Basic Studies of Long-term Fiscal Projection for National Health Insurance

Eunkyeong Lee · Sok Chul Hong · Wankyo Chung · Jae-Young Lim

May 2018

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Center for Long-Term Fiscal Projections

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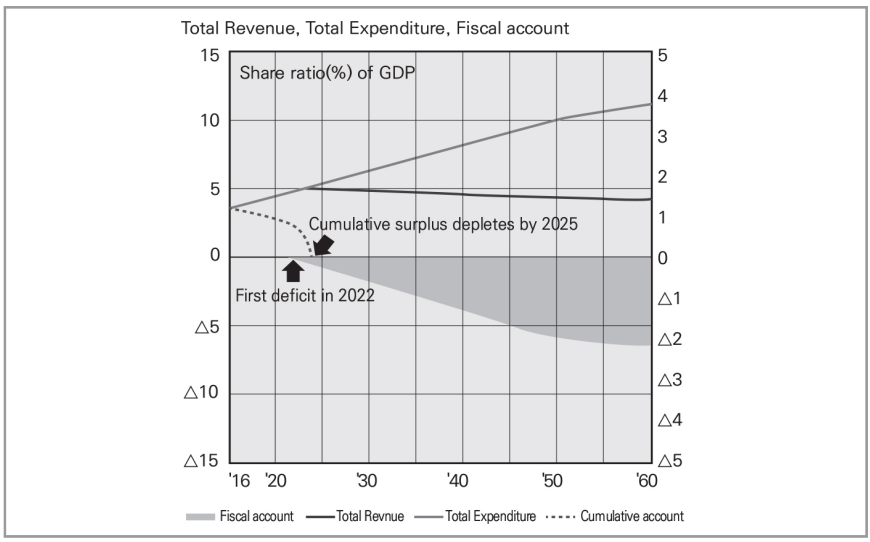
Introduction

According to the “2060 Long-term Fiscal Projections” announced by the Ministry of Strategy and Finance at 2015 year-end, the National Health Insurance Service (NHIS) is expected to record the largest surplus ever in 2016, totalling roughly 0.02% of GDP. The surplus will decline gradually in the coming years, and the balance will fall into a chronic deficit by 2022. The balance is then forecast to reach -4.9% of GDP by 2045 and -7.0% by 2060.

[Figure I-1] **Long-term fiscal projections for National Health Insurance**



Source: Ministry of Strategy and Finance, press release (December 7, 2015), 2060 Long-term Fiscal Projections

The long-term fiscal projections for National Health Insurance were put together by the National Health Insurance Service using the OECD's component-based projection model. Generally, three models including the component-based model have been used for projecting healthcare expenditures (OECD, 2017).

The first is the micro-simulation model, which utilizes data on individuals or households. The micro-simulation model has the advantage of being able to reflect individuals' behaviors, but it has a weakness in that it deals with vast amounts of data and fails to incorporate macroeconomic conditions into projections. This model is used in Canada for the population health model and in Sweden for projecting long-term demand for welfare services.

The second approach is the macro-level model. It projects health expenditures based on time series analysis with major economic variables. Its advantage is simplicity in data work, but it has limitations in that the time period needs to be sufficiently long without any breaks. The macro-level approach reflects seasonality and trends in projections and is used in the Australian Government Productivity Commission model and the US Medicare & Medicaid Services Dynamic Computable General Equilibrium model.

The third approach, the component-based model, is a hybrid of the macro-level and micro-simulation models. The population is divided into small groups broken down by age, gender, and other criteria, and then health expenditures are projected for each group, which are combined to arrive at the total health expenditure. The component-based model is widely used by international organizations because data work is simpler than micro-simulation models, but specificity and complexities are well reflected. The EU's Ageing Working Group model and the OECD's health expenditure growth projection method are good examples of the component-based approach.

Previously, fiscal projections for National Health Insurance were based solely on the National Health Insurance Service's macro-level projection model. Recently, many researchers have adopted the component-based projection model because it is less data intensive (more convenient) and produces highly reliable outcomes (Park *et al*., 2010; Lee *et al*., 2011; the National Health Insurance Service, 2014; Shin *et al*., 2015). National health expenditures are the total amounts spent on healthcare nationwide in Korea in a given year. They include

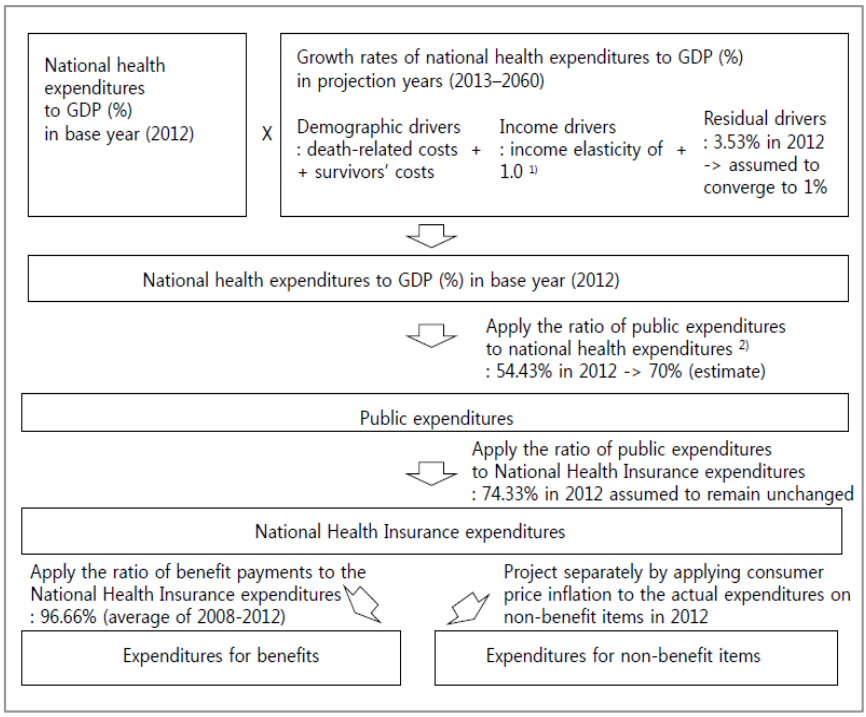
both the expenditures covered by National Health Insurance (payment by the insurer and co-payment by the insured) and the expenditures not covered by National Health Insurance.

As shown in [Figure I-2], the component-based model first projects the ratio of national health expenditures to GDP and then separates out the expenditures covered by National Health Insurance. Health expenditures are estimated separately based on three key drivers - demographics, income, and residual drivers - and the resulting three components are combined to obtain total national health expenditures. Population aging is a very important demographic driver, but end-of-life health expenditures have recently been found to be even more important in health spending projection. Therefore, researchers have started to decompose health expenditures into death-related costs and survivors' health expenditures.

The income driver is computed using income elasticity of health service, which is often estimated at either 1 or 0.8. The residual drivers refer to all drivers excluding demographic and income drivers, which include new medical technology, health policy, and institutions.

This study began with the following question: Are the assumptions used for the long-term fiscal projections for National Health Insurance based on the OECD approach sound and robust? This study aims to challenge the three underlying assumptions of the OECD projection model and present more reasonable alternatives. The three assumptions that we study in this paper are related to 1) the method of projecting death-related costs, 2) income elasticity of health services and 3) an optimal level of coverage for National Health Insurance.

[Figure I-2] **National Health Insurance expenditure projection model based on the OECD model (National Health Insurance Service, 2014)**



Note: 1) The income elasticity of 1.0 from the OECD (2006) is used, and for sensitivity analysis, the income elasticity of 0.8 is used for projections.
2) Expenditures are projected separately based on different annual average growth rates estimated.
Source: Shin *et al.* (2015)

In projecting death-related costs, the OECD framework assumes the healthcare spending for the oldest age group (85 and over) to be the costs of death without decomposing the spending into survivors' costs and non-survivors' costs. The OECD model also assumes that the death-related costs for those under 50 total 2.5 times the healthcare spending for the oldest age group (85 and over) and that people aged 50-84 see their death-related costs decline linearly with age. The cost of death calculated based on these somewhat far-fetched assumptions can distort long-term fiscal projections when the actual cost of death

by gender and by age group can be computed using the National Health Insurance Service database (such as the sample cohort data). Therefore, the first task for this study is to develop more precise death-related cost projections based on reliable data sets.

The second task is estimating income elasticity of health expenditures and checking the validity of income elasticity of 1 or 0.8 used in the OECD analysis. Developing reasonable income elasticity is critical because income elasticity is a parameter that has a substantial impact on projections. For this reason, it is deemed useful to directly estimate the income elasticity of healthcare demand to see if the income elasticity (1 or 0.8) generally used by the OECD is reasonable and justifiable.

The third problem is that in its long-term fiscal projections, the National Health Insurance Service assumes that the ratio of public to total health expenditures (level of coverage or coverage ratio) will increase from 55% today to 70% in the future. This assumption originates from the policy objective of raising coverage to the OECD average of 70%. This study attempts to verify whether 70% is an appropriate level of coverage for Korea by deriving a level of coverage that will maximize the overall health of the Korean people.

This paper is set out as follows. Chapter II is a study of death-related costs by Prof. Sok Chul Hong. Chapter III is projections of income elasticity of healthcare service in Korea by Prof. Wankyo Chung. Chapter IV is a study on an optimal level of coverage for Korea by Prof. Jae-Young Lim. Chapter V presents the overall conclusion and policy messages.

Ⅱ

Projections of health expenditure by population change[1)]

1 Introduction

In 2014, Korea's total healthcare expenditure reached 105 trillion won, or 7.1% of GDP, lower than the OECD average of 9.1%. Over the past decade, however, Korea's healthcare expenditure rose by 3.5% per annum, far outpacing the OECD average of 1.1%. The rapid growth in healthcare expenditure was driven primarily by sharp increases in healthcare demand associated with population aging. According to Hong (2014), 24% of Korea's healthcare spending growth from 1990 to 2010 was attributable to population aging. If population aging persists, *ceteris paribus*, the percentage of GDP accounted for by healthcare is forecast to rise to 8.8% by 2020, 10.5% by 2030 and to 12.1% by 2040.

In 2014, 56.5% (59.3 trillion won) of healthcare expenditures were public health expenditures and the remaining 43.5% (45.7 trillion) were private health expenditures. Of the public health expenditures, 74% (43.9 trillion won) came from National Health Insurance, 94% of which is funded by contributions from the insured. Rising health spending may mean more consumption of high-quality healthcare goods and services, which will help improve public health. There is, nevertheless, a concern that healthcare spending may be excessive and become a substantial burden on the public. For this reason, robust projections of healthcare expenditures and associated issues are needed to help the healthcare

1) This chapter is authored by Sok Chul Hong, a professor of economics at Seoul National University.

authorities formulate effective healthcare policies.

All residents in Korea are required to subscribe to National Health Insurance managed by the National Health Insurance Service. National Health Insurance coverage has been expanding and covers most major health services.[2] Public health policy in Korea focuses primarily on managing the social health insurance system and its funding, pointing to the great need to develop sound fiscal projections for National Health Insurance and to take necessary policy actions from a mid-and long-term perspective. Several long-term financial projections for National Health Insurance have been published by different entities, but their projections vary significantly. Whereas the National Health Insurance Service projected the National Health Insurance expenditures to reach 1,031 trillion won by 2060, Park (2014) projected them at 467 trillion won and Shin *et al*. (2014) at 846 trillion won. These gaps are largely driven by differences in the statistical models, assumptions, and data sets used for projections. They can disorient the authorities in managing the national health insurance scheme and undermine efficiency in developing and executing healthcare policy.

Although previous studies used different models for healthcare spending projections, many of them used the 2013 OECD framework that decomposes the drivers of healthcare spending growth into demographic and non-demographic drivers. The OECD model first projects the evolution of each driver separately and then combines them to compute total healthcare expenditures. Demographic drivers broadly refer to population change that causes changes in healthcare expenditures. Population change is usually captured from population projections published by Statistics Korea based on life expectancy. Projecting average healthcare expenditures by age group is at the heart of this analysis. Because there is a big gap in healthcare expenditures between non-survivors and survivors, it is necessary to project the two groups' healthcare expenditures separately and use population projections to compute total healthcare expenditure. Non-demographic drivers include rising incomes and residual drivers such as relative prices, advancements in medicine, and policy changes.

2) A universal health insurance system is in place, but some groups of people cannot enjoy its benefits. For example, some low-income families do not satisfy the requirements for medical benefit. There are others who lose eligibility for national health insurance because they cannot make insurance fee.

This study aims to develop long-term projections of healthcare expenditures associated with the National Health Insurance system for non-survivors and for survivors. Previous studies that published financial projections for National Health Insurance projected healthcare expenditures separately for non-survivors and for survivors, but those studies were based on somewhat unrealistic assumptions. For instance, they assumed the following: the total health expenditure for people aged 85 and over is death-related health expenditure; the costs of death increase linearly as age declines from 84 to 50; and the costs of death remain constant for people under 50. These assumptions may have been proposed by the 2013 OECD analysis due to lack of reliable data on country-specific healthcare expenditures for non-survivors and for survivors by age group. Given the rapid demographic change propelled by low birth rates and population aging, failure to accurately project healthcare expenditures by age group can have serious repercussions for policy and budget development.

To address the aforementioned issues with previous studies, this study uses a sample cohort database containing medical records for 2002-13 of one million National Health Insurance subscribers to develop more accurate projections of healthcare expenditures for non-survivors and for survivors. The main objectives of this study are to build healthcare expenditure projections for non-survivors and for survivors for the years up to 2059 using the sample cohort database and to compare the projections between this and previous studies. It must be noted that the sample cohort database only captures healthcare expenditures covered by the National Health Insurance system because it is based on the medical records managed by the National Health Insurance Service. The scope of coverage by National Health Insurance may change in the future. Therefore, it may be useful for future studies to consider incorporating healthcare expenditures not covered by National Health Insurance.

Section 2 reviews various health expenditure projection models used in different studies, domestic and international, and discusses problems with the 2013 OECD study regarding demographic driver analysis. Section 3 describes the sample cohort database and variables used for analysis. In Section 4, per-capita annual average healthcare expenditures for non-survivors and for survivors are projected and then healthcare expenditure growth is projected until 2059 based on possible population scenarios. In Section 5, healthcare expenditure

profiles for both non-survivors and survivors are analyzed by type of expenditure and by type of healthcare service provider. In addition, the ratios of total lifetime health expenditure during the last year of life for non-survivors are projected and policy implications of the projection results are discussed. Finally, Section 6 summarizes the findings of this study and discusses how the findings can be used and what policy implications they present.

2 Review of previous studies

Previous studies utilized various models such as a micro-level, a component-based, a macro-level, or a combined model for health expenditure projections. The choice of model used depended largely upon when the research was conducted and what was projected. The features of the four models are summarized below.[3)]

Firstly, a micro-level model is often used in projecting healthcare expenditures by individuals. It generally deals with large samples of individuals and data on their healthcare spending, health variables, and socioeconomic variables. In the analysis using the model, the marginal effects on healthcare expenditures of variables representing the characteristics of the individuals are projected and the projections are used to predict the impact of likely changes in the characteristics or policy intervention on healthcare expenditures.

Secondly, a component-based model has been widely used in projecting healthcare expenditures by funding source, provider, service type, or population group and combining those projections to estimate the total healthcare expenditure. The model typically divides the population by age group and decomposes healthcare expenditures by nature of spending. It then projects healthcare expenditures for each age group and for each spending segment and adds up the projected results to obtain the total healthcare expenditure. This model does not require as much data as the micro-level model.

3) Descriptions of the projection models are referenced from Astolfi, Lorenzoni, and Oderkirk (2012) and Jeong *et al.* (2015). Particularly, these two studies summarize the models used for projecting national health expenditures or budgets.

Thirdly, a macro-level model only analyzes the total amount of healthcare expenditures and uses a times series model to fit times series data. Because it does not require vast amounts of data, the macro model is suitable for short-term projections with relatively simple trends and no structural break. The computable general equilibrium model, which is a representative macro model, recognizes healthcare expenditures as a driver of the macro economy and analyzes interactions with other macroeconomic drivers to project healthcare expenditures.

Finally, a combined model is a hybrid model that combines other models. A good example is using the component model with micro-level data to estimate healthcare expenditures for each segment and combine all expenditures to understand the overall healthcare spending trend.

This study is based on the 2013 OECD projection model, which is a component-based model. The 2013 OECD analysis proposes a component-based model for projecting public healthcare expenditures and long-term care expenditures. Spending growth rates are projected separately for increases driven by demographic drivers and by non-demographic drivers and then combined to project the total expenditure. This framework of dividing expenditure growth into demographic and non-demographic drivers was first introduced in the 2006 OECD analysis and then updated and refined in the 2013 OECD analysis. The 2013 OECD methodology has been widely used by the OECD countries and many others for the estimation of national healthcare expenditure.

The theme of this study relates to the 2013 OECD methodology, particularly to the projection model for demographic drivers. In the methodology, changes driven by demographic drivers in healthcare spending are divided into death-related costs and the healthy-aging regime. To take into account these two elements, healthcare expenditures per age group are projected separately for non-survivors and for survivors. This distinction is based on the assumption that non-survivors and survivors show different health spending profiles.

Non-survivors' healthcare expenditures by age group can be computed by multiplying average health expenditures close to death by the number of deaths per age group. The 2013 OECD analysis defines the cost of death as the average per-capita health expenditure for the 95+ age group. The costs of death for the 0-59 age groups are forecast to remain constant at 4 times the cost of death

for the 95+ age group. For people aged 94 down to 60, the costs of death increase gradually from 1 to 4 times.[4] Population aging will increase the number of deaths, whereas rising life expectancy can reduce mortality rates. Then, the costs of death will be determined by the relative size of these two effects. In principle, the survivors' healthcare expenditures can be computed by subtracting the non-survivors' healthcare expenditure from total expenditures. However, this approach can make projections fluctuate widely depending on the initial conditions or external factors related to total healthcare expenditures. As an alternative, the 2013 OECD analysis proposes the projection of the survivors' expenditure per age group using a non-linear model.[5]

Previous domestic studies used the 2013 OECD methodology to project national healthcare expenditures and closely followed the methodology in analyzing demographic drivers. In Shin et al. (2015), all of the healthcare expenditures for the 85+ age groups are assumed to be the costs of death. Based on the National Health Insurance claims database, the cost of death is estimated at 8.622 million won for men and 8.655 million won for women. The per-capita costs of death for people under 60 are estimated to remain constant regardless of age at 2.5 times higher than the cost of death of the 85+ age groups. As a result, the cost of death for the 0-59 age groups is projected at 21.555 million won for men and 21.638 million won for women. The costs of death for the 60-84 age groups are assumed to decline with age. In the meantime, the per-capita healthcare expenditure for survivors is derived by dividing the difference between

4) To account for the dominance of end-of-life costs and the healthy-aging regime, the expenditure curve by age group needs to be split for each period into two segments of the population: survivors and non-survivors. The non-survivors' expenditure curve can be estimated by multiplying the estimated healthcare costs close to death by age group by the number of deaths per age group. The "cost of death" was proxied here by the healthcare expenditure per capita for the oldest age group (95+) multiplied by a factor that captures the tendency for the costs of death to be higher at younger ages. This factor is kept constant at 4 for people aged between 0 and 59 years and declines linearly (towards unity) afterwards. [OECD (2013), p.14]

5) In principle, the survivors' expenditure curve for each country could be derived from the difference between the total cost curve and that of the non-survivor. However, given the uncertainties surrounding these data, it seemed preferable to estimate an average expenditure curve for survivors and to then use that for all countries. This renders the projections less sensitive to initial conditions and to country-specific data idiosyncrasies. This expenditure curve for survivors was estimated econometrically as a non-linear function of age. Each country-specific curve is then calibrated in order to fit the base year of the projections. [OECD (2013), p.14]

total healthcare expenditures and the non-survivors' expenditures by the projected population. This methodology is similarly used in Lee, *et al*. (2011), and the analysis by National Health Insurance Service (2014).[6)]

There are, nevertheless, several issues with the above methodology. Firstly, the average healthcare expenditure for 85+ people is assumed to be the cost of death. However, meaningful differences are observed in healthcare expenditures for survivors and for non-survivors even in the 85+ age group. Secondly, it is assumed that there is no difference in the per-capita cost of death for people under 60, regardless of age. This is an unreasonable assumption given that meaningful differences exist in the causes of death by age group. For example, the costs of death can widely vary depending on whether the death was caused by an accident, a major killer of younger people, or by a chronic disease, a major killer of older people. Thirdly, the costs of death for non-survivors are not directly projected for each age group and are assumed unrealistically to increase at a certain rate based on the cost of death for the 85+ age groups. Aging does not occur in proportion to age, and patterns of the costs of death are expected to vary across age groups. Fourthly, previous domestic studies do not directly project the survivors' health expenditures. The problem here is that any biases in the non-survivors' healthcare expenditure projections can cause an error in the survivors' healthcare expenditure projections. This study is designed to address the above-mentioned issues and to develop more realistic projections of healthcare expenditures for both the non-survivors and the survivors.

