than 5 and half years.

In the results of Model 2 in Figure 4, which included private healthcare expenditure (PVT.H) as opposed to general government expenditure (GGE), once again the constant (CONS) was statistically significant. Except this time, CONS in Model 2 exhibited a higher coefficient of 14.322 than CONS in Model 1. Again, this implies that the minimum amount of HALE years at age 60 that will be added without any healthcare cost is about 14 years, giving a life expectancy of about 74 years, which is even greater than the average life expectancy too. Observing the other statistically significant coefficients in Model 2, we see a minuscule difference in magnitude for EXT. RES, SSF, and OOP. Therefore, the main result Model 2 mainly offers is PVT.H being significant with a negative coefficient of .029599. This signifies that a 100% increase in private healthcare expenditure would result in a decrease in life expectancy at age 60 of approximately 3 years. The fact that PVT.H had a negative coefficient is interesting, since this insinuates that the variable had an adverse effect compared to GGE on HALE.

CONCLUSION

With an R-squared of about 60% in both Model 1 and Model 2, overall it can be stated that cost is a significant contributor in determining the conditional life expectancy for older populations 60 and above. Furthermore, how different countries choose to fund certain programs or resources does affect the quality of elderly healthcare, hence ultimately determining how long more they can live. Both models showed that external resources expenditure, general government expenditure, private healthcare expenditure, social security funds, and out-of-pocket expenditure affected the conditional life expectancy for the elderly.

The first important point to be drawn from the results is that even though general government expenditure was significant in Model 1 and private healthcare expenditure was significant in Model 2, both variables had opposite effects on conditional life expectancy. The negative coefficient of private healthcare expenditure in Model 2 suggests that countries with higher percentages of private healthcare spending lowered the number of HALE years for the elderly. It also implies that countries with more public healthcare costs exhibited higher HALE year rates than countries with more private healthcare costs. Therefore, countries that had more private healthcare coverage than public deteriorated their potential to increase life expectancy for senior citizens. Essentially, this model contradicts the norm that private healthcare coverage is "better" in terms of service, healthcare, and quality – at least for older populations. Although out-of-pocket expenditure did help with HALE years in Model 1, it can be argued that it was offset by the negative coefficient of private healthcare expenditure in Model 2. Therefore, it can be interpreted that seniors 60 and over who spend more out of their pocket on various health services are helping to increase their life expectancy if they have government-funded healthcare as opposed to private healthcare.

However, the most eye-catching significant variable in this study, which had the largest adverse effect on conditional life expectancy, was external resources. One would think that extra resources for funding outside of private and public healthcare would positively impact life expectancy for the elderly rather than deteriorate it. Although this result may seem confusing, it can be explained by the following theory. The demographic of the countries that were chosen in the dataset was back in 2000, or 17 years ago. Developing nations at that time such as Guinea, Comoros, Cambodia, and more had higher values for external resource funding because they were relatively new sovereign states looking to lean on outside countries for foreign aid. These same developing nations have comparatively lower HALE expectancy years for the elderly than developed nations because they were so new nations in 2000 and had not yet grown. Therefore, external resources was represented as a negative coefficient since the foreign aid and extra funding for these developing countries had still not taken affect. If the cross-sectional data for HALE years at age 60 was taken from a more recent year such as 2015, the results for extra resources as a healthcare cost indicator might have been different. Consequently, extra resources as a variable has the potential to improve life expectancy for senior citizens despite having a negative coefficient in this model, but we would have to test it for a more recent year to see.

From a cost analysis standpoint, it is established that public healthcare expenditure helps to better conditional life expectancy for the elderly over private healthcare expenditure. Furthermore, this model helps to not only reveal which particular healthcare costs are significant in increasing life expectancy, but also in increasing the quality of life for older populations. The term, “health-adjusted life years,” or “HALE,” The World Organization has defined to be the number of additional years a certain person can live in “full heath” without

disease or injury on average.[11] Essentially, HALE becomes a qualitative indicator along with a quantitative indicator for life expectancy for people aged 60 and above. Through HALE's definition, it can be assumed that there is a proportional relationship between quality and quantity of life expectancy – the more HALE years people gain, the better quality health they get per year.

