PREDICTORS OF HEALTHCARE OUTCOMES AT THE LOCAL COMMUNITY LEVEL: VARIATIONS IN THE VALUE OF HEALTHCARE SERVICES UNDER KOREA'S UNIVERSAL HEALTH INSURANCE SYSTEM

by
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Abstract

Objectives: To determine the possible relationship between the premature death and national health insurance (NHI) healthcare services expenditures (HE) at the local community level, and possible local determinants of health that might affect the variation in premature deaths among 231 local communities (n=231).

Methods: Based on the simplified Local Determinants of Health (LDH) framework, a value of HE model for local healthcare services (HS) was designed, and the following health outcome variables were defined: Years of Potential Life Lost before age 75 (YPLL-75) of all premature deaths and YPLL-75s of premature deaths due to Cancers and Suicide in 231 local communities. The incremental Value of HS models and Multiple Linear Regression (MLR) models (n = 231 local communities) for all NHI HS as well as healthcare services for cancers and mental health problems were constructed to determine the relationships between the averted YPLLs (the dependent variables) and the changes of NHI HE (the main independent variable) between 2007 and 2012 at the local community level. In the MLR models, 16 independent variables were included in order to represent determinants of health outcomes.

Results: Overall, the recently increased NHI HE at the local community level was associated with a decrease of premature deaths under the Korean NHI system. But the regional variations in the values of HS were somewhat large. Specifically, when the various determinants of health were considered and controlled in the MLR model, the influences of the NHI HE increases on the health outcomes (the averted YPLLs) were very limited. More specifically it was found that in the important healthcare service areas like cancer care and mental health care, the values of HS showed negative ratios and diminishing trends as the NHI HE increased among communities. Regardless of NHI HE's increases, certain determinants of health including some biological and behavioral factors, affected the health outcomes directly and modified the values of NHI HE as well.

Conclusions: Improving the biological and behavioral health status and targeted health policies for low health performance areas are important to improve the health outcomes in terms of YPLLs and the value of NHI HE in Korea.

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Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1. Problem Statement

Recently, the world economy is experiencing slower growth and severe fiscal constraints, and these constraints are leading to the decreasing health expenditures globally as seen in Figure 1 (OECD, 2012). In this situation, policy makers are requesting higher value to be demonstrated by public services, and the health care sector is not an exception. To provide some evidence and policy priorities on how to ensure higher value of health care services and health expenditures in the national health policy perspective, country specific studies on the health related factors that produce better health outcomes under given health expenditure levels should be highlighted.

In South Korea, the national health insurance (NHI) system has been expanding its coverage continuously and the total health care expenditure for NHI covered services has increased about 2.5 times from 18.8 trillion KRW (1$ = 1,060 KRW) in 2002 to 46.2 trillion KRW in 2011. In spite of the difficult global

economy, Korea has also shown the fastest annual growth rate in health spending across the OECD countries (OECD, 2012). (Figures 2 & 3)

Especially, starting from 2005, the Korean government has expanded NHI coverage aggressively with their long term plan. But their NHI coverage expansion has focused on the health care services for 4 severe diseases including cancer, cardiovascular, cerebrovascular, and rare diseases. Starting in 2009, the coverage of services for 4 severe diseases has been expanded very aggressively again as the special coverage exception plan. In 2009, the out of pocket coinsurance rate for cancer treatment decreased from 10% to 5 % and for treatment of 138 rare diseases from 20% to 10%. In 2010, the coinsurance rate for cardiovascular and cerebrovascular disease treatment was lowered from 10% to 5% as well. During 2009 and 2011, many high-priced medicines and operations for cancer treatments were also newly included in the NHI coverage. (Table 1-1)

Actually, since cancer is recognized as the No. 1 cause of death in South Korea, and considering the socio-economic impacts on families as well as patients due to the high burden for cancer treatment, the Korean government has increased their NHI coverage of cancer care as a top priority. The total expenditure for NHI covered cancer treatments has increased 3.9 times from 1.0

trillion KRW in 2002 to 3.9 trillion KRW in 2011 which is 56% higher than the overall health expenditure growth rate during the same period in Korea. But these recent NHI coverage reforms have not been evaluated in terms of health outcomes including averting premature death and the value of health expenditures.

Now the Korean government recognizes that they need some policy measures to improve the efficiency or the value of NHI Health Services in terms of value for money considering the fiscal constraints and limited financial resources. But the studies on the value of NHI Health Services and the health related predictors that lead to better health outcomes have not been fully addressed in Korea in terms of public health policy perspectives.

Moreover, another important aspect of Korean society to consider in health policy is the problem of the rapid aging population due to the extremely low fertility rate[1] since the 1990's. (Table 1-3) While promoting a higher fertility rate is very important, decreasing mortality, specifically lowering premature

[1] The fertility rate decreased from 2.06 in 1983 to 1.19 in 2013 and the percentage of the over 65 population to the total population increased from 5.1% in 1990 to 12.2% in 2013.

death, should be a top priority and should be considered one of the most important health outcomes in Korean health care policy in the future.

1.2. Study Aims

Considering these health care policy needs in Korea, this study will focus on how to measure and how to improve the efficiency or the value of NHI Health Services at the local community level in terms of the health outcome of lowering premature death. Specifically, this study will examine if "recent NHI Health Expenditure growth has contributed to lowering premature death", and "which health determinants have facilitated the NHI's contribution to better health outcomes" at the local community level.

Assuming that the value of healthcare services at the local community level can be different due to the differences in health-related factors like various material circumstances, behavioral health factors, regional health prevention, health care service utilization, and health care resources, a broader study on determinants of health outcomes at the local community level would be needed to define major predictors which will facilitate the higher value of health services

in Korea. Therefore, this study starts from the question of why there have been health outcome and efficiency gaps among different local communities in terms of premature death even in a country in which local communities are under the same universal NHI system like in South Korea.