3 Data and variables

This study uses a sample cohort database of the National Health Insurance Service for projecting healthcare expenditures for non-survivors and survivors. The sample cohort database contains panel data of medical records for the period

6) These studies first estimated national healthcare expenditures and then applied the ratios of public expenditures and National Health Insurance expenditures (e.g.: coverage ratio) to develop fiscal projections for National Health Insurance.

2002-13 of one million subscribers to National Health Insurance. The samples are selected randomly to represent 1,476 segments of the population classified by gender, age, and income. The samples represent about 2% of Korea's population as about 50 million are eligible for National Health Insurance each year.[7)]

An advantage of using the sample cohort database is having access to twelve years of medical and socioeconomic data for the sampled individuals captured from various data sources of the National Health Insurance Service ranging from entitlement, medical examination, healthcare provider, and medical check-up databases. The entitlement database provides data on gender, age, and type of subscriber (employee insured or self-employed insured), address (city and district), income percentile, degree and type of disability, and disability registration date.[8)] The examination database contains detailed information on the department visited, date of first visit for treatment, provider code, disease and injury code, number of days of treatment, healthcare cost claimed and approved (total segmented into co-payment by the insured and payment by the insurer), diagnosis, and type of treatment and prescription. Information on the medical institutions visited by the patient is taken from the healthcare provider database. The healthcare provider database also contains information on the type and nature of the provider, location (province and city), the number of beds, the number of doctors, and equipment (CT/MRI/PET). Lastly, a large proportion of the National Health Insurance subscribers use the medical check-up service sponsored by National Health Insurance (general check-up and adulthood milestone check-up) and the health check-up database contains information on the questionnaire filled out by the patient and the results (e.g. height, weight, blood pressure, cholesterol level, blood sugar, personal health history, family health history, smoking, drinking, and exercise habits). In the meantime, because the sample cohort database is linked to Statistics Korea's vital statistics, it gives the non-survivors' date and cause of death coded according to the ICD (International Classification of Diseases).

7) Refer to https://nhiss.nhis.or.kr/bd/ab/bdaba002cv.do for more information on the sample cohort database.

8) Income percentile is a variable for understanding the level of income of the individuals based on the amounts of insurance contributions. As the amounts of contributions are determined per household, the income percentile for a household will apply equally to all members of the household.

This chapter is focused on projecting annual healthcare expenditures for non-survivors and for survivors across genders and five-year age groups. Whether the person in the sample is a non-survivor or a survivor is determined by existence of the date of death in the database. The annual healthcare expenditure for a non-survivor is defined as the total expenditure approved by the National Health Insurance Service during the one year before the 15th day of the month of death. The date of first visit for treatment in the medical examination database is used to compute the one year period. The annual health expenditure for a survivor is defined as the total healthcare expenditure approved by the National Health Insurance Service during the corresponding one year period. All healthcare expenditures are converted into constant values of December 2013 based on the Consumer Price Index for medical care (CPI).

For the purpose of this chapter, 'health expenditures' are defined as health expenditures covered by National Health Insurance (co-payment by the insured and payment by the insurer)[9]. It should be noted that healthcare expenditures not covered by National Health Insurance and other private expenditures are out of scope of this chapter. Healthcare expenditures not covered by National Health Insurance can be captured from 'A Healthcare Spending Survey for the National Health Insurance Patients' administered annually by the NHI Policy Research Institute. This survey collects data from the claim systems installed at healthcare institutions (including pharmacies) throughout the country during a certain period each year. Therefore, personal information such as gender or age of the patient, or whether or not the individual is deceased is unavailable, which renders the survey data unfit for this study.

9) The purpose of this study is to develop long-term projections for National Health Insurance (NHI). In light of this purpose, it may be reasonable to limit the scope of analysis to the healthcare expenditures paid by National Health Insurance Service excluding statutory co-payments. However, previous studies including Shin et al. (2015) subject to comparison by this study develop projections for NHI by first projecting national healthcare expenditures based on the NHI claims data as the sum of healthcare expenditures for non-survivors and for survivors (payments by the insurer and co-payments by the insured) and applying the ratios of public expenditures and of National Health Insurance expenditures. Following the same approach, this study conducts analysis on the sum of the payments by the insurer and co-payments by the insured. When necessary in the future, separate analyses on these two elements can be performed.

4 Health expenditure projections for non-survivors and survivors

A. Health expenditure projections for non-survivors

<Table II-1> provides annual average health expenditures by gender and by age group for the non-survivors in 2013 and 2003 derived from the sample cohort database. According to the database, there were 5,019 non-survivors in 2013 and 4,105 in 2003. Annual health expenditures are total spendings (in constant values of December 2013) on the healthcare services for which the date of first visit falls within one year before the 15th day of the month of death.

〈Table II-1〉 **Non-survivors' average healthcare expenditures during the last year of life: summary statistics**

Age group	Non-survivors in 2013				Non-survivors in 2003			
	Male		Female		Male		Female	
	Average spending (ten thousand)	Sample size (persons)	Average spending (ten thousand)	Sample size (persons)	Average spending (ten thousand)	Sample size (persons)	Average spending (ten thousand)	Sample size (persons)
0	2,449	1	988	2		0		0
1–4	2,112	8	3,871	4	1,383	8	619	8
5–9	1,898	2	7,029	1	421	9	365	8
10–14	943	4	282	2	536	6	909	1
15–19	1,618	15	2,442	2	425	15	226	5
20–24	559	11	4,008	6	84	26	344	12
25–29	296	14	593	9	219	29	234	7
30–34	1,021	26	2,644	13	346	36	457	15
35–39	1,193	31	1,892	21	524	63	715	29
40–44	1,523	53	1,983	26	482	106	866	43
45–49	1,310	110	2,058	40	506	142	823	48
50–54	1,663	174	2,007	75	659	159	997	55
55–59	1,739	185	2,200	68	657	165	851	69
60–64	1,841	234	2,421	87	771	271	666	115
65–69	1,855	246	2,216	101	719	340	728	169
70–74	1,547	398	1,939	237	593	306	523	199
75–79	1,447	473	1,638	337	505	290	357	294
80–84	1,324	361	1,321	447	443	235	291	335
85 and over	980	367	958	828	264	162	182	325
Total	1,469	2,713	1,473	2,306	567	2,368	460	1,737

Note: Average healthcare expenditures are projected by gender and by age group for the non-survivor samples taken from the sample cohort database. Non-survivors' average healthcare expenditures are the average of the total expenditures spent by the non-survivors during the one year before the 15th day of the month of death. All healthcare expenditures are converted into constant dollars of December 2013 using the Consumer Price Index for medical care.

A major feature found from <Table II-1> is that healthcare expenditures vary widely by year, gender, and age group. The average health expenditure for all male non-survivors during the one year period preceding death in 2013 was 14.69 million won, 2.6 times higher than the 5.67 million won in 2003. The figure for all female non-survivors climbed 3.2 times from 4.6 million won in 2003 to 14.73 million won in 2013. The sharp rise in average health expenditures can be attributed to rising demand for healthcare services for longer and healthier lives fueled by advances in medicine.

Looking at the expenditure trend by age group, the non-survivors' average healthcare expenditure is high in the 0-4 age group and declines until the late 20s before rebounding. It peaks in the 60s and declines onwards. This pattern of health expenditures across age groups may be a result of the common causes of death for each age group. Most deaths in infancy are caused by health issues at the time of birth. The high cost of death in infancy may reflect the great efforts of the parents who want to prevent the premature deaths of their children at any cost. Most deaths for the 5-29 age groups are due to accidents and suicides. Unlike chronic diseases, they are hard to prevent and generally do not incur substantial healthcare spending.

For people aged 30 and over, chronic diseases explain a significant percentage of deaths. Advances in medicine have heightened the chances of curing chronic diseases. Patients with severe chronic diseases have greater chances of living longer than before. This often leads to greater demand for healthcare services and subsequent increases in healthcare expenditures. However, the effectiveness of healthcare is likely to fall with the age of the patient. While the probability of dying can be drastically reduced for younger patients with chronic diseases when they receive proper healthcare, healthcare for older patients is relatively ineffective. The reduced effectiveness of healthcare for older people may result in lower consumption of healthcare service and a subsequent decline in healthcare spending on the same diseases. This can explain the gradual decline in the costs of death for the 60+ age groups. Also contributing to the decline may be lower disposable income and limited access to health information and to health institutions due to physical challenges and other factors.

Gender comparison shows slightly higher costs for men than for women in 2003 whereas the costs were higher for women than for men in 2013. Although

there is only a slight gender gap in total expenditures, there is a notable gender gap in most of the age groups. The gap may be driven by differences in the types of chronic diseases, the risks of death, and causes of death that commonly affect men vs. women in each age group.

The summary statistics in <Table II-1> show key attributes of health expenditure patterns of the non-survivors. However, the data cannot be directly used for the National Health Insurance financial projections because of small sample size for non-survivors as the sample cohort database represents a mere 2% of all National Health Insurance subscribers. The problem of small sample size is more pronounced in younger age groups (particularly under 30) where mortality rates are low, resulting in even fewer samples as seen in <Table II-1>. This can undermine the overall quality of the statistics. Furthermore, measurement errors can occur in some age groups due to the absence of observed values or a small number of samples.

To address these issues, this study uses a simple regression model to project the non-survivors' health expenditures by gender and by age group. The regression model is run with all available years of data and utilizes variations in the non-survivors' healthcare expenditures by gender and age group. The regression analysis is aimed at finding a model that best fits the distribution of the observed values. This study employs three regression models for analysis to find the best fitting model.

$$Y_i = \alpha + \sum_{k=0}^{18} \beta_k D(Age_i = k) + \gamma Male_i + \sum_{t=2003}^{2013} \delta_t D(Year_i = t) + \varepsilon_i \quad (1)$$

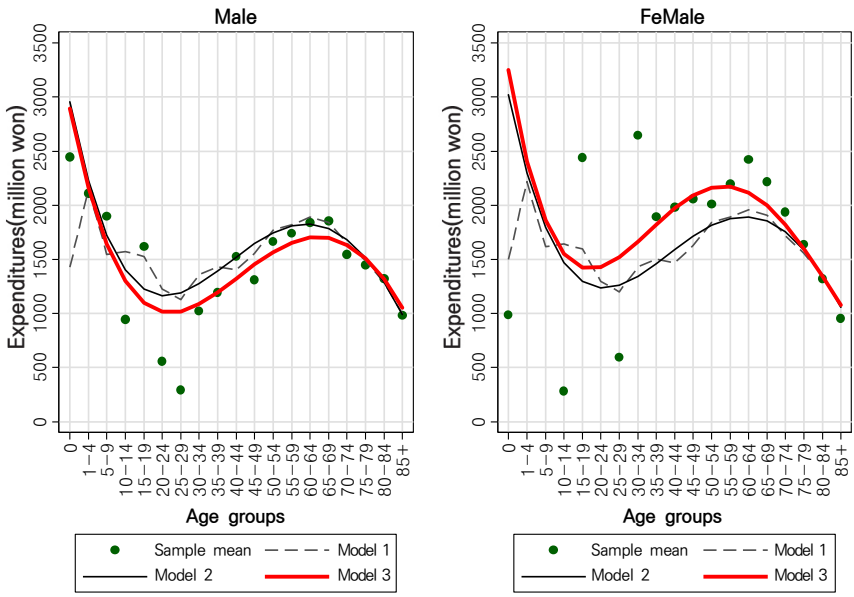
$$Y_i = \alpha + \sum_{k=0}^{4} \beta_k Age_i^k + \gamma Male_i + \sum_{t=2003}^{2013} \delta_t D(Year_i = t) + \varepsilon_i \quad (2)$$

$$Y_i = \alpha + \sum_{k=0}^{4} \beta_k Age_i^k + \sum_{t=2003}^{2013} \delta_t D(Year_i = t) + \varepsilon_i \quad (3)$$

Model (1) uses dummy variables for age group [$D(Age_i = k)$], male ($Male_i$) and year [$D(Year_i = t)$] as key explanatory variables that can explain variances in the non-survivors' healthcare expenditures. In other words, the model reflects differences in the non-survivors' average healthcare expenditures by age group, gender, and year to smooth out the observed values. The non-survivors are divided into 18 age groups as in <Table II-1>. Model (2) does not control for age with a dummy variable. Instead, it controls for a non-linear pattern by age. The sample cohort database does not provide the age and birth year of the samples. It only indicates the particular 5-year age group that each sample belongs to. Therefore, the age variable (Age_i) takes on a value from 1 to 18 and indicates a specific age group. As observed in <Table II-1>, the non-survivors' average healthcare expenditures and age show a relationship of a polynomial function of degree 3 or greater. Through various trials with polynomial models of different degrees, this study finds a quartic (degree 4) model that fits best and adopts it in Model (2). Finally, Model (3) applies Model (2) separately to the male and female samples. and the male dummy variable is excluded accordingly. The regression model does not take into account characteristics of individuals other than age, gender, and year because the purpose of this study is not analyzing the determinants of the non-survivors' healthcare expenditures.

[Figure II-1] exhibits the fitted values of the three regression models along with the observed values. The fitted values are the non-survivors' projected health expenditures based on the 2013 data by gender and by age group, and the observed values are also from the 2013 data. Compared to the observed values, Model (3) seems to fit best. Model (1) controls for age with a dummy variable, so differences in healthcare expenditures by age group are not smoothly fitted. Model (2) fails to accurately reflect the patterns of differences in healthcare expenditures between men and women by age group. Model (3) is not perfect, but it addresses these issues relatively well.

[Figure II-1] **Projections of non-survivors' average healthcare expenditures during the one year period preceding death**



According to the regression analysis, the non-survivors' average healthcare expenditures vary by year and rise rapidly over the past 10 years.[10] This growth trend needs to be reflected in the financial projections for National Health Insurance. However, non-demographic drivers such as income and healthcare demand are at play in this rapid growth. Likely changes in healthcare expenditures associated with non-demographic drivers have been analyzed by other studies. This study does not consider health expenditure growth over time and uses for subsequent analyses the non-survivors' average health expenditures by age and by gender projected above based on the 2013 data.

10) According to projections for male non-survivors in Model (3), the regression coefficient (t value) of the dummy variables is 74.6 (1.89) in 2004, and it is projected to be 932.6 (24.34) in 2013. The regression coefficients of dummy variables rose continually 2004–2013. In terms of constant values of December 2013, the average healthcare expenditures in 2004 and in 2013 are 746,000 won and 9.326 million won higher than in 2003, respectively.

<Table II-2> compares the non-survivors' health expenditures estimated above based on the 2013 data and the non-survivors' projected health expenditures from Shin et al. (2016). As discussed in Section 2, the non-survivors' projected health expenditures from Shin et al. (2016) are based on somewhat unrealistic assumptions and show considerable differences from the estimations of this study. This study has an advantage in that it projects health expenditures for each age group of the non-survivors. On the other hand, the previous study assumes that the non-survivors' health expenditures for people under 60 are the same. As a result, in Shin et al. (2016), the non-survivors' health expenditure projections are overestimated for young age groups and underestimated for the 65+ age groups.

〈Table II-2〉 **Comparison of non-survivors' projected health expenditures**

Age group	Age distribution of non–survivors in 2013 (%)		Non–survivors' projected health expenditures (in ten thousand won, constant values of Dec. 2013)			
			Shin *et al.* (2015)		This study	
	Male	Female	Male	Female	Male	Female
0	0.4762	0.5074	2,156	2,164	2,894	3,250
1–4	0.1310	0.1254	2,156	2,164	2,164	2,407
5–9	0.1091	0.0777	2,156	2,164	1,644	1,860
10–14	0.1201	0.0802	2,156	2,164	1,299	1,550
15–19	0.3800	0.2132	2,156	2,164	1,099	1,422
20–24	0.5669	0.3227	2,156	2,164	1,015	1,426
25–29	0.6951	0.4564	2,156	2,164	1,018	1,519
30–34	1.1638	0.8058	2,156	2,164	1,086	1,662
35–39	1.6215	1.0248	2,156	2,164	1,194	1,822
40–44	2.9586	1.6191	2,156	2,164	1,322	1,972
45–49	4.4314	2.0897	2,156	2,164	1,452	2,090
50–54	7.0640	3.1346	2,156	2,164	1,568	2,160
55–59	7.9904	3.2901	2,156	2,164	1,655	2,170
60–64	8.0722	3.6754	1,850	1,857	1,701	2,116
65–69	9.2067	4.9903	1,588	1,594	1,697	1,998
70–74	14.4643	9.7808	1,363	1,369	1,635	1,821
75–79	15.8818	15.0002	1,170	1,175	1,509	1,597
80–84	12.3584	18.9941	1,004	1,008	1,315	1,341
85 and over	12.3086	33.8120	862	866	1,054	1,077
Total	100	100				
Per capita average expenditure for non–survivors			1,506	1,240	1,477	1,497

Note: Age distribution of non–survivors in 2013 is based on national vital statistics found in KOSIS. Non–survivors' projected health expenditures are taken from projections by gender and by age group in Shin *et al.* (2015) and projections in this study based on Model 3. Per capita average expenditures for non–survivors are computed by multiplying the percentage of each age group in total number of samples by the group's average health expenditure and combining each group's resulting values.

The per-capita average health expenditure for the non-survivors based on age distribution in 2013 is 14.77 million won for men and 14.97 million won for women. The comparable value from Shin *et al*. (2016) is 15.06 million won for men and 12.4 million won for women. Compared to this study's projections, the per capita average health expenditure is overestimated by 290,000 won for men and underestimated by 2.59 million won for women. If the per-capita average health expenditure is multiplied by the number of the male non-survivors in 2013 (146,589), the male non-survivors' projected health expenditures for National Health Insurance during the last year of life are overestimated by 42.1 billion won. When the 2.59 million won for women is multiplied by the number of the female non-survivors (119,632), the female non-survivors' projected health expenditures for National Health Insurance during the last year of life are underestimated by 308.6 billion won. This indicates that inaccurate projections of the non-survivors' average health expenditures for each age group can cause a serious distortion in health expenditure projections, particularly so as significant demographic changes are forecast.

B. Health expenditures for survivors

Next, the survivors' annual average health expenditures are to be estimated. The survivors refer to those individuals in the samples who are not deceased in the given current year in the sample cohort database, and the health expenditures refer to total health expenditures for that year. <Table II-3> displays the average health expenditures by gender and by age group for the survivors in 2013 and in 2003.

Because the survivor samples are used in this analysis, over 900,000 individuals are available for each year for the summary statistics. Thus, the sample size for each age group is adequate and the average healthcare expenditures by age group show a very smooth pattern. The average health expenditure generally declines from birth to the early 20s. Afterwards, it gradually rises until the 50s and accelerates sharply afterwards. This pattern of health expenditures by age coincides with a pattern of aging and chronic disease.

〈Table II-3〉 **Survivors' annual average health expenditures: summary statistics**

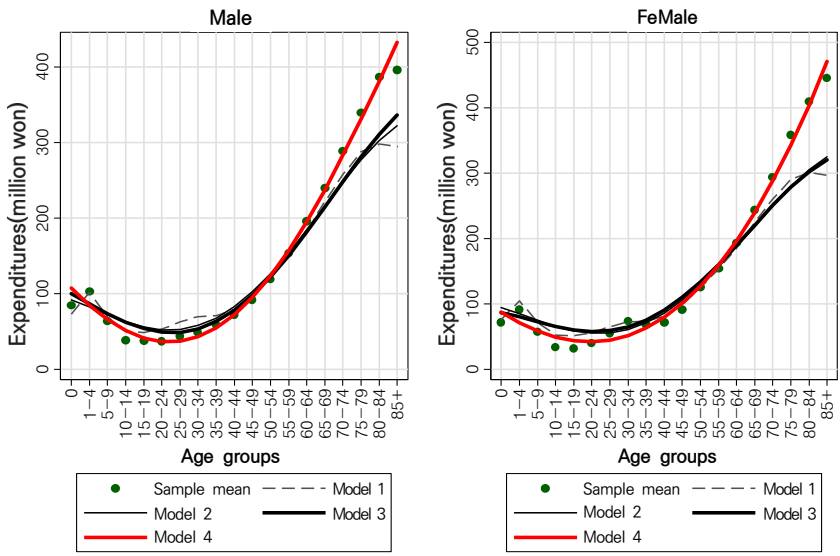
Age group	Survivors in 2013				Survivors in 2003			
	Male		Female		Male		Female	
	Average spending (ten thousand)	Sample size (persons)	Average spending (ten thousand)	Sample size (persons)	Average spending (ten thousand)	Sample size (persons)	Average spending (ten thousand)	Sample size (persons)
0	84	4,527	72	4,294	39	4,915	32	4,522
1–4	102	18,948	91	17,883	62	24,846	55	22,623
5–9	63	22,150	57	20,663	37	37,972	33	34,125
10–14	38	28,700	33	26,093	22	38,358	19	33,983
15–19	38	36,595	32	32,872	23	35,064	19	31,930
20–24	37	36,473	40	32,620	24	41,986	25	41,391
25–29	44	32,321	55	30,464	26	40,378	37	39,393
30–34	49	40,491	73	39,042	30	48,466	39	46,705
35–39	59	38,971	69	37,350	35	46,063	38	44,422
40–44	72	46,166	72	44,575	41	47,711	45	45,707
45–49	92	43,430	91	42,257	53	39,308	58	37,811
50–54	119	44,268	125	43,383	69	27,185	77	26,849
55–59	154	35,756	154	35,555	85	21,804	95	22,605
60–64	196	24,018	193	25,200	106	20,211	111	22,929
65–69	240	18,751	244	20,686	125	14,881	131	18,747
70–74	289	15,973	294	20,271	149	8,571	142	13,875
75–79	339	10,092	358	15,285	150	4,780	139	9,051
80–84	386	4,543	409	9,658	135	2,618	118	5,732
85 and over	396	2,343	445	6,944	114	1,164	84	3,558
Total	105	454,189	120	481,460	49	408,620	55	445,887

Note: Average annual healthcare expenditures are calculated by gender and by age group for survivor samples taken from the sample cohort database. All healthcare expenditures are converted into constant values of December 2013 using the Consumer Price Index for medical care.