Alluding to Becker and Lewis's quality versus quantity theory, the findings from this study are consistent with their prediction of quality and quantity having a close relationship. In countries that had higher HALE years because of higher public healthcare costs, the quality of health for people over 60 increased as well since they got to live longer in full health. It can be further argued that the reason why general government expenditure and social security seemed to be more beneficial in terms of HALE than private healthcare expenditure is because its health services are targeted more towards increasing the quality of health. For instance, countries with social security programs (i.e. United States, Canada) give money to senior citizens who use it not just for healthcare, but also for other factors that contribute to a healthy lifestyle such as retirement, social activities, and living in senior home communities.

While this study helps to explain the effect of cost on elderly life expectancy, there were many limitations. Some of the limitations that affected the conclusions drawn in this paper included lack of information involving costs directly associated with senior citizen healthcare, missing data in the model, and accounting for only one year of data. Future research that can be made on this study should include these missing factors and further examine more quality measures other than HALE for ageing populations. Moreover, further

[11] Refer to Appendix A

research should be more specific in associating direct senior citizen healthcare costs with senior citizen life expectancy to help strengthen the cost-effective analysis. Future research also should provide time series data, or data collected over a longer period of times, so that a change in each healthcare cost variable's effect on life expectancy could be analyzed. With time series data, rather than having a linear multi-regression model that does not account for time and fixed effects, a panel regression model can be performed to obtain results for each.

After assessing the quality and quantity gains in health for older populations, it is clear that public healthcare expenditure is necessary in improving both. Hence, public policy makers of countries around the world should aim to provide more funding towards public healthcare services for senior citizens that include health insurance coverage, social security, and drug-prescription coverage. Senior citizens internationally have a basic human right to live their life healthy and for as long as they possibly can in whatever country they reside. Therefore, countries need to take into consideration the findings of this study to better rectify existing policies and monetary budgets in public healthcare coverage for older populations.

APPENDIX A

Variables in Regression Model	In-Depth Explanation/Description
Y_1 = Health-Adjusted Life Years (HALE) at Age 60	This dependent variable for our model is measured by the additional amount of years the WHO predicts an individual can live at age 60. Specifically, the WHO explains how they measure the additional years of life expectancy to be the average number of years a person can expect to live in full health by taking into account years lived in less than full health due to disease or injury.[12] From the research question proposed, the purpose of this variable in this model is to highlight the conditional life expectancy of the elderly populations in healthcare systems around the world.
X_1 = External Resources on Health (EXT.RES)	This serves as one of the cost indicators in the regression model and is measured as a percentage value of total health expenditure (THE). Considered a core NHA (National Health Accounts) indicator, external resources are defined to be funding for healthcare that does not come directly from private or public financing agents, but through other means. For example, funding for public healthcare can sometimes come from external private insurance agencies or NGO sectors. Many sourcing for elderly healthcare activities is sponsored from major external resources. For example, a huge NGO in India, HelpAge India, has spread across 26 states and sponsored right from healthcare to home plans for thousands of senior citizens.[13]
X_2 =General Government Healthcare Expenditure (GGE)	Another healthcare cost indicator that measures the level of general government expenditure on health as a percent of total healthcare expenditure on health (THE). This variable contributes to understanding the relative weight of public entities in total expenditure on health. It includes resources channeled through government budgets to providers of health services and the expenditure on health by

[12] The World Health Organization

[13] HelpAge NGO, "History," HelpAge India, https://www.helpageindia.org/aboutus/history.html.