The three models used previously for the non-survivor analysis are utilized to derive a smoother pattern in the survivors' health expenditure projections by age group and by gender. The estimated values derived from each model based on the 2013 data and the observed values are presented in [Figure II-2]. Unlike the curves in [Figure II-1], the estimated values predict the distribution of the observed values very closely. This seems to be attributable to large sample size. However, some discrepancies in the 60+ survivors are observed across the three models. Over the years of 2003-2013, which regression analyses above are based on, healthcare expenditure among the elderly substantially increased. It seems

that controlling for year dummies in regression fails to fully reflect such trends. To rectify this problem, Model (4) builds projections using Model (3) with the 2013 data, excluding the year dummy variable in Model (3). The projected values derived from Model (4), shown in [Figure II-2], well reflect expenditure trends by age group and by gender. Therefore, this result is used in this study.

[Figure II-2] **Projections of survivors' annual average health expenditures**



<Table II-4> presents the age distribution of the survivors in 2013 and projected average health expenditures. The per capita average expenditures for the survivors are computed by multiplying the distribution of each age group by the group's average health expenditure and combining each group's resulting values. The per-capita average expenditure is estimated to be 1.01 million won for the male survivors and 1.18 million won for the female survivors.[11] The

11) Korea's per-capita average annual healthcare expenditure for 2013 (covered by National Health Insurance) is reported at 1.09 million won (The Health Insurance Policy Research Institute, 2014), without respect to gender or to non-survivor or survivor. The projected expenditure in 〈Table II-4〉 is very close to this actual value.

non-survivors' projected average health expenditure for the last year of life is 15 times higher for men and 13 times higher for women than the survivors' projections by gender as shown in <Table II-4>. This gap is particularly higher in younger age groups. The expenditure gap between the survivors and the non-survivors shrinks rapidly with age. This means that as people get older, the percentage of the cost of death out of lifetime healthcare expenditures declines.

〈Table II-4〉 **Comparison of health expenditure projections for non-survivors and the survivors**

Age group	Age distribution of population (survivors) in 2013 (%)		Age distribution of non-survivors in 2013 (%)		Projected average annual healthcare expenditures				Non-survivors' healthcare expenditures as a % of survivors' expenditures	
					Survivors		Non-survivors			
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0	0.8448	0.8034	0.4762	0.5074	107	87	2,894	3,250	27.0	37.3
1–4	3.7792	3.5722	0.1310	0.1254	85	71	2,164	2,407	25.6	33.7
5–9	4.6884	4.3945	0.1091	0.0777	66	59	1,644	1,860	25.0	31.7
10–14	5.7266	5.2590	0.1201	0.0802	51	49	1,299	1,550	25.4	31.3
15–19	7.0394	6.3369	0.3800	0.2132	41	44	1,099	1,422	26.7	32.4
20–24	7.0435	6.2727	0.5669	0.3227	36	42	1,015	1,426	28.0	33.8
25–29	6.4478	6.0049	0.6951	0.4564	37	45	1,018	1,519	27.7	34.0
30–34	8.1501	7.8294	1.1638	0.8058	43	52	1,086	1,662	25.3	32.2
35–39	7.8365	7.5297	1.6215	1.0248	55	63	1,194	1,822	21.8	28.9
40–44	9.1613	8.8266	2.9586	1.6191	72	79	1,322	1,972	18.3	24.9
45–49	8.5842	8.3110	4.4314	2.0897	95	101	1,452	2,090	15.2	20.8
50–54	8.7103	8.5126	7.0640	3.1346	124	127	1,568	2,160	12.7	17.0
55–59	7.0824	7.0790	7.9904	3.2901	157	159	1,655	2,170	10.5	13.6
60–64	4.7558	4.9691	8.0722	3.6754	195	196	1,701	2,116	8.7	10.8
65–69	3.6860	4.0805	9.2067	4.9903	237	239	1,697	1,998	7.2	8.3
70–74	3.1113	3.9404	14.4643	9.7808	283	288	1,635	1,821	5.8	6.3
75–79	1.9670	2.9994	15.8818	15.0002	331	343	1,509	1,597	4.6	4.7
80–84	0.9007	1.8695	12.3584	18.9941	381	404	1,315	1,341	3.4	3.3
85 and over	0.4847	1.4092	12.3086	33.8120	432	471	1,054	1,077	2.4	2.3
Total	100	100	100	100						
Per capita average healthcare expenditure for survivors or non-survivors					101	118	1,477	1,497	14.6	12.7

Note: Age distributions of survivors and non-survivors in 2013 are based on KOSIS statistics on population and deaths. Non-survivors' projected healthcare expenditures are from Model (3) analysis displayed in [Figure II-1] and survivors' projected healthcare expenditures are based on projections using Model (4) in [Figure II-2]. Per capita average expenditures for non-survivors or survivors are computed by multiplying the percentage of each age group in the total number of individuals by the group's average healthcare expenditure and combining each group's resulting values.

C. Healthcare expenditure estimation: 2013-2059

This sub-section uses health expenditure projections for the non-survivors and for the survivors generated in Sections 4.A and 4.B to estimate the impact of demographic changes on health expenditures through the National Health Insurance Service (NHIS) until 2059[12]. A simple way to estimate the MHIS health expenditures (HE_t) until 2059 is summing up the non-survivors' healthcare expenditures for each year t ($\sum ND_{i,t} \times HED_{i,t}$) and the survivors' healthcare expenditures for each year ($\sum NS_{i,t} \times HES_{i,t}$), as shown below. However, this method is problematic in that, because the average healthcare expenditures by gender and by age group are projected values, the estimate of NHIS health expenditure at the first year of analysis is different from the actual value.

$$HE_t = HED_t + HES_t \tag{4}$$

$$HED_t = \sum_{i=0}^{a} ND_{i,t} \times HED_{i,t},\ HES_t = \sum_{i=0}^{a} NS_{i,t} \times HES_{i,t}$$

$i : agegroup, t : year, ND : \nu mberofnon-survivors,$

$HED : non-survivors'healthcare\ \exp enditures,$

$NS : \nu mberofsurvivors, HES : survivors'healthcare\ \exp enditures$

To address this problem, the previous year's health expenditures for the non-survivors and for the survivors are multiplied by each group's expenditure growth rates to compute health expenditures for a given year.[13]

12) This study projects health expenditures until 2059 whereas previous studies project health expenditures until 2060. The number of the non-survivors cannot be projected for 2060 because the difference in population between two consecutive years is used to estimate the number of the non-survivors per age each year.

13) Annual healthcare expenditures projected from the model could have been used here, but this approach was used to utilize the actual healthcare expenditures as of 2013.

$$HE_t = HED_{t-1}(1+g_{d,t-1}) + HES_{t-1}(1+g_{s,t-1}) \quad (5)$$

Each year's expenditure growth rates for the non-survivors and the survivors (g_d or g_s) are estimated using equation (6). In the equation, the health expenditures for the non-survivors and for the survivors (HED_t or HES_t) are calculated by multiplying the average health expenditures by gender and by age group times the number of the non-survivors and of the survivors. The numbers of non-survivors and survivors by age group are taken from the medians of the projected population published by Statistics Korea.[14] If the projected population for age i in the year t is $P_{i,t}$, the number of the non-survivors ($ND_{i,t}$) can be the difference in population between two consecutive years ($P_{i,t} - P_{i+1,t+1}$). And the number of the survivors each year can be obtained by subtracting the number of the projected non-survivors from the projected population ($NS_{i,t} = P_{i,t} - ND_{i,t}$). The average health expenditures for the non-survivors and for the survivors for each year come from the projections in <Table II-2> and <Table II-3> based on the 2013 data.

$$g_{d,t-1} = \frac{(HED_t - HED_{t-1})}{HED_{t-1}},\ g_{s,t-1} = \frac{(HES_t - HES_{t-1})}{HES_{t-1}} \quad (6)$$

The initial value for the non-survivors' healthcare expenditure in 2013 is 4 trillion won, the sum of products between the per-capita average healthcare expenditure for the non-survivors by gender and by age group and the actual number of the non-survivors by gender and by age group. On the other hand, the initial value for the survivors' health expenditures in 2013 is 37.5 trillion won, the difference between the National Health Insurance heath expenditures in 2013 of 41.5 trillion won and the non-survivors' healthcare expenditure in 2013 of 4 trillion won. The survivors' healthcare expenditures are projected indirectly to match the projected values to the observed values for the initial

14) The median estimation of 1960–2060 age-specific population projections in KOSIS is used for the analysis. Population projections are based on various assumptions on the current demographic drivers (births, deaths, and movement) and are believed to reflect net effects of cross-border movement including immigration and emigration.

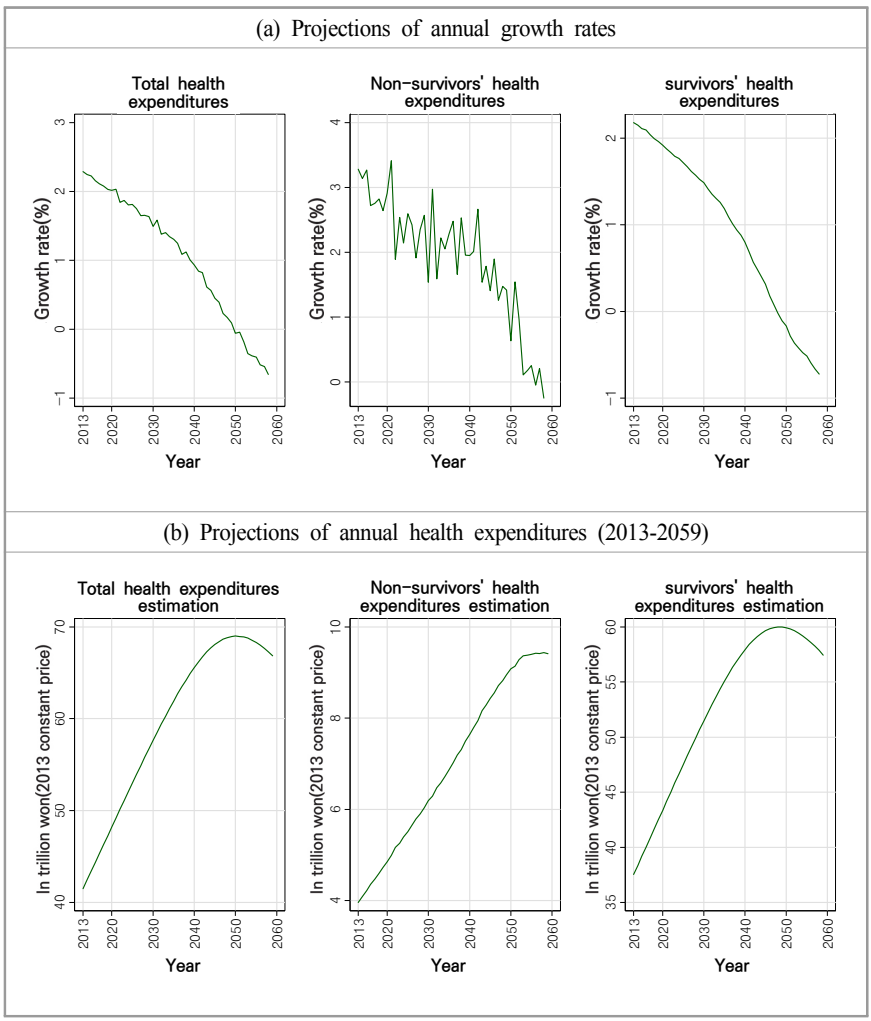
year.

[Figure II-3] displays the National Health Insurance expenditure trends projected using population changes estimated above. The top curves in (a) show patterns of annual expenditure growth for the non-survivors and for the survivors.[15] In 2013, the health expenditure for the non-survivors is projected to rise 3.3% YoY and that for the survivors is projected to rise by 2.2% YoY. But growth is expected to decelerate afterwards. This may be attributable to a growing number of people aged 60 and over. The non-survivors' average health expenditure declines with age in the 60+ age groups as seen in [Figure II-1]. On the other hand, the decelerating growth in the survivors' health expenditure can be driven by population decline. In sum, the number of people aged 60 and over will increase, but at an increasingly slower rate. As this pattern persists, the survivors' health expenditure is projected to begin declining in the late 2040s and the non-survivors' health expenditure to start declining in the late 2050s.[16]

15) High fluctuations in the non-survivors' health expenditure growth rates in [Figure II-3] (a) are attributable to a jagged pattern in the number of the survivors estimated based on population projections.

16) According to the National Health Insurance Statistical Yearbook 2015, the total National Health Insurance expenditures rose 6.5% YoY. Over the same period, the Consumer Price Index for medical care rose about 1.5%. As a result, real healthcare expenditures rose 5%. Because the actual growth rate is higher than the projected growth above, there may be concerns that this study's result underestimates health expenditure growth. However, the purpose of this study is to project healthcare expenditure growth driven by change in population distribution across age groups while fixing prices at the 2013 level. The difference between the actual growth in 2015 and the projected growth may stem from non-demographic drivers such as higher demand for healthcare services. Please be noted that contributions of non-demographic drivers on healthcare expenditure growth are being analyzed in other chapters. In the meantime, in [Figure II-3], survivors' expenditure growth is projected to begin declining in the mid 2040s. This may seem puzzling. However, as explained above, the negative growth can be caused by population decline. According to the population projections of Statistics Korea, from 2013 to 2060, the male population is expected to decline 13.5% and the female population to fall 11.2%. The greatest driver of the overall decline is a 50% population decrease in people younger than 60. If the population in the 60+ age groups increases, overall healthcare spending will rise. However, the rate of decline caused by few younger people is expected to outpace the rate of growth driven by increase in the older population. As a result, healthcare spending growth starts to decelerate and ultimately peaks.

[Figure II-3] **Projections of annual health expenditures and growth rates (2013-2059)**



Note: Figure (a) shows health expenditure growth rates estimated based on population changes. Figure (b) shows health expenditures projected for 2013–2059 using the projected growth rates in calculating the initial value for 2013. All expenditures are in constant values of Dec. 2013. The projection methodology is detailed in this study.

The health expenditure curves for the non-survivors and for the survivors shown in [Figure II-3] (b) are estimated by applying the annual growth rates projected above to the initial values for the first year. The health expenditures for the non-survivors and for the survivors are then combined to project total health expenditures. The total of health expenditures for the non-survivors is projected to increase from 4 trillion won in 2013 to 9.4 trillion won in 2058 and to decline afterwards. The survivors' health expenditures are forecast to increase from 37.5 trillion won in 2013 to 60 trillion won in 2048 before declining onwards. The total of health expenditures, the sum of the health expenditures for the non-survivors and for the survivors, is expected to rise from 41.5 trillion won to 69 trillion won in 2050 and diminish slightly to 66.9 trillion won by 2059. In 2013, the non-survivors' expenditures during the last year of life are projected at about 9.54% of the total National Health Insurance expenditures. The projections in [Figure II-3] show this ratio rising to 14.08% by 2059. This indicates that despite rising life expectancy and falling death rates, costs of death can increase because of population decline.

The projection results above are based on several assumptions. Firstly, the per capita health expenditures for the non-survivors and for the survivors are projected based on the 2013 data and are assumed to remain constant until 2059. The per-capita health expenditures are expected to rise over time due to rising income, advances in medicine, changing preferences, and rising demand for medical services.[17] The OECD (2013) analysis classifies them as non-demographic drivers and proposes a separate analysis on them. Analysis of expenditure growth driven by non-demographic drivers are to be carried out in future studies. This study only reflects demographic drivers, which results in a big projection gap against previous studies. Previous studies do not present projections that solely reflect demographic drivers, so direct comparison is not possible. This should be noted in the interpretation of this study. Population projections are important inputs that can affect the outcome of this study. This

17) These non-price factors can impact health expenditures in real terms. However, price factors such as reimbursement price increases or rising healthcare prices effect nominal health expenditures. If price changes are considered, nominal health expenditures until 2059 will be substantially higher than the health expenditures projected in this study.

study uses the medians of Statistics Korea's population projections. It should be noted that this study's projections may not hold if population aging and life expectancy take different paths than projected by Statistics Korea.

5 Additional analyses

A. Analysis by type of expenditure and by provider

In this section, health expenditures for non-survivors and for survivors are analyzed by the type of expenditure and by health service provider.[18] This additional analysis is designed to understand which types of expenditures and service providers will see most growth from demographic changes associated with population aging and rising life expectancy and to derive policy implications.

Health expenditures are classified as those for Western medicine, dentistry, Oriental medicine, or pharmacy. Western medicine is further classified as outpatient and inpatient service. Unlike the analysis of the previous section, this section focuses on understanding the current status. Therefore, instead of projecting health expenditure patterns by age group using regression models, average health expenditures by expenditure type and by age group are computed based on the NHIS sample cohort database. Health expenditures of each type are then combined to calculate the total expenditure. However, this approach can produce a total expenditure that differs significantly from what is estimated in the previous section. Because this may cause confusion, the shares of each expenditure type are presented <Table II-5> instead of the average health expenditures.

It is noteworthy that in <Table II-5> the ratio of the non-survivors' health expenditure during the last year of life for the Western medicine inpatient segment is extremely high at 87.6% on average. The figure is even higher at

18) Healthcare service providers provide National Health Insurance–covered healthcare services to the insured and their dependents in case of disease, injury, and child labor. They include medical institutions, pharmacies, and public health centers.

94% in the 0-39 age groups where demand for life extension through inpatient treatment is strong. The share of the inpatient service is equally high for the survivors. However, the figures for younger age groups are lower than those for the corresponding age groups for the non-survivors. In addition, while the share of dentistry and Oriental medicine for the non-survivors is a mere 3%, the figure for the survivors is as high as 10%. Generally, accidents and severe chronic diseases are major causes of death, and they often require surgery and hospitalization. In the future, population aging will raise the number of patients suffering chronic deceases. Subsequent growth in inpatient expenditures is likely to lead overall spending growth. This calls for measures to improve policies and delivery systems regarding benefits on inpatient care and end-of-life care.

〈Table II-5〉 **Health expenditures by expenditure type for non-survivors and survivors in 2013 (%)**

Age group	Non-survivors in 2013							Survivors in 2013						
	Total health-care spending	Western medicine			Dentistry	Oriental medicine	Pharmacy	Total health-care spending	Western medicine			Dentistry	Oriental medicine	Pharmacy
		Sub-total	Out patient	Inpatient					Sub-total	Out patient	Inpatient			
0–19	100	96.28	5.71	94.29	0.16	0.30	3.25	100	81.08	19.67	80.33	5.09	5.67	8.15
20–39	100	97.93	5.94	94.06	0.36	0.55	1.16	100	82.55	15.92	84.08	5.59	6.10	5.77
40–59	100	94.36	11.91	88.09	0.65	1.19	3.80	100	81.12	16.87	83.13	3.87	5.66	9.35
60–79	100	91.59	14.43	85.57	0.85	1.79	5.77	100	79.65	18.29	81.71	2.67	4.61	13.08
80 and over	100	89.52	9.91	90.09	1.55	3.14	5.79	100	82.48	10.53	89.47	4.14	3.79	9.60
Total	100	91.71	12.35	87.65	0.95	2.04	5.29	100	82.61	14.72	85.28	3.46	5.25	8.68

Note: Non-survivors and survivors are captured from the sample cohort database, and average health expenditures and percentages are computed by age group and by expenditure type. The figures in the inpatient and outpatient segments are percentages of the Western medicine sub-total. The Western medicine sub-total, dentistry, Oriental medicine, and pharmacy figures are percentages of total healthcare expenditures.