	parastatals, extra budgetary entities and health insurance payments. For example, in the U.S., Medicare or Medicaid covers 26.3% of senior citizens over 65 years of age.[14] It will be interesting to see how much of public healthcare covers senior citizen populations around the world and how government funding for public healthcare affects the outcomes.
X_3 = Out-of-Pocket Expenditure (OOP)	As a subset of private healthcare expenditure, this cost indicator is expressed as US $ per capita. To further clarify, this variable measures people's own payments of private pre-paid plans or other risk-pooling plans. Note that this variable does not measure coverage of private healthcare. Therefore, in terms of cost effectiveness, this variable will reveal how much money each country's citizens either valuably spend or waste on private healthcare.
X_4 =Private Health Expenditure (PVT.H)	Expressed as a percent of total health care expenditure (THE), this cost indicator the WHO defines as the sum of outlays for health by private entities. Private entities include households, commercial or mutual health insurance, non-profit institutions serving households, resident corporations and quasi-corporations with a health services delivery or financing function. It includes expenditures from all sources, so includes any donor-funding passing through these financing agents as well. In the U.S., the majority of senior citizens over 65 are currently covered through private insurance with 65%. Therefore, it is important to see how many added HALE years these citizens will get in the U.S. because the model will reveal whether private healthcare better to have than public healthcare or not.
X_5 = Private Insurance (PVT.I)	This cost indicator is expressed as a percentage of private healthcare expenditure (PVT.H). To further clarify, this variable measures how much private insurance companies spend on their patients through private pre-paid plans or other risk-pooling plans. Note that this variable does not measure coverage of private healthcare. Therefore, in terms of cost

[14] USA.gov, "Health Insurance Coverage," National Center For Health Satistics, last modified March 31, 2017, https://www.cdc.gov/nchs/fastats/health-insurance.htm.

	effectiveness, this variable will reveal how much money each country's citizens either valuably spend or waste on private insurance.
X_6 = Social Security Funds (SSF)	This cost indicator is expressed as a percent of general government expenditure (GGE). The WHO defines social security or national health insurance schemes to be controlled schemes by government units for the purpose of providing health services to members of the community. They include payments to medical care providers and to suppliers of medical goods as well as reimbursements to households and the direct outlays on supply of services in kind to the enrollees. It includes current and capital expenditure and donor funds channeled through these institutions too.[15] Social security is probably one of the most prominent ways the elderly not only get retirement income, but also get direct payment (in checks) from the government which they can choose to use anyway they want. Hence, it is important to see if social security schemes do provide benefits to the elderly in terms of health outcomes.
X_7 = Total Health Care Expenditure (THE)	Total healthcare expenditure as a variable is measured as a percent of GDP (gross domestic product). This independent variable is technically comprised of two main branches of spending – government and private. Hence, total healthcare expenditure is recognized to be the sum of all outlays for health maintenance, restoration or enhancement paid for in cash or supplied in kind and sum of general government expenditure and private expenditure on health. Not just for seniors, but also for all aged citizens, this variable gives a macro-economic view of how cost impacts a country's healthcare system provided their wealth, demographics, and geography.
X_8 = Total Health Care Expenditure per Capita (THE P. C.)	This independent variable measures the same premise as the previous x-variable, except it is expressed in per capita $US. This variable makes it more convenient to compare countries' expenditure against each other using a common currency ($US) rather than a

[15] The World Health Organization

	percentage of GDP (especially considering the vast range of GDPs internationally between developing and developed nations).
X_9 = Developed/Developing Nation (DEV. NAT)	This independent dummy variable has two possible outcomes, 0 = developing nation and 1 = developed nation. The United Nations categorizes nations around the world to be "developed" or "developing" based on their gross national income per capita (GNI per capita). Countries with less than US$1,045 GNI per capita are classified as low-income under "developing nations;" those with a GNI per capita between US$1,046 and US$4,125 are classified as lower-middle income countries under "developing nations;" those with a GNI per capita between US$4,126 and US$12,735 were classified as upper-middle income countries under "developing nations;" and those with a GNI per capita of US$12,735 and above are classified as high-income countries under "developed nations."[16] This variable is meant to see if HALE will be affected by the healthcare systems offered in high-income, developed countries or lower income, developing countries.

[16] *World Economic Situation and Prospects 2016*, report no. 978-92-1-109172-4 (New York, NY: United Nations, n.d.), [Page 158], http://www.un.org/en/development/desa/policy/wesp/wesp_current/2016wesp_full_en.pdf.

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