<Table II-6> displays health expenditures for non-survivors and for survivors divided by healthcare service provider. Healthcare service providers are classified into general (tertiary) hospitals, hospitals and clinics, and others which include dental clinics, maternity clinics, public health centers, pharmacies, and Oriental clinics. Age groups are classified in the same way as in <Table II-5>, and the percentages of the total are presented.

〈Table II-6〉 **Health expenditures by provider for non-survivors and survivors in 2013 (%)**

Age groups	Non-survivors in 2013				Survivors in 2013			
	Total	General hospitals	Hospitals /clinics	Others	Total	General hospitals	Hospitals /clinics	Others
0–19	100	95.13	0.84	4.03	100	54.31	26.46	19.23
20–39	100	85.79	12.56	1.65	100	57.62	25.77	16.61
40–59	100	83.20	12.16	4.64	100	54.08	23.56	22.37
60–79	100	68.99	24.29	6.73	100	44.93	27.96	27.11
80 and above	100	46.71	46.60	6.69	100	33.92	44.98	21.11
Total	100	65.83	28.10	6.07	100	52.85	25.83	21.32

Note: Non-survivors and survivors are captured from the NHIS sample cohort database. Average healthcare expenditures and percentages are computed by age group and by provider. 'Others' in hospital classification include dental clinics, maternity clinics, public health centers, pharmacies, and Oriental clinics.

A key observation from <Table II-6> is that the ratio of general hospitals is very high for the non-survivors. The overall average stands at around 66%, but the figure for 0-19 is 95% and that for 20-59 is over 80%. The high percentage of general hospitals in young age groups may be explained by higher demand for quality service to prevent premature death. The percentage of general hospitals is lower in older age groups presumably due to preference at end of life for convalescent hospitals than general hospitals or other large institutions, the physical challenges of traveling to distant institutions, declining income, and lower chances of extending life through medical service.

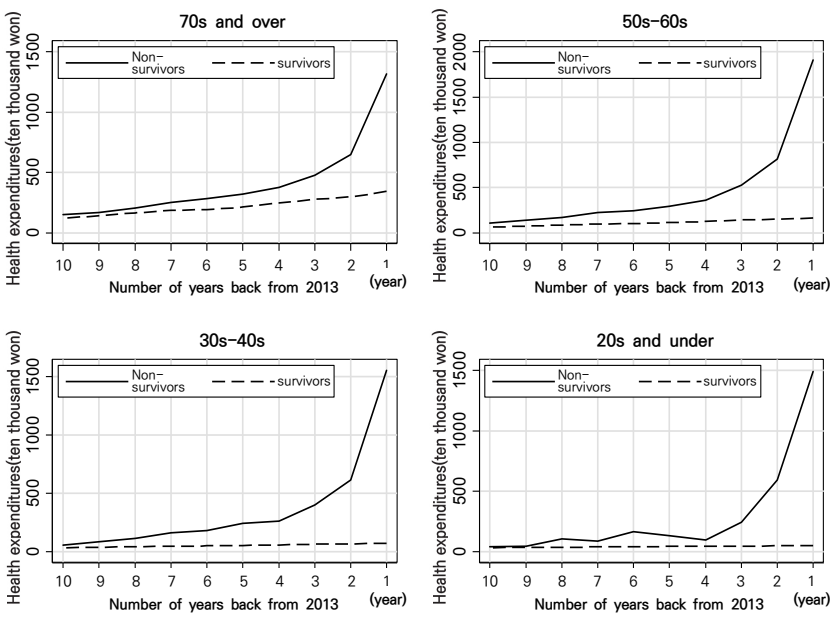
B. Long-term health expenditure projections for non-survivors and survivors

This chapter is mainly intended to project the non-survivors' average health

expenditures during the last year of life by gender and by age group. However, death-related costs are not limited to that period. If the non-survivors suffered from chronic diseases for years, they must have incurred higher healthcare expenditures than healthy individuals over the years. In the main analysis of this study, these expenditures are added to lifetime healthcare expenditures. Analyzing the long-term pattern of the non-survivors' health expenditures during years before death will generate useful implications for this study.

[Figure II-4] displays average health expenditure patterns over time for the non-survivors and for the survivors by age group. The results show changes during the 10-year period from 2013 backward, captured from the 2002-13 sample cohort database based on the 2013 data. The non-survivors and the survivors are taken from the 2013 data, and the average health expenditures are projected by age group over the past decade separately for the non-survivors and for the survivors.

[Figure II-4] **Past healthcare expenditure patterns for non-survivors and survivors**



In all age groups, the health expenditures for the non-survivors are substantially higher than those for the survivors, and these gaps are not limited only to the one year period preceding death. As for people in the 50s and 60s, the average health expenditure for the non-survivors for the last year of life is 19.085 million won, 11.5 times higher than 1.654 million won for the survivors in 2013. The average health expenditure for the non-survivors for two years before death is 8.154 million won, 5.4 times higher than 1.514 million won for the survivors in 2012. Although this gap narrows as it goes further back in time, the gap starts far back in time (3.7 times 3 years back, 2.6 times 5 years back, 2.4 times 7 years back, and 1.7 times 10 years back).

A significant finding from [Figure II-4] is that the non-survivors' health expenditures date far back in time and gradually increased. This means the non-survivors' health issues are generally long-standing. From another perspective, preventing or delaying the occurrence of health issues such as chronic disease can be an effective way to curb the growth in healthcare expenditures.

C. The shares of lifetime healthcare expenditures during the last year of life

Finally in this sub-section, the shares of lifetime healthcare expenditures during the last year of life are projected by gender and by age group. It is known that health expenditures peak immediately prior to death. Many studies have been performed on the elderly, but only a few have been done by gender and by age group. The timing and cause of death, and health issues at each life stage vary by gender and by age group. Therefore, the shares of lifetime healthcare expenditures during the last year of life are expected to vary by gender and by age group. Analyzing such differences will help identify new health policy agenda associated with population aging and subsequent growth in healthcare spending.

The shares of lifetime health expenditures during the last year of life are projected by the following formula.

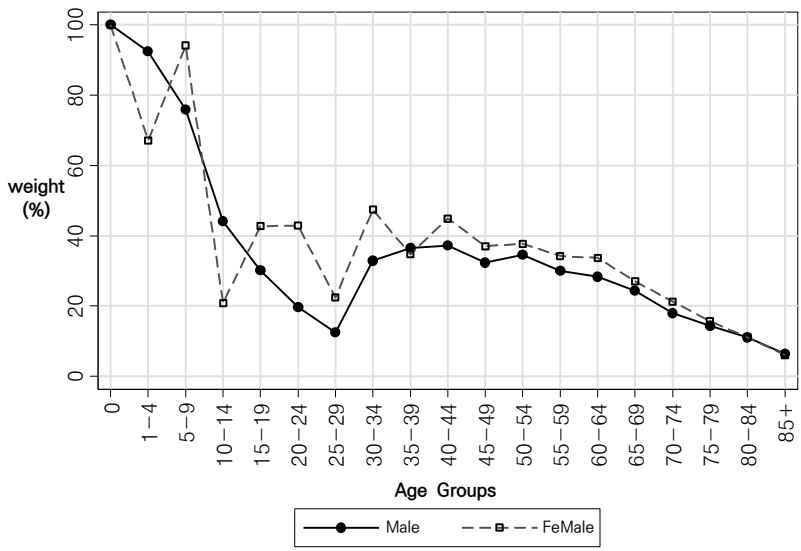
$$R_a = \frac{HED_a}{\sum_{t=0}^{a-1} HES_t + HED_a} \quad (7)$$

In the formula, HED_a refers to the total amount that a non-survivor who died at the age of a spent on healthcare during the last year of life; and HES_t is the total amount that the non-survivor spent on healthcare during his or her lifetime until one year before dying ($t < a$). The denominator is the total of lifetime healthcare expenditures, the sum of healthcare expenditures from birth until one year before dying and healthcare expenditures during the last year of life. The numerator is the healthcare expenditures during the last year of life. To use equation (7) for projecting the shares of healthcare expenditures during the last year of life out of lifetime healthcare expenditures, the non-survivors' healthcare expenditures from birth to death are required. However, the sample cohort database captures data only up to 12 years back. This means that lifetime healthcare expenditures of the individuals aged 12 and over cannot be computed. As an alternative, the total of healthcare expenditures for the non-survivors and the survivors are calculated for each age group using the 2013 data. The average health expenditures per age group can be used as if they were health expenditures of an individual in each life stage. However, as demand for medical service has risen, the shares can be overstated.

[Figure II-5] shows the shares of lifetime health expenditures during the last year of life projected using the methodology above. The percentages are highest in the 0-9 age groups for both men and women and decline to 20-30% in mid and late 20s. The shares remain essentially unchanged for a while and then continue to fall in the 50s and onward. The percentage may be high in infancy because high amounts are spent on health to prevent premature death when a health issue occurs, though lifetime health expenditures are not high due to the young age. The share declines from the 50s because lifetime health expenditures are high with constant spending on healthcare and health expenditures during the last year of life fall with age in older age groups as previously explained. The weighted average health expenditures during the last year of life based on the age distribution of the non-survivors account for about

20.9% of lifetime health expenditures for men and 16.7% for women based on the 2013 data.

[Figure II-5] Projections of shares of lifetime health expenditures during the last year of life



Note: solid line for males and dotted line for females
X-axis indicates age groups (0, 1-4, 5-9, ... , 85+ years of age)
Y-axis indicates share of lifetime health expenditures (%)

The results above can be largely seen as a result of the health expenditures incurred during the last year of life for older age groups being lower than lifetime health expenditures excluding the final one year. This indicates that, as the population ages and demand rises for healthcare to live longer and have better quality of life, spending on healthcare can increase in any year, not necessarily shortly before death. If spending more on healthcare in normal years can help improve the chances of a healthy life, subsequent increases in health spending may not be entirely negative. Additional analysis is required, however, on whether this pattern is cost-efficient after all.

6 Conclusion

This chapter is aimed at improving the methodology used for long-term fiscal projections for National Health Insurance adopted from the 2013 OECD analysis, particularly for the approach considering demographic drivers. Changes in health expenditures driven by demographics are projected by estimating average annual health expenditures by gender and by age group and applying population projections. Although the non-survivors' health expenditures by gender and by age group are significant drivers in the projection model, they are based on somewhat unrealistic assumptions. After highlighting the problems of these unrealistic assumptions, this study uses the sample cohort database of the National Health Insurance Service to directly project the non-survivors' health expenditures and reviews possible changes in health expenditures associated with demographic changes.

According to the projections, there are significant differences in health expenditures for the non-survivors and for the survivors across genders and age groups, which may be associated with different major causes of death and incidences of chronic disease in each group. When calculated using the projection expenditures and the medians of populations, the National Health Insurance expenditures are expected to rise from 41.5 trillion won in 2013 to 69 trillion won in 2050. Increases in health expenditures are forecast to be driven by a rise in the population of elderly persons stemming from rising life expectancy. There will, nevertheless, be a decline in population as the very low birth rate can hardly be expected to rebound and will eventually offset the greater life expectancy. This will, in turn, cause health expenditures to rise at a decelerating rate, reaching 66.9 trillion won in 2059.

This study also sheds light on the relation between population aging and healthcare spending. Health expenditure trends by age group show that health expenditures for the survivors rise with age whereas health expenditures for the non-survivors increase from the age groups in the 20s to 60s and then decrease slightly afterwards. This means that a growing share of the elderly in the population caused by rapid population aging may cause total health expenditures to rise even if other drivers (non-price drivers such as demand for medical service

and price drivers such as prices charged for medical service) remain unchanged. This implication runs counter to the conclusion of Zweifel et al. (1999) that population aging will have less impact on overall health expenditures than has been feared. However, since countries have different healthcare systems and demographic structures, additional analysis is required to generalize the conclusion of this study.

Finally, this study is performed on an assumption that per-capita health expenditures remain constant until 2059 for both the non-survivors and the survivors. Due to rising demand for healthcare services and healthy aging, per-capita health expenditures can change over time. Furthermore, sensitivity and robustness analyses are needed considering various non-price factors such as advances in medicine and demographic changes. These need to be factored into future studies.

Ⅲ

Income elasticity of healthcare service in Korea[19)]

1 Introduction

Korea's per capita health expenditures increased about 35.7 times from 56,000 won in 1970 to 2 million won in 2014 in constant values of 2010 (OECD 2016). Over the same period, Korea's per capita GDP in real terms rose about 13.5 times, from 2.1 million won to 28.3 million won. Their growth trends over the past decades are shown in [Figure III-1]. Per capita GDP has increased at a somewhat constant rate since 1980, whereas per capita health expenditure has risen at a steeper rate since 1998. Per capita health expenditure has in fact outpaced per capita GDP for the past 44 years. The ratio of health expenditures to GDP hovered around 2% until 1978 and around 3.4% between 1979 and 1994 without showing any particular pattern. Then, it rose steadily from 3.4% in 1995 to 7.1% in 2014.

The determinants of health expenditures include demographic drivers, advances in technology, changes in healthcare policy and institutions including health insurance, and change in income. Understanding the relative contribution of each factor to health expenditures is critical in projecting future health expenditures and in formulating and executing effective policy for managing health expenditures.

19) This paper is authored by Prof. Wankyo Chung from the Dept. of Public Health Science & Institute of Health & Environment, Graduate School of Public Health, Seoul National University.

Previous studies developed projections of national health expenditures with income elasticity of either 0.8 or 1 (Jong-Myeon Kim and Woo-Cheol Kim, 2007; Byung-Mok Jeon and Eunkyung Lee, 2010; National Health Insurance Service, 2014; de la Maisonneuve and Martins, 2013).[20] However, income elasticity of healthcare spending varies by the level at which analysis is performed, for example, individuals (households), regions, or the nation as a whole. It also depends upon the data and methodology used (Getzen, 2000; de la Maisonneuve and Martins, 2013).

This study aims to estimate the income elasticity of healthcare spending, which is an important input in the projection of Korea's health expenditures. The Korea Health Panel is used for the estimation of income elasticity at the household level, and OECD Health Data are used for the national-level estimation.[21] Diverse analysis models are used to reflect the time-invariant country fixed effects, year fixed effects, and heteroskedasticity in an effort to come up with a more reliable estimate for income elasticity.[22]

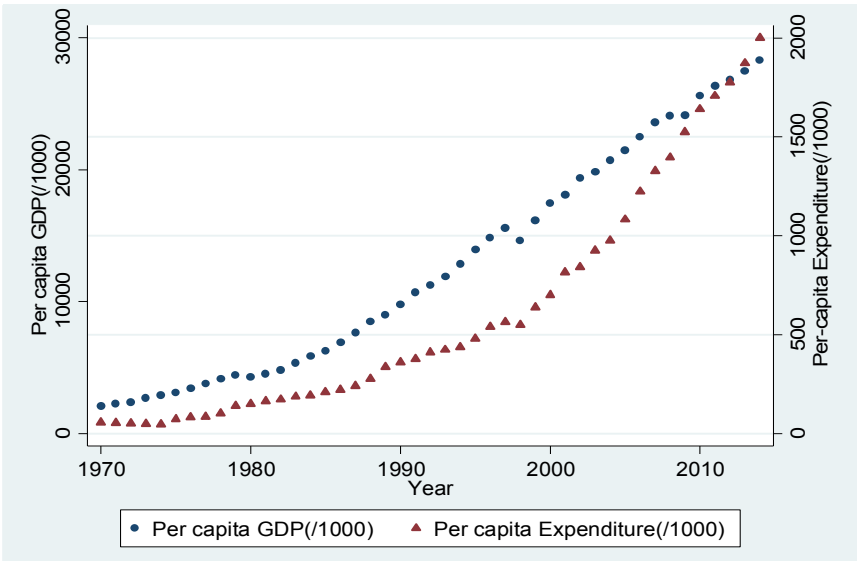
Chapter 2 reviews previous studies on income elasticity of health expenditures, and Chapter 3 estimates income elasticity of health expenditures at the household level. Chapter 4 estimates income elasticity of health expenditures at the national level. Finally, Chapter 5 discusses the findings of the analysis and their implications.

20) Jong-Myeon Kim (2002) estimated income elasticity at 1.21 using the OECD Health Data (2002) and Jong-Myeon Kim and Woo-Cheol Kim (2007) projected income elasticity by age group in the range of 0.7-1.2 using Korea's macro-economic data for 2003-2005.

21) Data used for national-level research always pose issues of credibility and comparability. See Reinhardt, Hussey, and Anderson (2002) for a discussion of the OECD data-related issues used in our analysis.

22) The time-invariant country fixed effects can include existence of a social health insurance scheme, its coverage, and its reimbursement to healthcare providers, that can impact health expenditures. See Gerdtham et al. (1992) for a discussion on the impact of a nation's healthcare policy and institutions on health expenditures.

[Figure III-1] **Yearly changes in per capita GDP and per capita health expenditures**



Source: OECD Health Data 2016

2 Previous studies

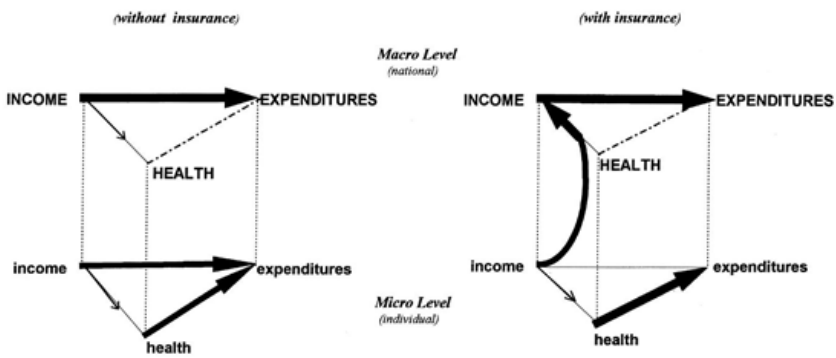
Along with the size and structure of population, medical technology, and healthcare policy and institutions, income is one of key determinants of health expenditures. According to the de la Maisonneuve and Martins (2013) study on OECD and BRIICS (Brazil, China, India, Indonesia, Russia, and South Africa) countries, Korea's per capita real public health expenditures increased 11% per annum for the period of 1995-2009, of which 3.1 percentage points was due to income effects with income elasticity of 0.8.[23)]

However, it needs to be noted that income elasticity is dependent upon the level or model of the analysis just as price elasticity ([Figure III-2]). At the individual (household) level, both health and income of the individuals can

23) When income elasticity of 1 is used instead, income effects accounted for 5.7 percentage points.

influence healthcare spending, but at the national level, income effects become larger because the differences in health across individuals are averaged out. In other words, at the individual level, both health and income are key determinants of health expenditures, but at the national level, due to the average-out effect of health differences across individuals, income alone remains as a key determinant. If insurance is also considered, insurance has an separate effect of attenuating the impact of budget constraints such as income on health expenditures. As a result, at the individual level, health status exerts higher influence than income on health expenditures whereas at the national level, income effects become greater because the differences in health among individuals are averaged out (Getzen, 2000). Therefore, income elasticity of health expenditures is greater when estimated at the national level than at the individual level.

[Figure III-2] **Determinants of health expenditures by level of analysis**



Source: Getzen (2000)

Specifically, <Table III-1> displays how income elasticity changes depending on the level of analysis. If analysis is performed at the individual level, income elasticity is below or close to 0. Only for certain services like dental service or plastic surgeries not covered by insurance is income elasticity close to or above 1. At the national level, income elasticity is always greater than 1. Income elasticity is also affected by the analysis model. More recent studies than ones

listed in <Table III-1> pointed out that omission of technological development as a variable in the analysis model can result in an overestimation of income elasticity (Hall and Jones, 2007; Okunade and Murthy, 2002; Blomqvist and Carter, 1997; Dreger and Reimers 2005). Also Acemoglu et al. (2009) estimated income elasticity at 0.7 by using regional oil prices as an instrumental variable for income. Costa-Font *et al*. (2011) ran a meta-regression analysis on 48 published reports (167 values of income elasticity) and found a bias in papers published in leading academic journals toward higher estimates of income elasticity. After taking into account the bias, the estimates of income elasticity showed values of between 0.4 and 0.8.

〈Table III-1〉 **Income elasticity by level of analysis from previous studies**

	Income Elasticity
Individuals	
General (insured/mixed)	
Newhouse and Phelps (1976)	〈=0.1
AMA (1978)	~0
Sunshine and Dicker (1987)	~0
Manning *et al.* (1987)	~0
Wedig (1988)	~0
Wagstaff *et al.* (1991)	〈=0
Hahn and Lefkowitz (1992)	〈=0
AHCPR (1997)	〈=0
Special/uninsured	
Falk *et al.* (1933)	0.7
Weeks, (1961)	0.3
Anderson *et al.* (1960)	0.4
Anderson *et al.* (1960)	0.2
Other	
USPHS (1960)	0.1
USPHS (1960)	0.8
AMA (1978)	1.0–1.7
Andersen and Benham (1970, physician expenses)	0.4
Andersen and Benham (1970, dental expenses)	1.2
Silver (1970, physician expenses)	0.85
Silver (1970, dental expenses)	2.4–3.2
Newman and Anderson (1972)	0.8

〈Table III-1〉 **Continue**

	Income Elasticity
Feldstein (1973)	1.2
Scanlon (1980)	2.2
Sunshine and Dicker (1987)	0.7–1.5
Hahn and Lefkowitz (1992)	1
AHCPR (1997)	1.1
Parker and Wong (1997)	0.9–1.6
Regions	
Feldstein (1971)	0.5
Fuchs and Kramer (1972)	0.9
Levit (1982)	0.9
McLauglin (1987)	0.7
Baker (1997)	0.8
Di Matteo and Di Matteo (1998)	0.8
Countries	
Abel–Smith (1967)	1.3
Kleiman (1974)	1.2
Newhouse (1977)	1.3
Maxwell (1981)	1.4
Gertler and van der Gaag (1990)	1.3
Getzen (1990)	1.6
Schieber (1990)	1.2
Gerdtham *et al.* (1992)	1.2
Getzen and Poullier (1992)	1.4
Fogel (1999)	1.6

Source: Getzen (2002)

3 Income elasticity of health expenditures at the household level

We use Korea Health Panel data to estimate income elasticity of health expenditures at the household level. The Korea Health Panel is one of the best data sources available for the analysis of healthcare usage and spending patterns of households, an economic unit that shares economic resources within the members. The Korea Health Panel provides all expenditures on healthcare

services regardless of whether or not they are covered by National Health Insurance. It can have low measurement error because it collects medical bills.

To estimate income elasticity of health expenditures at the household level, a log-log model is used where health expenditures is an explained variable and income is a major explanatory variable. Variables used in the analysis are selected from those in a recent study (Parker and Wong, 1997) and those available from the Korea Health Panel.

<Table III-2> shows summary statistics of the sample and variables used in income elasticity estimation at the household level. Data from the Korea Health Panel on individuals and households for the period 2008-2012 are combined for the estimation. It covers 30,090 individuals from 7,272 households for which all necessary information such as total income and health expenditures are available. The mean of total household income (wage income and property income combined) is 34.57 million won and that of health expenditures is 1.6 million won. 67.2% of the individuals belong to households that own their homes and 6% belong to poor households receiving the National Basic Living Security for all or some of the members. 5.4% of the individuals are Medical Aid beneficiaries (type 1 and type 2) and 65.5% are private insurance policy holders. Although there is a high corelation of between being a member of households receiving National Basic Living Security and a Medical Aid beneficiary (r=0.84, p=0.00), the former is a variable of poverty and the latter is one for insurance for the poor influencing healthcare usage.[24] For example, type-1 Medical Aid beneficiaries are exempt from copayment for inpatient services while type-2 ones pay 10% of copayment.[25]

The average household has three members, and as to the educational attainment of household head, 23.1% completed primary or lower education, 12.3% middle school, 33.5% high school, and 31.1% college or higher education. As for other variables indicating the existence of household members who are likely to use more healthcare service, 4.6% of householders have children aged 6 and under, 19.7% have female members of childbearing age (15-49), and 24.3%

24) Both variables show statistically significant results in the following estimations.

25) Refer to the National Health Insurance Service website (www.nhis.or.kr) on the national health insurance scheme. Copayment for type-2 recipients with disabilities is subsidized by disability medical grants.

have old members aged 65 and over. In order to control for high end-of-life costs, following health-related variables are included. About 0.3% of householders had one or more members who died of disease and 6.7% have members with disabilities. More than half of householders (55.1%) have members suffering from chronic diseases for over three months and 0.7% have female members who gave birth.[26)]

〈Table III-2〉 **Summary statistics (2008-2012)**

Variable		Mean	Std. Dev.	Min	Max
Household income (10,000 won)		3,457.59	2,811.73	0	64,000
Healthcare expenditure		1,609,988	2,290,733	0	140,036,755
Healthcare expenditure>0		0.991	0.093		
Home ownership		0.672	0.469	0	1
Poverty		0.060	0.237	0	1
Medical aid		0.054	0.227	0	1
Private insurance		0.655	0.475	0	1
Household size		3.038	1.316	1	11
Household head education	Primary	0.231	0.422	0	1
	Middle school	0.123	0.329	0	1
	High school	0.335	0.472	0	1
	University	0.311	0.463	0	1
Proportion of households	Children (age<=6)	0.046	0.122	0	1
	Fertile women (15<=age<=49)	0.197	0.216	0	1
	Elderly (age>=65)	0.243	0.383	0	1
	Death	0.003	0.048	0	1
	Disability	0.067	0.195	0	1
	Chronic diseases	0.551	0.372	0	1
	Birth	0.007	0.042	0	0.5
N(household years)		30,090			
n(households)		7,272			

26) Chronic diseases are defined as those that lasted longer than three months. The disabled include people with disabilities of grade 1 to 6 and a small group of non-registered people (for example, those registered with the Ministry of Patriots and Veterans Affairs).

Frequently, a two-part model is used to analyze healthcare spending. In the first-part, whether the individuals or households spent money on healthcare service will be analyzed. In the second part, how much money they spent on healthcare service will be analyzed. However, given that the goal of this study is to estimate income elasticity of health expenditures and that 99.1% of the individuals have used healthcare service (see <Table III-2>), this paper focuses on the second part of analysis.[27)]

<Table III-3> displays income elasticity estimated using the ordinary least squares method. Income elasticity derived from Model (1) using variables employed in previous studies is 0.283. In Model (2), home ownership is added as an additional variable. Also, instead of the percentages of householders with children, fertile women, and the elderly, the percentages regarding death, disability, chronic disease, and birth within the household are added as variables because they may be more directly related to health expenditures. As a result, income elasticity declines to 0.224. In Model (3) where all variables from the first and second models are used, income elasticity is estimated at 0.265. All values of income elasticity are statistically significant at the 0.01 significance level.[28)]

Regarding other variables, health expenditures of National Basic Living Security recipients and Medical Aid beneficiaries are statistically significantly lower and those of private insurance holders are statistically significantly higher. Health expenditures are higher when the household is larger, the household head is more educated and the household has more members who incur health expenditures. Health expenditures are particularly high if any members are suffering chronic diseases or female members give birth.

27) 250 observations with 0 health expenditures and 45 ones with 0 income were excluded from the estimation. When they were included, income elasticity declined slightly. From now on, household income is the equivalized household income (household income/ $\sqrt{no.\ of\ hoseholders}$) to measure available within-household resource depending on the number of householders.

28) Parker and Wong (1997) defined people aged 18 and under as children. This study defines people aged 6 and under as children, that are assumed to be more closely related to health expenditure. When the 305 observations with 0 observed values of health expenditure and income are included in the estimation (using 1 for log transformation), the values of income elasticity using the three models are 0.271 (robust standard error of 0.018), 0.197 (robust standard error of 0.016), and 0.245 (robust standard error of 0.017), respectively.

〈Table III-3〉 **Household-level income elasticity of health expenditures (2008-2012, OLS, Unbalanced Panel)**

		(1)	(2)	(3)
Ln(income)		0.283***	0.224***	0.265***
		(0.013)	(0.012)	(0.013)
Home ownership			0.177***	0.168***
			(0.015)	(0.015)
Poverty		−0.285***	−0.248***	−0.239***
		(0.060)	(0.058)	(0.058)
Medical aid		−0.439***	−0.608***	−0.585***
		(0.064)	(0.062)	(0.062)
Private insurance		0.076***	0.027*	0.081***
		(0.018)	(0.016)	(0.017)
Household size		0.237***	0.295***	0.306***
		(0.007)	(0.007)	(0.007)
Household head education	Middle school	0.107***	0.041*	0.081***
		(0.026)	(0.024)	(0.025)
	High school	−0.020	0.015	0.049**
		(0.022)	(0.021)	(0.021)
	University	0.014	0.100***	0.109***
		(0.025)	(0.023)	(0.023)
Proportion of households	Death		0.939***	0.854***
			(0.130)	(0.132)
	Disability		0.325***	0.308***
			(0.042)	(0.042)
	Chronic diseases		1.336***	1.271***
			(0.025)	(0.026)
	Birth		3.156***	2.693***
			(0.123)	(0.134)
	Children	0.368***		0.433***
		(0.050)		(0.055)
	Fertile women	−0.299***		0.071*
		(0.043)		(0.041)
	Elderly	0.722***		0.329***
		(0.028)		(0.028)
Constant		10.907***	10.417***	9.953***
		(0.110)	(0.099)	(0.107)
N(household−years)		29,785	29,785	29,785
R−squared		0.121	0.207	0.213

Note: Five year dummies and sixteen area dummies are included. Robust standard errors are shown in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Some individuals cause a problem of heterogeneity, showing very high health expenditures due to severe health conditions. To mitigate this heterogeneity, <Table III-4> uses the generalized linear model (Liang and Zeger, 1986), resulting in income elasticity in all three models with 0.192 in Model (1), 0.166 in Model (2), and 0.194 in Model (3). The values are all statistically significant at the 0.01 significance level. The influence of all other variables but income declined slightly.

These results are based on all the available individuals. Therefore, another income elasticity is estimated using a balanced panel of individuals who stay in the panel throughout the period 2008-12 without being excluded for reasons such as death.[29] According to the results of the ordinary least squares analysis in <Table III-5>, income elasticity rises slightly from that of the unbalanced panel to 0.289 in Model (1), 0.233 in Model (2), and 0.277 in Model (3). The results of generalized linear model analysis in <Table III-6> show income elasticity of 0.19 in Model (1), 0.169 in Model (2), and 0.195 in Model (3).

Therefore, income elasticity of health expenditures at the household level for Korea is estimated at 0.195 based on the generalized linear model analysis reflecting heterogeneity and Model (3), which includes all the variables related to health expenditures. Compared to the income elasticities at the individual level laid out in <Table III-1>, income elasticity of 0.195 is slightly higher than that of health expenditures covered by health insurance and is significantly lower than that of health expenditures not covered by health insurance. This is probably because the Korea Health Panel data used for the estimation capture all health expenditures regardless of their coverage by the National Health Insurance.

29) In the balanced panel, 28 observations have observed value of 0 for income and 176 have observed value of 0 for health expenditures.

〈Table III-4〉 **Household-level income elasticity of health expenditures (2008-2012, GEE(Gamma family, Log link, AR(1)), Unbalanced Panel)**

		(1)	(2)	(3)
Ln(income)		0.192***	0.166***	0.194***
		(0.015)	(0.014)	(0.014)
Home ownership			0.158***	0.154***
			(0.020)	(0.020)
Poor		−0.224***	−0.197***	−0.194***
		(0.070)	(0.068)	(0.068)
Medicaid		−0.460***	−0.579***	−0.562***
		(0.081)	(0.079)	(0.079)
Private insurance		0.063**	0.029	0.076***
		(0.025)	(0.023)	(0.024)
Household size		0.224***	0.286***	0.298***
		(0.011)	(0.010)	(0.010)
Household head education	Middle school	0.099**	0.037	0.074*
		(0.042)	(0.038)	(0.038)
	High school	−0.000	0.028	0.059*
		(0.036)	(0.032)	(0.032)
	University	0.048	0.127***	0.136***
		(0.039)	(0.035)	(0.035)
Proportion of households	Death		0.670***	0.615***
			(0.146)	(0.145)
	Disability		0.275***	0.257***
			(0.065)	(0.065)
	Chronic diseases		1.192***	1.142***
			(0.035)	(0.036)
	Birth		1.842***	1.553***
			(0.121)	(0.129)
	Children	0.325***		0.428***
		(0.065)		(0.068)
	Fertile women	−0.214***		0.070
		(0.060)		(0.055)
	Old	0.619***		0.304***
		(0.041)		(0.039)
Constant		11.390***	10.635***	10.267***
		(0.136)	(0.122)	(0.130)
N(hosehold-years)		28,065	28,065	28,065
n(households)		6,178	6,178	6,178

Note: Five year dummies and sixteen area dummies are included. Robust standard errors in parenthesis.
*** p<0.01, ** p<0.05, * p<0.1

〈Table III-5〉 **Household-level income elasticity of health expenditures (2008-2012, OLS, Balanced Panel)**

		(1)	(2)	(3)
Ln(income)		0.289***	0.233***	0.277***
		(0.014)	(0.013)	(0.014)
Home ownership			0.174***	0.161***
			(0.017)	(0.017)
Poor		−0.248***	−0.214***	−0.204***
		(0.063)	(0.061)	(0.061)
Medicaid		−0.459***	−0.623***	−0.599***
		(0.067)	(0.065)	(0.065)
Private insurance		0.069***	0.011	0.071***
		(0.019)	(0.018)	(0.018)
Household size		0.238***	0.297***	0.311***
		(0.008)	(0.007)	(0.008)
Household head education	Middle school	0.104***	0.042	0.081***
		(0.027)	(0.026)	(0.026)
	High school	−0.002	0.028	0.061***
		(0.024)	(0.023)	(0.023)
	University	0.022	0.100***	0.107***
		(0.027)	(0.025)	(0.025)
Proportion of households	Death		0.870***	0.789***
			(0.147)	(0.149)
	Disability		0.356***	0.343***
			(0.044)	(0.044)
	Chronic diseases		1.334***	1.261***
			(0.027)	(0.029)
	Birth		3.093***	2.647***
			(0.153)	(0.166)
	Children	0.303***		0.383***
		(0.057)		(0.061)
	Fertile women	−0.296***		0.074*
		(0.047)		(0.045)
	Old	0.720***		0.346***
		(0.030)		(0.030)
Constant		10.648***	10.026***	9.538***
		(0.118)	(0.105)	(0.114)
N(household-years)		24,396	24,396	24,396
R-squared		0.125	0.210	0.216

Note: Five year dummies and sixteen area dummies are included. Robust standard errors in parenthesis.
*** p<0.01, ** p<0.05, * p<0.1

〈Table III-6〉 **Household-level income elasticity of health expenditures (2008-2012, GEE(Gamma family, Log link, AR(1)), Balanced Panel)**

		(1)	(2)	(3)
Ln(income)		0.190***	0.169***	0.195***
		(0.016)	(0.015)	(0.015)
Home ownership			0.154***	0.148***
			(0.022)	(0.022)
Poor		−0.188***	−0.162**	−0.158**
		(0.073)	(0.072)	(0.072)
Medicaid		−0.498***	−0.611***	−0.595***
		(0.084)	(0.082)	(0.082)
Private insurance		0.059**	0.020	0.068***
		(0.027)	(0.024)	(0.025)
Household size		0.221***	0.285***	0.299***
		(0.012)	(0.011)	(0.011)
Household head education	Middle school	0.085*	0.029	0.062
		(0.044)	(0.040)	(0.040)
	High school	0.011	0.040	0.069**
		(0.038)	(0.035)	(0.034)
	University	0.054	0.130***	0.139***
		(0.041)	(0.037)	(0.038)
Proportion of households	Death		0.613***	0.567***
			(0.159)	(0.157)
	Disability		0.302***	0.288***
			(0.066)	(0.066)
	Chronic diseases		1.190***	1.136***
			(0.037)	(0.039)
	Birth		1.734***	1.501***
			(0.148)	(0.155)
	Children	0.238***		0.338***
		(0.074)		(0.075)
	Fertile women	−0.213***		0.064
		(0.066)		(0.061)
	Old	0.590***		0.289***
		(0.042)		(0.041)
Constant		11.420***	10.622***	10.272***
		(0.143)	(0.130)	(0.138)
N(household− years)		24,098	24,098	24,098
n(households)		4,835	4,835	4,835

Note: Five year dummies and sixteen area dummies are included. Robust standard errors in parenthesis.
*** p<0.01, ** p<0.05, * p<0.1

4 Income elasticity of health expenditures at the national level

As reviewed above, income elasticity is dependent upon the level of analysis or the model used. At the individual level, both health status of individuals and income influence health expenditures whereas at the national level income effects become larger because health differences among individuals are averaged out (Getzen, 2000).

To begin with, income elasticity based on Korea's per capita health expenditure and per capita GDP for the period 1970-2014 (shown in [Figure III-1]) is estimated to be 1.40 (a robust standard error of 0.03). This is the result of analyzing only the Korean data, without using other variables influencing health expenditures. Importantly, this study estimates national-level income elasticity of health expenditures based on the OECD Health Data (2015). This analysis will be useful in making the long-term projections of Korea's national health expenditures by comparing them against other nations.

<Table III-7> is the summary statistics on 34 OECD countries including Korea for the 14 year period 1999-2012. To estimate income elasticity for national health expenditures, a log-log model is used where per capita healthcare expenditure is the explained variable and per capita GDP is a key explanatory variable. As for other variables, those used in a recent study (Sen, 2005) are used selectively.

The average real per capita health expenditure for the 34 OECD countries including Korea is 2,446 dollars (USD, Purchasing Power Parity (PPP), 2005=100) and real per capita GDP is 29,939 dollars. The average share of the elderly aged 65 and over in population is 14.3% and the infant mortality rate per 1,000 live births is 5.3. The average length of stay in hospital is nine days, and the average number of medical doctors per 1,000 people is three. And on average, 97.6% of the population have health insurance, public and private.

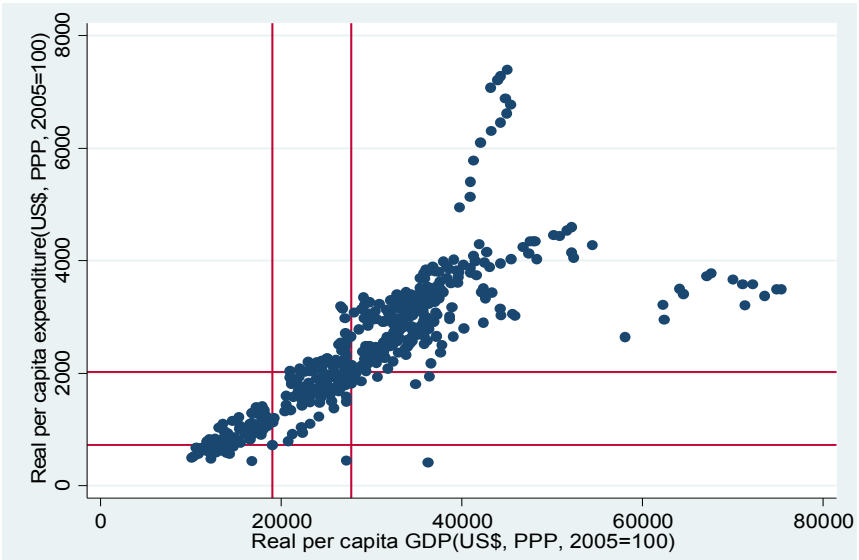
〈Table III-7〉 **Summary statistics (1999-2012, 34 Countries)**

Variable	N(country years)	Mean	Std. Dev.	Min	Max
Real per capita expenditure (US$, PPP, 2005=100)	476	2446.699	1229.414	403.8	7395
Real per capita GDP (US$, PPP, 2005=100)	476	29939.33	11600.92	10090.61	75452.89
Percentage of elderly (age)=65)	476	14.26954	3.591466	5.1	24.1
Infant mortality rate (per 1,000 live births)	470	5.281277	4.027691	0.9	33.9
Average length of stay	429	9.087413	5.35255	3.9	39.8
Doctors per 1,000 population	331	2.940816	0.696835	1.3	4.9
Percentage of insurance covered (public and private)	446	97.55964	6.832111	48.3	100

[Figure III-3] exhibits a relation between per capita income represented by per capita GDP and per capita health expenditure. Korea's per capita income rose from 19,039 dollars in 1999 to 27,748 dollars in 2012 and over the same period, per capita health expenditure increased from 718 dollars to 2,013 dollars. These changes in per capita income and per capita health expenditure for Korea are captured by the four solid lines in [Figure III-3].[30)]

30) The per capita healthcare expenditure increased steadily while per capita income increased to 27,272 dollars in 2008, declined to 26,048 dollars in 2009, and then rebounded to 27,748 in 2012.

[Figure III-3] **Relation between per capita income and health expenditure for 34 OECD countries (1999-2012)**



<Table III-8> shows income elasticity estimated using the general ordinary least squares method and generalized linear models mitigating heterogeneity concern. Generalized linear models are used in consideration of the small panel size of 34 and an error of auto-corelation (AR(1)) within the panel.[31)]

As for the results from the ordinary least squares method, when only income is included, income elasticity is estimated to be 1.289. When other variables from the summary statistics are included into the analysis, income elasticity is 1.106, and when taking into account of the country and year fixed effects, income elasticity falls substantially to 0.371.

As for the results from the generalized linear models, when only income

31) When missing values exist for some variables, a new variable indicating the missing value was created and included in the analysis instead of excluding those observations with missing values, to include as many observations as possible in the analysis. The 34 countries are Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

is included, income elasticity is estimated to be 1.203. When other variables are included, income elasticity is 0.847, and when the country and year fixed effect are included, income elasticity becomes 0.267.

Variables other than income do not show statistically significant results possibly due to measurement error. The infant mortality rate shows a negative value. This is counterintuitive and may be due to the high infant mortality rates in low-income countries. Further analysis is clearly required.

〈Table III-8〉 **Cross-country income elasticity of health expenditures (34 countries, 1999-2012)**

	OLS			GLS (heteroskedastic with cross-sectional correlation, country specific AR(1)		
Ln(Real per capita GDP)	1.289***	1.106***	0.371***	1.203***	0.847***	0.267***
	(0.029)	(0.029)	(0.042)	(0.014)	(0.020)	(0.026)
Percentage of old (age>=65)		0.021***	0.008		0.017***	0.015
		(0.004)	(0.006)		(0.004)	(0.010)
Infant mortality rate (per 1,000 live births)		−0.031***	−0.021***		−0.038***	−0.015***
		(0.004)	(0.003)		(0.002)	(0.002)
Average length of stay		−0.006***	0.009**		−0.001	0.004*
		(0.002)	(0.004)		(0.003)	(0.002)
Doctors per 1,000 population		0.044**	−0.065***		−0.001	−0.009
		(0.020)	(0.018)		(0.011)	(0.022)
Percentage of insurance covered (public and private)		−0.014***	0.000		−0.003***	−0.000
		(0.002)	(0.001)		(0.000)	(0.000)
Country fixed effect			Yes			Yes
Year fixed effect			Yes			Yes
Constant	−5.534***	−2.511***	3.969***	−4.755***	−0.762***	0.000
	(0.294)	(0.334)	(0.417)	(0.154)	(0.180)	(0.000)
Observations	476	476	476	476	476	476
R-squared	0.810	0.875	0.987			
Number of countries				34	34	34

Above are the results of an analysis of 34 countries whose health systems vary widely. A recent study (Böhm, 2012) considered regulation, financing, and service provision to classify OECD countries into five health system clusters: the National Health Service (NHS), the National Health Insurance (NHI), the Social Health Insurance (SHI), the Private Health System (PHS), and the Etatist Social Health Insurance (ESHI). Korea is classified into the Etatist Social Health Insurance along with Belgium, Estonia, France, Czech Republic, Hungary, Netherlands, Poland, Slovakia, Israel, and Japan. The following analysis estimates income elasticity only for the 11 countries sharing similar health systems with Korea. The comparison against these countries can be more helpful for developing Korea's long-term healthcare expenditure projections.

<Table III-9> shows summary statistics of the 11 countries sharing the Etatist Social Health Insurance system with Korea for the 14 years from 1999 through 2012.

〈Table III-9〉 **Summary statistics (1999-2012, 11 ESHI countries including Korea)**

Variable	N(country years)	Mean	Std. Dev.	Min	Max
Real per capita expenditure (US$, PPP, 2005=100)	154	1886.082	962.8018	583	4290.2
Real per capita GDP (US$, PPP, 2005=100)	154	24804.68	8099.98	11867.89	43095.87
Percentage of old (age)=65)	154	14.47143	3.312537	6.9	24.1
Infant mortality rate (per 1,000 live births)	150	4.760667	1.657721	2.2	9.6
Average length of stay	130	12.27308	8.361278	6.4	39.8
Doctors per 1,000 population	113	2.812212	0.616874	1.3	3.67
Percentage of insurance covered (public and private)	143	98.81259	1.835329	91	100

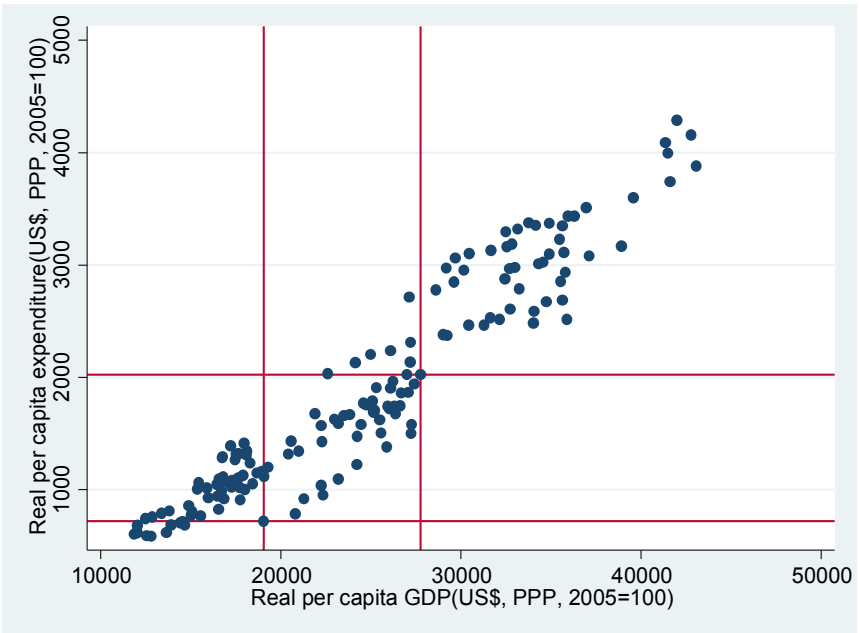
Note: Etatist Social Insurance countries include Belgium, Czech Republic, Estonia, France, Hungary, Israel, Japan, Korea, Netherlands, Poland, and Slovakia

The average real per capita healthcare expenditure for the 11 countries including Korea is 1,886 dollars (USD, Purchasing Power Parity (PPP),

2005=100)) and per capita GDP is 24,804 dollars. The average percentage of the population aged 65 and over is 14.5%, and the average infant mortality rate per 1,000 live births is 4.8. The average length of stay in hospital is 12.3 days, and the number of doctors per 1,000 population is 2.8. And on average, 98.8% of the population has health insurance, public or private. Compared to the figures for all 34 countries, the average per capita income and per capita expenditure are lower but the percentage of the insured and average length of hospital stay are higher.

[Figure III-4] shows the relationship between per capita income represented by per capita GDP and per capita health expenditures for the 11 countries having the Etatist Social Health Insurance system. Compared to the results for the 34 countries shown in [Figure III-3], a positive linear relationship is more pronounced here.

[Figure III-4] **Relation between per capita income and health expenditures for 11 ESHI countries (1999-2012)**



<Table III-10> displays the results of income elasticity estimation for the 11 countries sharing the Etatist Social Health Insurance system with Korea. As for the results from the ordinary least square method, when only income is considered, income elasticity is estimated to be 1.510. When other variables from the summary statistics are incorporated into the analysis, income elasticity is 1.301. When taking into account the country and year fixed effects, income elasticity is estimated to be 1.052.

As for the results from the generalized linear models, when only income is considered, income elasticity is 1.4. When other variables are incorporated, income elasticity is 1.237. And when the country and year fixed effected are taken into account, income elasticity is 0.863.

Therefore, income elasticity of national health expenditures is estimated at 0.863 based on the generalized linear model analysis reflecting heterogeneity with all the variables related to health expenditures included. This result of 0.863 is larger than 0.7 estimated by Acemoglu et al. (2009) using the latest oil prices as an instrumental variable for income. It is also slightly larger than 04-0.8 projected by Costa-Font et al. (2011) excluding a publication bias in 167 income elasticity estimates of 48 researches published in leading academic journals.

〈Table III-10〉 **Cross-country income-elasticity of health expenditures (11 ESHI countries, 1999-2012)**

	OLS			GLS (heteroskedastic with cross-sectional correlation, country specific AR(1))		
Ln (Real per capita GDP)	1.510***	1.301***	1.052***	1.400***	1.237***	0.863***
	(0.038)	(0.061)	(0.111)	(0.021)	(0.031)	(0.049)
Percentage of old (age)=65)		0.027***	−0.004		0.039***	0.021***
		(0.004)	(0.011)		(0.004)	(0.005)
Infant mortality rate (per 1,000 live births)		−0.008	−0.039***		−0.012***	−0.010**
		(0.011)	(0.013)		(0.003)	(0.005)
Average length of stay		−0.007***	0.030***		−0.003**	0.025***
		(0.002)	(0.006)		(0.001)	(0.002)

〈Table III-10〉 **Continue**

	OLS			GLS (heteroskedastic with cross-sectional correlation, country specific AR(1))		
Doctors per 1,000 population		−0.003	−0.019		0.024***	0.002
		(0.025)	(0.038)		(0.007)	(0.011)
Percentage of insurance covered (public and private)		0.017**	0.011*		−0.008***	0.005**
		(0.007)	(0.007)		(0.001)	(0.002)
Country fixed effect			Yes			Yes
Year fixed effect			Yes			Yes
Constant	−7.793***	−7.689***	−4.188***	−6.687***	−4.862***	−2.223***
	(0.386)	(0.707)	(1.380)	(0.211)	(0.297)	(0.545)
Observa-tions	154	154	154	154	154	154
R-squared	0.911	0.950	0.988			
Number of countries				11	11	11

Note: Etatist Social Insurance countries include Belgium, Czech Republic, Estonia, France, Hungary, Israel, Japan, Korea, Netherlands, Poland, Slovakia.

5 Conclusion

Income elasticity of either 0.8 or 1 has been used in previous studies for the projection of Korea's health expenditures. However, income elasticity for healthcare expenditure changes depending on whether it is estimated at the individual (household), the region or the national level. It also depends upon the data and models used for the analysis (Getzen, 2000; de la Maisonneuve and Martins, 2013). In an effort to estimate a more reliable figure of income elasticity, this study used the Korea Health Panel, a reliable and representative panel data for the estimation of household-level income elasticity, and the OECD Health Data for the estimation of national income elasticity, and utilized diverse analysis models that account for country and year fixed effects and heteroskedasticity.

Household-level income elasticity of Korea is estimated at 0.195 based on the generalized linear model taking account of heteroskedasticity and models encompassing diverse variables related to health expenditures. Compared to the income elasticity of health expenditures estimated at the individual level in previous studies, this result is slightly larger than that for health expenditures covered by health insurance, but much smaller than that for expenditures not covered by health insurance. Income elasticity for national healthcare expenditure is estimated at 0.863 based on the generalized linear model reflecting heteroskedasticity for 11 countries sharing the Etatist Social Health Insurance system with Korea and analysis models that controls for all healthcare expenditure-related variables. This outcome is slightly larger than 04-0.8 from recent studies (Acemoglu et al., 2009; Costa-Font et al., 2011).

It must be noted for future studies that income elasticity estimates can change depending on how endogeneity of income and advances in health technology are reflected in analysis models and at which level analysis is run. For example, individuals with high income can be healthy and spend less on healthcare, but they may in fact spend more on healthcare because they have strong desire to stay healthy, have a higher incentive to spend on healthcare, and have better access to healthcare services. Also, income elasticity based on a cross-sectional study within a country can be smaller than income elasticity across multiple countries that are in different development stages of health technology (Phelps, 2013).

Korea's health expenditures outpaced income growth: the healthcare share of GDP rose from 2.7% in 1970 to 7.1% in 2014. Many factors influence health expenditures such as demographic drivers, technological development, and changes in healthcare policy and institutions. Among them, income is one of the key drivers of health expenditures, and understanding the relationship between income and health expenditures is critical in projecting future health expenditures and developing and executing policies to maintain health expenditures. In that regard, it is worthwhile to note that household-level income elasticity for health expenditures may be small for such reasons as health insurance, but national health expenditures may continue to rise in tandem with national income.

Ⅳ

A study on an optimal level of coverage for Korea[32)]

1 Introduction

Korea's National Health Insurance has positioned itself as a representative social security system since the introduction of universal coverage in 1989. However, due to the 'low contribution, low benefit' principle maintained since its foundation, the National Health Insurance system falls short of the OECD average level of coverage, prompting citizens to increasingly resort to private fee-for-service health insurance.

The history of National Health Insurance shows that discussions on its coverage began only recently. Between 1989 and 1999, National Health Insurance was managed in a decentralized way involving hundreds of insurers throughout the country, and coverage expansion was capped by the capacity of the least financially viable insurer (cooperative). Even after the insurers were integrated into a single entity, discussions on coverage expansion progressed very little because the National Health Insurance Service was mired in a chronic deficit. Finally, new momentum came when National Health Insurance recorded a current account surplus in both 2003 and 2004 and a surplus in the cumulative account by the end of 2004. (Soon-Im Huh et al., 2007, p.109~110).

The Korean government has implemented mid-term coverage expansion plans every four or five years since 2005 to raise coverage from a long-term

32) Authored by Prof. Jae-Young Lim from Korea University, Department of Food and Resource Economics

perspective, and health insurance coverage expansion recently made its way into the policy platforms of candidates in presidential elections. In fact, coverage expansion is now an issue of intense debate, particularly with regard to enhancements for four particularly serious illnesses, the top two non-coverage expenditures, nursing and patient care service, and the out-of-pocket maximum.

Despite the government's efforts, the level of coverage of Korea's National Health Insurance is still lower than that of other countries, and higher coverage will sharply increase expenditure estimates.

The "2015 Health Service Industry Trend Analysis"published by the Korea Health Industry Development Institute (2015) classifies national health expenditures of major countries by funding source. According to the study, only 54.3% of Korea's national health expenditures are covered by public funds: the remaining 45.7% are financed by private insurance or out of pocket spending by households. Korea's public share of national health expenditures is significantly lower than that of other major OECD countries - 70.6% for Canada, 78.7% for France, and 82.7% for Japan (2012) - except the United States, which is in the initial stage of establishing social health insurance. (<Table IV-1>).

〈Table IV-1〉 **Decomposing national health expenditures by funding source in major countries (national health expenditures=100)**

Classification	Canada	France	Germany	Japan (2012)	Korea	US
Public sector	70.6	78.7	76.8	82.7	54.3	47.1
Government	69.2	4.0	8.4	10.4	11.5	–
Social security fund	1.5	74.7	68.3	72.3	42.8	–
Private sector	29.4	21.3	23.2	17.3	45.7	52.9
Private insurance	13.2	13.9	9.2	2.4	6.2	33.5
Households' out of pocket payment	14.3	6.7	13.2	13.9	35.2	11.8
Others	1.9	0.6	0.9	1.0	4.3	7.6

Note: The figures for Canada and France are the shares in recurrent health expenditures.
Source: Korea Health Industry Development Institute, 2015 Health Service Industry Trend Analysis, 2015, p. 56.

The percentage of public health expenditures of recurrent health expenditures exhibits a similar result for Korea. Public funds accounted for 55.9% of recurrent health expenditures in 2013, markedly lower than the OECD average of 72.7%. Even considering that the effect of continued policy efforts to expand coverage just began to show in 2013, the figure is still lower compared to the OECD average. (<Table IV-2>).

〈Table IV-2〉 **Public shares of recurrent health expenditures (%) over time**

Classification	2005	2006	2007	2008	2009	2010	2011	2012	2013
Korea	54.9	56.4	56.7	56.5	57.6	58.0	57.2	56.3	55.9
OECD average	71.3	71.7	71.8	72.5	73.2	73.0	73.1	72.7	72.7

Note: The OECD averages for years without official figures were computed based on those of the closest years.
Source: Ministry of Health and Welfare, the Korea Institute for Health and Social Affairs, the OECD Health Data 2015, 2015, p. 101.

Korean citizens perceive that health insurance coverage is low and want expanded coverage. In a public awareness study on National Health Insurance conducted in 2015, the respondents were asked what they considered to be the appropriate level of coverage. The actual coverage was 62.0% according to a 2013 study on health expenditures covered by National Health Insurance. Their answers averaged out at 73.9% (Yeon-Hee Hwang *et al*., 2015, p. 170), which is coincidentally close to the OECD average.

Based on the aforementioned, this study aims at conducting a national-level analysis on health insurance coverage to logically ascertain the validity of an appropriate level of coverage.

For this purpose, the OECD Health Data are largely used to develop national-level panel data of OECD countries between 1989 and 2013. This study first analyzes the relative effects on coverage of different drivers including each country's demographic, social, economic drivers, health and political drivers, and institutional drivers and uses the results to derive the determinants of health insurance coverage. This study then conducts analyses to build a logical foundation for an optimal level of coverage. It considers public health enhancements as a major effect of coverage and presents an optimal level of

coverage that help maximize health status of the public.

This study consists of six chapters. Chapter 2 explains the concept of health insurance coverage, which is a core variable of this study and Chapter 3 explains various data sources used to conduct empirical analyses. Chapter 4 presents the methodologies used to derive the determinants of health insurance coverage and an optimal level of coverage that can maximize health status of the public. The results of these analyses are presented in Chapter 5. Finally, Chapter 6 summarizes the findings and presents policy implications in the conclusion and consideration section.

2 The concept of health insurance coverage

The first step of this study is defining the concept of health insurance coverage.

Soon-Im Huh (2003, pp.41~42) explains coverage of National Health Insurance as a combination of the scope of benefit and the level of coverage. The scope of benefit refers to the types of services that National Health Insurance covers in terms of insurance benefit, and the level of coverage refers to how much of the health expenditures are covered by National Health Insurance. For the purpose of this study, the scope of benefit and the level of coverage are not distinguished and coverage simply means the percentage of health expenditures covered by National Health Insurance.

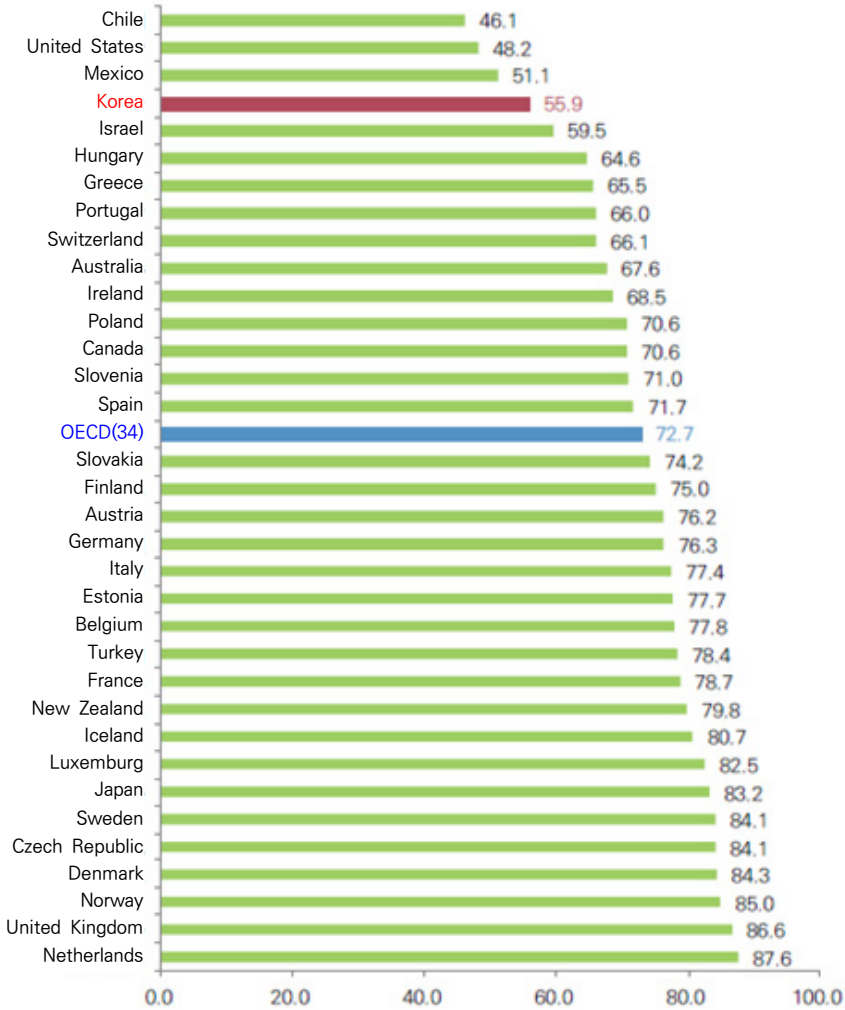
Hyoung-Sun Jeong (2004, p.97~98) presents the following four measures to represent the level of health insurance coverage. The first measure is public share in recurrent health expenditures used in the OECD Health Data, computed by dividing public health expenditures by recurrent health expenditures. The second measure calculates the level of coverage by dividing the sum of public health expenditures and private social insurance by national health expenditures. The third measures is an effective coverage ratio of Korea's four major medical social security programs, computed by dividing total amounts paid by the insurers and the government by total expenditures of national health insurance, medical aid, industrial accident compensation insurance, and auto insurance. Finally, the

fourth measure is the coverage ratio of National Health Insurance, calculated by dividing the amounts paid by the insurer (the National Health Insurance Service) by the National Health Insurance expenditures. This measure is used in a study of health expenditures for National Health Insurance subscribers.

The public share in recurrent health expenditures or the coverage ratio presented by the National Health Insurance Service are more frequently used in discussions on health insurance coverage. However, there exist considerable differences in the two indicators in terms of computation (numerator and denominator) and scope, which results in different values. The OECD average of 72.7% in public share in recurrent health expenditures of 2013 is often presented as a target level of coverage. Considering that the 34 OECD countries have different healthcare systems, direct comparison among the countries may not be feasible. Nevertheless, as presented in Hyoung-Sun Jeong (2004), the OECD public share in recurrent health expenditures is believed to be the only measure that can be used to compare coverage of different countries within a limited scope. Therefore, this study uses the OECD's public share in recurrent health expenditures as a variable for the coverage ratio.

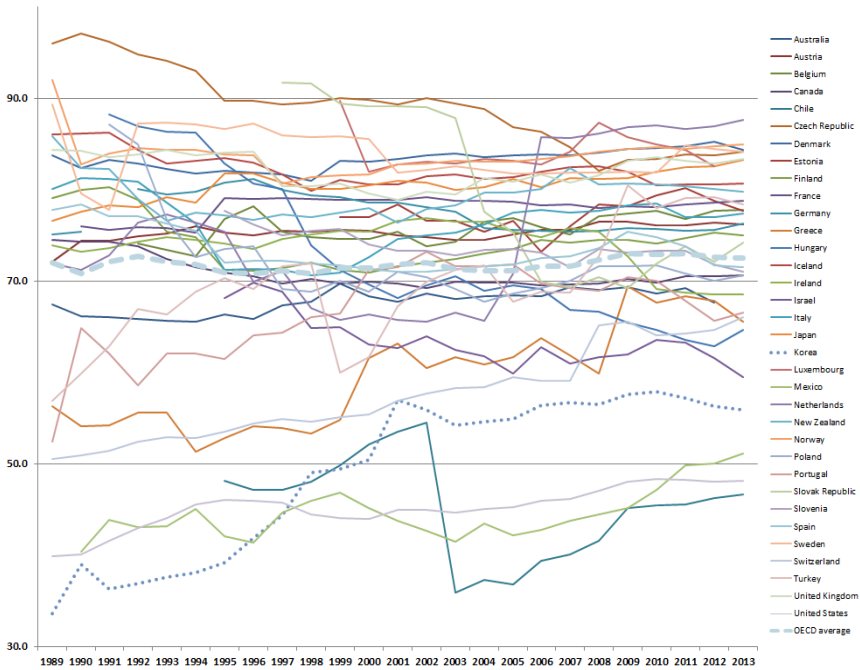
This study adopts the public share of recurrent health expenditures as a common measure indicating the level of coverage for a cross-country analysis of the 34 OECD countries with varying healthcare systems because its concept is relatively well established among OECD countries, and it can be computed using the OECD Health Data based on the standardized concept and guidelines, and it is, therefore, widely used for cross-country comparisons.

[Figure IV-1] **Public shares of recurrent health expenditures for OECD 34 countries (2013)**



Source: Ministry of Health and Welfare, Korea Institute for Health and Social Affairs, OECD Health Data 2015, 2015, p. 102.

[Figure IV-2] **Public shares of recurrent health expenditures of 34 OECD countries over time**



Source: Derived by the author based on the 2015 OECD Health data

The public shares in recurrent health expenditures of the 34 OECD countries in 2013 are presented in [Figure IV-1], and their trends over time by country are mapped in [Figure IV-2]. As presented in <Table IV-2>, Korea's public share in recurrent health expenditures was 58.0% in 2010, 57.2% in 2011, 56.3% in 2012, and 55.9% in 2013, exhibiting a declining trend over the past four years. According to [Figure IV-1], in 2013 Korea was ranked fourth from the bottom, only above Chile, the United States, and Mexico among the 34 OECD countries. The Netherlands topped the list at 87.6%.

[Figure IV-2] shows the changes in the public shares of each country for an extended period from 1989. The average share of the 34 OECD countries

remains stable in the low 70% since 1990. Korea saw a rapid increase in coverage until 2000, but a gradual decline after peaking at around 60% in 2001. Korea's coverage ratio has been hovering around the low 50% since then. Continued efforts to raise the coverage ratio led to remarkable growth in early 2000s. However, it remains at around 50% due to expanded non-coverage expenditures and other reasons, one of which may be that this study is peformed for the period 1989-2013, before the mid-term coverage expansion plans (2009-13 and 2014-18) had effect.

3 Data Sources

In an effort to build a logical foundation for an optimal level of coverage by analyzing the determinants of coverage and estimating health improvement effects of coverage, this study constructs secondary data, taking some variables from the OECD Health Data (2015), Polity IV data set, IDEA data set, and the OECD Revenue Statistics (2015).

Key variables representing coverage, demographic, social, and economic factors and health status are taken from the OECD Health Data (2015). The OECD Health Data is extremely useful as it contains not only public health variables for the 34 OECD countries for the period between 1970 and 2013, but it also provides data on comprehensive indicators such as demographic, social, and economic factors. In conducting a fixed effect panel analysis, which is a methodology selected for this study, using as many years of data as possible can generate more robust results. However, because the initial year of available data is different for each variable and because there are missing data points for some years or for some countries in the early years, the period for 1989-2013 is selected to minimize data omission and to maximize use of the data available.

To represent each country's political characteristics, this study uses the 'policy' variable indicating how democratic a country is and the 'vote' variable as a dummy variable indicating whether a general or presidential election was held in a particular year. These variables are introduced to represent how fast or how easily policy on coverage can be implemented.

The policy variable captures relevant data from the Polity IV data (http://www.systemicpeace.org/inscrdata.html) provided by the Center for Systemic Peace (CSP). The data contains diverse indicators that reflect the political characteristics of different countries including OECD countries. This study uses the policy variable that scores a country's level of democracy on a 21-point scale of -10 to 10, 10 being strongly democratic and -10 being strongly autocratic.

The vote variable uses data from the International Institute for Democracy and Electoral Assistance (IDEA) (http://www.idea.int/vt/countryview.cfm?id=14). This data provides detailed information on presidential or parliamentary elections, the voting rate, and population by country and by year. This study uses these data to reconstruct the vote dummy variable to indicate whether or not health insurance coverage is part of the policy pledges in each nation's election campaign.

Other variables such as World Governance Indicator indicating the level of democracy, and the World Bank's Country Policy and Institutional Assessment (CPIA) evaluating progress in policy implementation were considered, but not selected due to the availability of only a short period of data. The aggregate total armed conflict data (ACTOTAL) representing the occurrence of political upheaval such as war or a terrorist attack using Major Episodes of Political Violence (MEPV) data provided by the Center for Systemic Peace was also considered as a variable, but not adopted because all 34 OECD countries were found to be free from political upheaval.

Although the public share of recurrent health expenditures in the OECD Health Data is defined as a measure of coverage in this study, classifying the countries by the type of health insurance system is essential. Therefore, to control for the characteristics of the health insurance system, countries have been classified into different healthcare system clusters. Furthermore, for the purpose of considering healthcare systematic features of countries, the ratios of total tax revenue and social security contribution to GDP are also used.

In addition, each cluster is analyzed separately to control for the difference in the health insurance system. According to Böhm (2012), the health systems of OECD countries are classified into clusters including the Social Health Insurance (SHI), the Etatist Social Health Insurance (ESHI), the National Health

Service (NHS), and National Health Insurance (NHI). Böhm (2012, p.12) classifies healthcare systems of OECD countries depending on which of the state, society, or private sector is in charge of regulation, financing, or service provision. According to this classification, Korea belongs to the Etatist Social Health Insurance system along with Japan, Hungary, Netherlands, and others where the government manages regulation, society provides financing, and the private sector provides healthcare services (<Table IV-3>). <Table IV-3> summarizes the classification using the approach from Böhm (2012).

〈Table IV-3〉 **Classification of healthcare systems of OECD countries by Böhm (2012)**

Funding	System Classification	Attributes			Countries
		Regulation	Funding	Service Provision	
Social insurance	Social Health Insurance	Society	Society	Private sector	Luxemburg, Austria, Germany, and Switzerland
	Etatist Social Health Insurance	Government	Society	Private sector	Hungary, Poland, Korea, Belgium, France, Japan, Greece, Czech Republic, Netherlands, Slovakia, and Israel
	Social–based Mixed	Society	Society	Government	Slovenia
Tax	National Health Service	Government	Government	Government	Denmark, Finland, Iceland, Norway, Sweden, Portugal, Spain, and United Kingdom
	National Health Insurance	Government	Government	Private sector	Australia, Canada, Ireland, New Zealand, and Italy
	Private Healthcare System	Private sector	Private sector	Private sector	United States

Source: Reconstructed by the author based on Kee–Chul Shin, A Comparative Study On Health Care Financing Of 9 OECD Countries, 2015, p. 123.

And data for the two variables indicating systematic characteristics, total tax revenue as percentage of GDP and social security contribution as percentage of GDP, are taken from the OECD Revenue Statistics 2015.

4 Analysis Methodology

A. Definition of Variables

Variables used for this study are summarized in <Table IV-4>.

The 'coverage' variable, a key variable in this study, is represented by the percentage of public funds in recurrent health expenditures as explained above. To reflect demographic characteristics of each country, population size and the proportion of the elderly aged 65 and over are added as variables. As for economic features, the percentage of the working population and GDP (PPP) are used as variables, and the data are log transformed. Variables indicating health status include the expected remaining lifetime, mortality rates, infant mortality rates, and live-birth rates.

The level of democracy is added as a variable to account for political features, and a dummy variable is used to indicate whether a presidential or parliamentary election was held in the given year. Finally, systematic features are controlled for with total tax revenue as a percentage of GDP and social security contribution as a percentage of GDP used as variables.

〈Table IV-4〉 **Definition of variables**

Name of variables		Description
Coverage	Coverage	Share of public funds in recurrent health expenditures (%)
Population	demographics	Total population (1,000 persons)
Ratio of 65+ people	population65	Share of people aged 65 and over in population (%)
Ratio of working population	labour	Share of working people in population (%)
ln(gdp)	lngdp	ln(GDP ppp)(US$)
Expected remaining lifetime	life	Expected remaining lifetime
Mortality rates	mortality	Standardized rates of mortality by any cause per 100,000 population
Infant mortality rates	infant	Infant mortality rates
Live-birth rates	births	Live-birth rates per 1,000 population
Level of democracy	polity	-10: strongly autocratic ~ 10: strongly democratic
Presidential or parliamentary elections	vote2	1: the year in which a presidential or parliamentary election was held 0: the year in which no presidential or parliamentary election was held
Total tax revenue	ttr	Share of total tax revenue to GDP (%)
Social security contribution	ssc	Share of social security contribution to GDP (%)

Source: Drawn by the author

B. Methodology

As mentioned previously, this study analyzes Korea's health insurance coverage level derived from a cross-country analysis and it consists of two parts: first, identifying the determinants of health insurance coverage; second, building logical foundations for coverage by projecting the effect of coverage on health enhancements.

Firstly, a cross-country analysis is run on OECD countries to identify the drivers that influence the coverage level for each country while controlling for the characteristics of healthcare systems and socioeconomic conditions. Given the fact that OECD countries have different healthcare systems, they are classified

into clusters of countries sharing similar healthcare systems, and additional analyses are performed on each cluster.

These analyses are performed using the following model.

$$Coverage_{it} = \alpha_0 + \beta_0 X_{it} + \beta_1 E_{it} + \beta_2 H_{it} + \beta_3 P_{it} + \beta_4 I_{it} + \beta_5 Year_t + \epsilon_{it} \quad (1)$$

The dependent variable denoted $Coverage$ refers to the level of health insurance coverage (public share of recurrent health expenditures), and X is a demographic variable indicating total population and the share of people aged 65 and over. E is an economic variable representing the ratio of working population and log-transformed values of GDP (PPP), and H is a health variable proxied by the expected remaining lifetime, mortality rates, infant mortality rates, and live-birth rates. P is a political variable proxied by the degree of democratic progress and the year when a presidential or parliamentary election was held. As for the variable denoted P, the time of the years when a presidential or a parliamentary election was held was matched to the time of the dependent variable for the analysis. Finally, I is a healthcare systematic variable proxied by the ratios of total tax revenue to GDP and social security contribution to GDP and a dummy variable for the year is added. And in the analysis on each of the clusters, all variables laid out in the model (1) are used with an exception of the healthcare systematic variable.

Secondly, to identify the relation between health insurance coverage and health status of the public, the following model is built.

$$Health_{it} = \alpha_0 + \beta_1 coverage_{it-s} + \beta_2 coverage_{it-s}^2 + \beta_3 X_{it} + \epsilon_{it} \quad (2)$$

In this model, $Health_{it}$ is a variable indicating the health status of the country i in the year t, represented by the expected remaining life, infant mortality rates, mortality rates due to cardiovascular disease (CVD) and cancer mortality rates. Separate analyses are run with each of the four used as a dependent variable, respectively. The expected remaining lifetime and infant mortality rates are used as they are indicators generally used to represent the overall health status of a country. CVD-induced mortality rates are used for

the analysis to represent the effect of curative medical service on health status because for cardiovascular disease, curative medical service and timely treatment (meeting the golden time) can have big marginal effect on overall health status. Cancer mortality rates are adopted as a proxy variable indicating the effect of preventive health services such as regular medical check-ups because early detection through regular health check-ups is critical for cancer.

As for independent variables, to identify the level of coverage that can maximize health status, non-linear regression analysis is peformed with coverage and coverage squared used as variables. Given that the effect of coverage on health status can occur over an extended period of time, multiple analyses are run by setting three different time lags for coverage for each run. The three time lags are one year, two years, and three years, represented by $(i = 1)$, $(i = 2)$, and $(i = 3)$, respectively. X indicates controlled variables such as total population, percentage of people aged 65 and over, percentage of working population, and log-transformed GDP (PPP) values for each country and for each year.

5 Analysis results

A. Summary statistics of variables

Summary statistics of the variables are laid out in <Table IV-5>.

〈Table IV-5〉 **Summary statistics**

Variables	Obs	Mean	Standard Deviation	Min	Max
Coverage	791	71.81	12.33	33.66	97.06
Demographics					
Total population	850	34,198	53,570.8	252.9	316,128.8
People 65 + (%)	850	13.65	3.60	4.1	25.1
Economic features					
Working population(%)	816	44.71	6.78	26.9	71.3
ln(gdp)	838	1.57	1.68	0	6.76
Health status					
Expected remaining lifetime	846	77.45	3.21	65.7	83.4
Mortality rates	768	1,019.12	276.65	610.6	3,459.2
Infant mortality rates	826	6.45	4.81	0.9	40.9
Live-birth rates	839	12.68	3.59	7.9	28.6
Political features					
Level of democracy	813	9.25	1.72	0	10
Presidential or general elections	850	0.24	0.43	0	1
Institutional features					
Total tax revenue	817	33.50	7.63	13.89	49.48
Social security contribution	817	8.57	4.96	0	19.17

Source: Derived by the author

The mean of coverage represented by the percentage of public health expenditures of recurrent health expenditures for the period 1989-2013 is 71.81%. The mean of level of democracy for the 34 OECD countries is 9.25, slightly lower than 10, meaning strongly democratic with most of the countries scoring 10. The mean of total tax revenue and social security contribution as % of GDP is 33.5% and 8.57%, respectively.

Because the correlations of all variables are less than ±0.8 as shown in <Table IV-6>, they can be used as independent variables for projecting the determinants of coverage.

〈Table IV-6〉 **Correlations**

	demo	popul65	labour	gdp	lngdp	life	mortality	infant	births	polity	vote2	ttr	ssc
demo	1												
popul65	−0.0915	1											
labour	−0.04	0.2532	1										
gdp	0.0642	−0.2833	−0.0163	1									
lngdp	0.0668	−0.1972	−0.0027	0.7801	1								
life	0.0017	0.4742	0.384	−0.0076	−0.0493	1							
mortality	−0.1488	−0.2985	−0.3552	−0.0412	0.008	−0.942	1						
infant	0.2092	−0.6663	−0.416	−0.0042	0.0204	−0.6844	0.5257	1					
births	0.148	−0.7344	−0.235	−0.0299	0.0244	−0.2107	0.0388	0.6139	1				
polity	−0.0294	0.4691	0.2303	−0.125	−0.0354	0.4069	−0.3106	−0.6193	−0.4251	1			
vote2	−0.0111	0.0311	0.0057	−0.0084	−0.0187	0.0628	−0.0607	−0.0358	−0.011	0.0283	1		
ttr	−0.3746	0.5726	0.0991	−0.3497	−0.2452	0.1599	0.0031	−0.4682	−0.3851	0.2518	0.011	1	
ssc	−0.0648	0.5153	−0.1092	−0.1989	−0.2002	−0.0074	0.1224	−0.2585	−0.5336	0.2245	−0.044	0.4977	1

Source: Derived by the author

B. Determinants of coverage

Projections for the determinants of coverage are presented in <Table IV-7>. The projected values are from analyses on all 34 OECD countries and on three health systems of the ESHI, NHI and NHS.

According to the results of a cluster-specific analysis, none of the variables indicating demographics, economic features, or health status are found to have statistically significant effect, consistent across the clusters. This suggests that the effectiveness of the cluster-based analysis should be reconsidered. In other words, this cluster-based analysis is not particularly useful. Therefore, all OECD countries are to be analyzed as a whole while adding the total tax revenue and social security contribution ratios as variables to take into account the different features of social security systems of the countries.

Looking at the results more closely, coverage increases with increases in population and the percentage of working population. As per health status, coverage rises with increases in expected remaining lifetime and mortality rates and declines with increases in infant mortality rates and live-birth rates.

As for the impact of political and healthcare systematic features on coverage on which this study is particularly focused, the coverage level rises with increases in total tax revenue ratio and social security contribution ratio, showing statistically significant results at the 0.01 significance level. Therefore, the features of the social security system can be taken as a major determinant of coverage.

As for political variables, the coverage level does not increase particularly in the years when a presidential or general election is held. The dummy variables indicating the existence of elections are used in such a way as to match the years when a presidential or general election is held to the time of the dependent variable. Furthermore, additional analyses are conducted reflecting potential time lags between the variables. However, the results are not very different, and the dummy variable for the year when a presidential or parliamentary election was held is not found to have statistically significant impact.

There is, nevertheless, a statistically significant negative correlation between the level of democracy and coverage. This may indicate that increasing the level of coverage is more difficult in a more democratic country. Specifically, this

suggests that a more democratic country necessarily has a more complex decision-making process, and this complexity could prolong the process and incur higher costs. Conversely, it may be easier to increase coverage in a less democratic country. Given these results, a conclusion can be drawn that the level of coverage can be determined by political features of a country.

The projection results of the year dummy variable show that the level of coverage, the public share of recurrent health expenditures, falls over time against the base year of 1989. This may be attributable to the fact that as presented in [Figure IV-2], there is a combination of countries whose public shares of recurrent heath expenditures increase, decrease, or fluctuate up and down after 1989. Korea's coverage level continues to decline after 2010 till 2013, as indicated in <Table IV-2>, which may be partly ascribed to rapid increases in non-coverage expenditures that are not managed by the public sector. However, additional study may be required to shed light on this trend.

〈Table IV-7〉 **Determinants of coverage**

	Overall		ESHI		National Health Insurance		NHS	
	coef.	std.err	coef.	std.err	coef.	std.err	coef.	std.err
Demographics								
demo	1.7×10^{-4}***	(3.9×10^{-5})	-5.6×10^{-4}	(0.001)	-2.6×10^{-4}	(0.001)	6.3×10^{-4}	(3.5×10^{-4})
popu	−0.08	(0.167)	−1.02**	(0.406)	1.44**	(0.647)	−0.53	(0.332)
Economic features								
labour	0.41***	(0.074)	0.21	(0.215)	0.98***	(0.268)	−0.06	(0.150)
lngdp	−10.80***	(1.937)	−25.00***	(3.254)	−14.02	(12.456)	6.44	(9.477)
Health status								
life	2.06***	(0.432)	5.11***	(1.199)	0.22	(1.750)	−3.85	(2.626)
mortality	0.02***	(0.005)	0.02*	(0.013)	−0.01	(0.013)	−0.05*	(0.024)
infant	−0.57***	(0.209)	−0.40	(0.631)	0.11	(0.658)	−2.96***	(0.482)
births	−0.93***	(0.191)	−2.62***	(0.438)	−0.78	(0.644)	−0.35	(0.440)
Political features								
polity	−0.55***	(0.190)	−1.40***	(0.499)	−0.16	(0.279)		
vote2	0.24	(0.309)	0.25	(0.695)	−0.36	(0.499)	0.08	(0.467)
Institutional features								
ttr	0.34***	(0.105)						
ssc	0.83***	(0.223)						

〈Table IV-7〉 **Continue**

	Overall		ESHI		National Health Insurance		NHS	
	coef.	std.err	coef.	std.err	coef.	std.err	coef.	std.err
ref=1989								
1990	−0.84	(1.068)	1.26	(3.294)	−1.14	(1.398)	−2.01	(1.276)
1991	−0.75	(1.065)	3.37	(2.982)	−1.05	(1.539)	−3.38**	(1.302)
1992	−1.00	(1.079)	1.52	(3.106)	−1.73	(1.825)	−4.89***	(1.457)
1993	−2.60**	(1.098)	0.05	(2.982)	−3.36	(2.204)	−6.13***	(1.723)
1994	−2.84**	(1.135)	0.13	(3.123)	−4.55*	(2.590)	−7.75***	(1.781)
1995	−3.60***	(1.160)	0.00	(3.237)	−6.90**	(2.895)	−10.12***	(1.850)
1996	−3.99***	(1.184)	−0.82	(3.319)	−7.85**	(3.380)	−9.88***	(1.885)
1997	−4.27***	(1.259)	−0.45	(3.565)	−7.80**	(3.789)	−11.69***	(2.046)
1998	−5.04***	(1.308)	−1.91	(3.604)	−9.07**	(4.403)	−11.79***	(2.152)
1999	−5.26***	(1.325)	−3.65	(3.564)	−9.69*	(4.885)	−11.84***	(2.325)
2000	−5.33***	(1.412)	−4.39	(3.720)	−10.65*	(5.598)	−11.15***	(2.481)
2001	−5.91***	(1.495)	−5.51	(3.884)	−11.13*	(6.222)	−12.31***	(2.699)
2002	−6.24***	(1.553)	−6.51*	(3.915)	−11.43*	(6.768)	−12.01***	(2.824)
2003	−7.24***	(1.586)	−7.15*	(3.973)	−11.66	(7.165)	−12.42***	(3.041)
2004	−8.00***	(1.725)	−9.68**	(4.186)	−11.95	(7.892)	−12.63***	(3.460)
2005	−8.49***	(1.797)	−9.91**	(4.302)	−13.88	(8.527)	−13.25***	(3.605)
2006	−8.50***	(1.928)	−10.24**	(4.578)	−13.79	(8.956)	−12.60***	(3.955)
2007	−8.82***	(1.994)	−10.81**	(4.784)	−13.39	(9.249)	−12.74***	(4.051)
2008	−8.48***	(2.085)	−10.97**	(5.002)	−13.70	(9.614)	−12.35***	(4.323)
2009	−7.61***	(2.137)	−11.99**	(5.025)	−13.28	(9.694)	−11.56**	(4.505)
2010	−8.01***	(2.213)	−12.38**	(5.088)	−14.37	(10.255)	−11.99**	(4.726)
2011	−8.60***	(2.314)	−14.22***	(5.332)	−14.49	(10.893)	−11.68**	(5.025)
2012	−9.31***	(2.385)	−14.91***	(5.505)	−14.60	(11.180)	−11.59**	(4.960)
2013	(omitted)		(omitted)		(omitted)		(omitted)	
Constant	−107.19***	(37.300)	−211.75**	(94.275)	30.54	(149.974)	453.60**	(228.765)
Obs	673		210		111		164	
R2	0.323		0.603		0.488		0.438	
Num of id	33		11		5		7	

Source: Derived by the author

C. Relationship between coverage and health status

As explained previously, to identify the relationship between coverage and health status of country, the expected remaining lifetime, infant mortality rates, CVD-induced mortality rates, and cancer mortality rates are used as variables indicating health status.

〈Table IV-8〉 **Variables for health status**

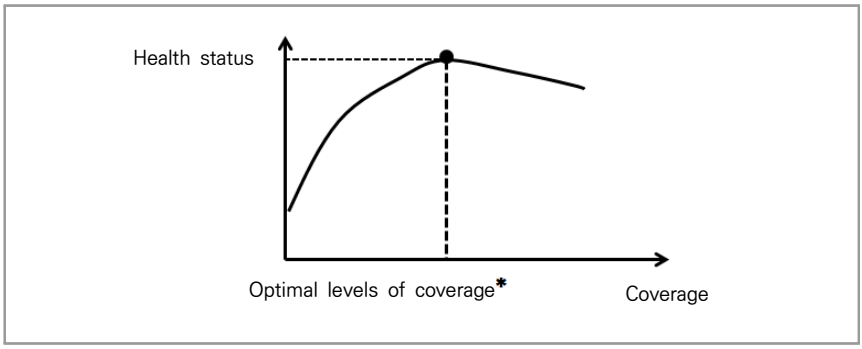
Variables	Obs	Mean	Standard deviation	Min	Max
Expected remaining lifetime	846	77.45	3.21	65.7	83.4
Mortality rates	826	6.45	4.81	0.9	40.9
Infant mortality rates	768	434.20	211.94	165.5	2,058.9
Live-birth rates	768	237.94	36.69	125.1	357.1

Source: Derived by the author

In <Table IV-9> to <Table IV-13>, Models 1 and 2, Models 3 and 4, and Models 5 and 6 show prediction results for different time periods (L. L2 and L3) that reflect time lags in the effect of coverage on health status which might span a different extended period of time. The difference between Models 1 and 2, Models 3 and 4 and Models 5 and 6 is that the odd numbered model uses only coverage as an independent variable whereas the even numbered model uses coverage along with other variables such as total population, percentage of 65+ population, percentage of working population, and GDP as covariates.

This study tries to project an optimal level of coverage that maximize health status by identifying the relationship between coverage and health status. An expected projection result is shown as a graph in [Figure IV-3].

[Figure IV-3] **Optimal levels of coverage based on the relation between coverage and health status**



The relationship between coverage and health status is expected to exhibit a concave function when health status is proxied by the expected remaining lifetime. The expected remaining lifetime is expected to rise with increases in coverage to a certain point, but health status will no longer improve even if coverage rises beyond that point. On the other hand, a convex function is expected when health status is proxied by mortality rates, CVD-induced mortality rates, or cancer mortality rates because these rates are estimated to decline with increases in coverage to a certain point, but they are not expected to decline further even if coverage increases beyond the inflection point. Therefore, the inflection point can be regarded as the optimal level of coverage.

The projection results of the respective relationships between mortality rates and coverage, between infant mortality rates and coverage, between CVD-induced mortality rates and coverage, and between cancer mortality rates and coverage are exhibited in <Table IV- 9>, <Table IV-10>, <Table IV-11>, and <Table IV-12>.

<Table IV-9> lays out the projected relationship between coverage and health status represented by the expected remaining lifetime. As anticipated, the relation between coverage and the expected remaining lifetime shows a concave function with the linear term having a positive sign and the quadratic term a negative sign. All three projections with different time lags of the relationship between coverage and the expected remaining lifetime show a statistically significant

result at the 0.01 significance level, suggesting that the expected remaining lifetime rises with increases in coverage until the optimal level of coverage is reached.

<Table IV-10> and <Table IV-11>, respectively, show relationships of a convex function between infant mortality rates and coverage and between CVD-induced mortality rates and coverage where the linear term has a negative sign and the quadratic term has a positive sign. When the relationships are projected separately for the 1st, 2nd, and 3rd periods, statistically significant results are identified in all three projections at the 0.01 significance level, which may be interpreted to mean that infant mortality rates and CVD-induced mortality rates should decrease as coverage increases until the optimal level of coverage is reached.

Finally, <Table IV-12> shows the relationship between cancer mortality rates and coverage, statistically significant results are not derived in Models 2, 4, and 6 that use other covariates in the analysis. However, Models 1, 3, and 5 that use only coverage as a variable without covariates generated statistically significant results at the 0.01 level where the linear term has a negative sign and the quadratic term has a positive sign.

〈Table IV-9〉 **Relationship between expected remaining lifetime and coverage**

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
L.coverage	0.8337***	0.2862***				
	(0.074)	(0.048)				
$L.coverage^2$	−0.0057***	−0.0020***				
	(0.001)	(0.000)				
L2.coverage			0.8152***	0.2928***		
			(0.073)	(0.047)		
$L2.coverage^2$			−0.0056***	−0.0020***		
			(0.001)	(0.000)		
L3.coverage					0.7986***	0.3071***
					(0.071)	(0.047)
$L3.coverage^2$					−0.0056***	−0.0022***
					(0.001)	(0.000)
demographics		2.6×10^{-5}***		2.5×10^{-5}***		2.5×10^{-5}***
		(0.000)		(0.000)		(0.000)
population65		0.7924***		0.7786***		0.7645***
		(0.030)		(0.030)		(0.031)
labour		0.1988***		0.2045***		0.2052***
		(0.016)		(0.016)		(0.017)
lngdp		1.1887***		1.1405***		1.0823***
		(0.177)		(0.180)		(0.183)
Constant	48.3807***	45.3201***	49.2639***	45.0290***	50.2717***	44.9173***
	(2.629)	(1.745)	(2.576)	(1.724)	(2.526)	(1.710)
Observations	757	752	723	718	689	684
Number of id	34	34	34	34	34	34

Note: *** p<0.01, ** p<0.05, * p<0.1
Source: Derived by the author

〈Table IV-10〉 **Relationship between infant mortality rates and coverage**

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
L.coverage	−1.0344***	−0.4716***				
	(0.122)	(0.098)				
$L.coverage^2$	0.0072***	0.0032***				
	(0.001)	(0.001)				
L2.coverage			−0.9232***	−0.4102***		
			(0.114)	(0.094)		
$L2.coverage^2$			0.0065***	0.0028***		
			(0.001)	(0.001)		
L3.coverage					−0.8623***	−0.4316***
					(0.121)	(0.102)
$L3.coverage^2$					0.0060***	0.0029***
					(0.001)	(0.001)
demographics		-2.7×10^{-5}***		-2.5×10^{-5}***		-2.4×10^{-5}**
		(0.000)		(0.000)		(0.000)
population65		−0.8092***		−0.7936***		−0.7772***
		(0.053)		(0.056)		(0.058)
labour		−0.1422***		−0.1389***		−0.1302***
		(0.029)		(0.030)		(0.031)
lngdp		−3.5768***		−3.2982***		−3.1224***
		(0.291)		(0.299)		(0.308)
Constant	42.2874***	47.3470***	37.9809***	43.9540***	35.7160***	43.8021***
	(4.377)	(3.569)	(4.083)	(3.448)	(4.367)	(3.795)
Observations	738	734	706	702	673	669
Number of id	34	34	34	34	34	34

Note: *** p<0.01, ** p<0.05, * p<0.1
Source: Derived by the author

〈Table IV-11〉 **Relationship between CVD-induced mortality rates and coverage**

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
L.coverage	−31.7514***	−8.5897***				
	(3.808)	(2.779)				
$L.coverage^2$	0.2389***	0.0766***				
	(0.027)	(0.020)				
L2.coverage			−31.2156***	−9.5119***		
			(3.738)	(2.695)		
$L2.coverage^2$			0.2367***	0.0807***		
			(0.027)	(0.019)		
L3.coverage					−30.6242***	−10.6930***
					(3.658)	(2.621)
$L3.coverage^2$					0.2362***	0.0896***
					(0.026)	(0.019)
demographics		−0.0018***		−0.0017***		−0.0017***
		(0.000)		(0.000)		(0.000)
population65		−32.7940***		−31.3571***		−29.9744***
		(1.818)		(1.845)		(1.878)
labour		−12.0327***		−12.863286***		−13.221967***
		(0.956)		(0.959)		(0.962)
lngdp		−49.7248***		−45.135104***		−38.515794***
		(11.458)		(11.643)		(11.784)
Constant	1,420.7971***	1,749.8146***	1,387.8401***	1,799.2459***	1,341.2640***	1,820.2859***
	(135.334)	(100.544)	(132.797)	(98.690)	(129.768)	(97.077)
Observations	683	682	650	649	617	616
Number of id	34	34	34	34	34	34

Note: *** p<0.01, ** p<0.05, * p<0.1
Source: Derived by the author

〈Table IV-12〉 **Relationship between cancer mortality rates and coverage**

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
L.coverage	−2.5416***	1.1925*				
	(0.740)	(0.612)				
$L.coverage^2$	0.0219***	−0.0038				
	(0.005)	(0.004)				
L2.coverage			−2.7370***	0.9510		
			(0.736)	(0.598)		
$L2.coverage^2$			0.0235***	−0.0026		
			(0.005)	(0.004)		
L3.coverage					−3.0825***	0.4762
					(0.731)	(0.582)
$L3.coverage^2$					0.0266***	0.0006
					(0.005)	(0.004)
demographics		−0.0005***		−0.0005***		−0.0005***
		(0.000)		(0.000)		(0.000)
population65		−5.1969***		−5.3495***		−5.4558***
		(0.400)		(0.410)		(0.418)
labour		−2.0867***		−2.1102***		−2.1434***
		(0.211)		(0.214)		(0.215)
lngdp		−1.4022		−1.9568		−2.5254
		(2.674)		(2.755)		(2.826)
Constant	300.5082***	353.8362***	304.7788***	368.1127***	312.7277***	388.5723***
	(26.567)	(22.232)	(26.389)	(22.011)	(26.149)	(21.703)
Observations	683	682	650	649	617	616
Number of id	34	34	34	34	34	34

Note: *** p<0.01, ** p<0.05, * p<0.1
Source: Derived by the author

<Table IV-13> summarizes the projections of an optimal level of coverage that maximizes health status that are statistically significant.

The levels of coverage that optimize overall health status projected by the expected remaining lifetime and infant mortality rates range from 70.76% to 74.35%, and the levels of coverage that optimize the level of curative medical service indicated by CVD-induced mortality rates range from 56.10% to 66.45%. The levels of coverage that optimize preventive medical service measured by cancer mortality rates range from 58.03% to 58.12%.

〈Table IV-13〉 **Optimal levels of coverage**

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Expected remaining lifetime	73.14	70.76	72.79	71.83	71.3	71.43
Infant mortality rates	72.02	74.35	71.5	73.3	71.5	73.65
CVD-induced mortality rates	66.45	56.1	65.94	58.91	64.82	59.65
Cancer mortality rates	58.1		58.12		58.03	

Source: Derived by the author

Based on the results above, the OECD average of 72.7% introduced at the outset of this paper can be regarded as an optimal level of coverage that can maximize overall public health.

6 Conclusion and Consideration

The goals of this study are building panel data of OECD countries for the period 1989-2013; projecting the determinants of health insurance coverage taking into account the demographic, social, political and economic characteristics, the health status of the public, and the features of the healthcare system of each country; and presenting an optimal level of coverage that can maximize health status through the effect of coverage on health improvements.

The analyses performed on each healthcare system cluster with variables representing demographic, economic, and health features do not show statistically

significant results consistent across the clusters. Therefore, instead of the cluster-level analyses, the OECD countries are analyzed as a whole by adding the ratios of total tax revenue and social security contribution to GDP as variables to consider the features of the countries' social security systems. This approach is believed to generate more meaningful results.

According to the results, coverage increases with increases in population, working population, and expected remaining lifetime and decreases with increases in infant mortality rates. Also, coverage represented by the share of public health expenditures in recurrent health expenditures rises with an increase in mortality rates and a decline in live-birth rates. This somewhat unexpected result may be attributable to a negative correlation that may have been caused by a relatively short data span and lack of control for the fixed effect among the countries. No effect on coverage of the political variable indicating a presidential or general election is found, whereas the level of democracy is found to have a negative correlation with coverage. This means coverage can be determined by political features when the features of the healthcare system are considered.

The level of coverage that optimizes overall health status of a country is found to range from 70.76% to 74.35% when health status is proxied by expected remaining lifetime and infant mortality rates. This range includes 72.7%, the OECD average level of coverage in 2013. According to a cross-country analysis of coverage, Korea's coverage level is lower than other countries, and it is seen as a call to expand coverage to improve public health. Faced with resource restrictions, Korea needs to secure additional sources to fund coverage expansion and develop policy that duly reflects priorities in order to prevent moral hazard.

This study has limitations in that it only covers the 34 OECD countries: it does not include countries that have different demographic, social, political and economic characteristics, and different healthcare systems. Nor does it include more diverse variables to control for these features.

The analyses using three different variables representing health status generated similar results overall, but different results in terms of an optimal level of coverage. This can be seen as a limitation of this study. However, as the expected remaining lifetime and infant mortality rates have been widely used in previous studies to represent overall health status, an interpretation of this

study's results may need to be focused on the projection using those two variables.

In addition, from a perspective that raising the level of coverage or improving the health status variables will help raise overall welfare, it is regrettable that this study fails to include variables representing public welfare like happiness due to lack of reliable data. Finally, there is a possibility of simultaneous bias driven by interactions between the dependent and independent variables. This issue stems from the endogeneity of independent variables, and to address it, an analysis using lagged variables is recommended for future studies.

V

Conclusion and policy implications

This study conducted empirical analyses regarding assumptions or premises deemed somewhat unrealistic or in need of logical grounds as they were used in the previous long-term fiscal projections for National Health Insurance based on the OECD component-based model. This study yields interesting results as a basic study and offers logical foundations on death-related costs, income elasticity, and health insurance coverage used in the OECD model.

First of all, in projecting death-related costs, this paper derived actual spending by the non-survivors based on data instead of projecting them based on a set of assumptions. According to the 2013 sample cohort database of the National Health Insurance Service, health expenditures during the last year of life for male non-survivors totaled 15.06 million won and those for female non-survivors were 12.4 million won. These figures are lower for men and higher for women than the corresponding figures from previous studies; they conducted with somewhat unrealistic assumptions that the healthcare expenditure for the non-survivor of the highest age groups is defined as the cost of death, which increases linearly as age declines. In other words, previous studies overestimated the cost of death for male while the cost of death for female is underestimated. Furthermore, Chapter 2 projected the health expenditures of National Health Insurance by solely reflecting demographic changes using more accurate projections of death-related costs.

The second study estimated income elasticity for Korea's health expenditures. The study aimed at ascertaining the validity of using income elasticity of 1 or 0.8 for Korea as used in the OECD methodology. Chapter 3 projected income

elasticity based on two sets of data, one individual-level data and the other national-level data. We hypothesized that individual-level income elasticity approaches 0, but national-level income elasticity can be close to or over 1; at the individual level, health status influences the consumption of health service more than income as the individuals are insured with health insurance, whereas at the national-level, income has higher impact on the consumption of health service, resulting in higher income elasticity since the levels of health status of the individuals are averaged out. We used the Korea Health Panel data for the micro-level analysis and OECD data for the macro-level analysis. The analyses show income elasticity for health expenditures of 0.195 at the individual/household level (ranging between 0.1 and 0.3 depending on the analysis model) and 0.863 at the national level (ranging between 0.8 and 1.3 depending on the analysis model). Therefore, using income elasticity of 1 or 0.8 following the OECD methodology seems reasonable.

Finally, to check the validity of setting the target level of coverage for Korea at the OECD average of 70%, optimal levels of coverage were estimated that would maximize the health indicators for Koreans. Here, coverage is defined to be the percentage of public health expenditures out of total (recurrent) health expenditures, and the OECD Health Data (2015) are used as main data along with the Polity IV data set, the IDEA data set, and the OECD Revenue Statistics (2015). First, an empirical analysis was performed to identify the determinants of coverage by using the level of coverage of each country as a dependent variable. The analysis shows that coverage increases with increases in the ratios of total tax revenue and social security contribution to GDP, confirming that the maturity of social security systems plays a pivotal role in health insurance coverage. The next analysis was designed to identify the level of coverage that will maximize health status, which was proxied by expected remaining lifetime, infant mortality rates, CVD-induced mortality rates, and cancer mortality rates. The results varied slightly depending on the indicators or models used, but a projection using expected remaining lifetime, the most widely used health indicator, yielded an optimal level of coverage ranging from 70.76% to 73.14%. Based on the results, Korea's target coverage level of 70% based on the OECD methodology is believed to be a reasonable target that can maximize the health status of the public in Korea.

Based on these three basic research studies, this paper proposes that fiscal projections of National Health Insurance use actual death-related costs based on data instead of using the methodology used in previous studies. On the other hand, income elasticity of 1 or 0.8 and Korea's target level of coverage of 70% are found to be reasonable and can be used for future studies.

With population aging, health insurance expenditures will continue to put a strain on the national finances along with other social security insurances. Therefore, it is essential to project health care expenditures and growth drivers and to be prepared for the future. It is, however, challenging to project health care expenditures for a long period of time because the conditions of the future that have not been realized need to be projected and simplified for analysis. And unexpected changes in the economy, and policy or institutional reforms, can completely change the projections. Given this uncertainty, some try to downplay the significance of long-term projections. However, projecting the future direction using the best methodology available is thought to carry certain meaning. We hope that if the assumptions and premises set in this paper have stronger logical grounds, the long-term fiscal projections will have greater credibility.

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