To compare communities and analyze the variations of premature death, this study will focus on comparing the value of NHI Health Services (HS) overall and for cancer and mental health at the local community level since these are considered among the leading causes of deaths[2] and their associated burdens in terms of premature deaths in Korea.

Although the introduction of new treatment technologies and medicines is important to improve overall health outcomes, healthy life styles and behaviors, good preventive care, and effective health care systems might be more important under the given health technology and expenditure levels.

In this regard, this study aims to evaluate the effects of various possible health determinants on the value of NHI HS at the local community level, and to develop a value of HS model based on certain relationships between health

[2] Especially in Korea, the suicide rate is a big problem compared with other countries. Among OECD countries, the suicide rate in Korea has been the highest for more than 10 years, and the rate in 2012 is 29.1 per 100,000 persons compared with the OECD average, 12.1.

determinants and the value of NHI HS at the local community level. Although there are many socio-economic dimensions and regional characteristics that might affect the value of local HS in Korea, this study will consider broader health related factors representing life styles and health environments, health promotion and prevention, health resources, and health utilization within a social determinants of health perspective.

In South Korea there are 16 provinces including 7 metropolitan cities, and under these provinces, there are 230 municipal regions including 143 cities and 87 towns[3]. Among these regions, the different levels of indicators related to health promotion and prevention can be recognized to result in some of the variations of local health outcomes. Moreover, it is assumed that more efforts on better life styles, better health environments, better preventive care, better coordination of services, and better health resource allocation at the local community level would be desirable to promote better regional health outcomes under the given level of health expenditures in the Korean NHI system.

In this context, this study has two specific objectives as follows:

[3] If Cheju special province is included as a community region for analytical purposes, the total number is 231.

1) This study will analyze the values of NHI HS in the 231 local communities in terms of lowering premature death and compare the variation among different cities and towns.

2) This study will analyze the possible local determinants of health that might affect the variation of the values of HS among 231 local communities (n=231). This analysis will determine which health related factors might influence less premature death or higher value of NHI HS at the local community level. Basically health determinants will include indicators of health circumstances, health behaviors and prevention like smoking control, and health care resources and utilization like the number of physicians (specialists), and hospital beds.

These objectives assume that we can develop a Value of HS model in terms of premature death at the local community level in Korea and evaluate the local Health Care Values which will be different among the local communities, including different cities and towns. The health care policy perspective also supposes that the Value of healthcare services can be increased in cases where

other health circumstances and resource allocations in the local communities are improved.

South Korea also can provide a very good study population to analyze many of the predictors that affect the variations of health outcomes at the local community level since it has the universal national health insurance system (NHI) and a single ethnicity in all communities. This will be helpful to control possible confounding factors which are difficult to control in a cross country level study.

Figure 1. Average OECD Health Expenditure Growth Rates (2000 to 2010)

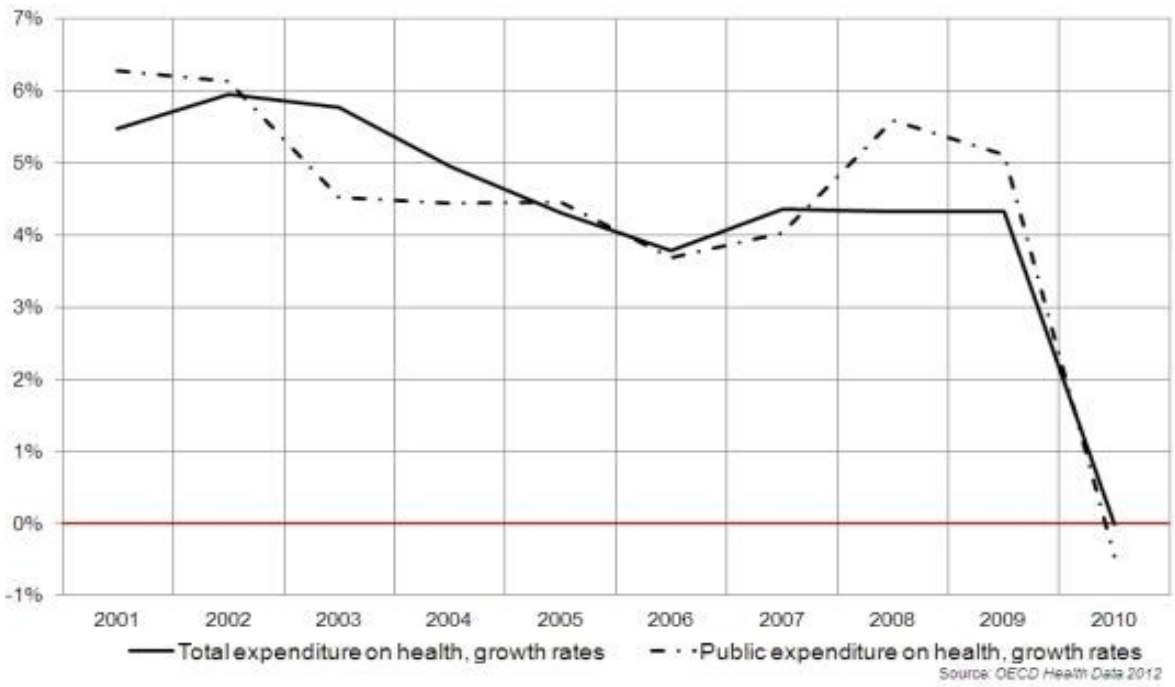
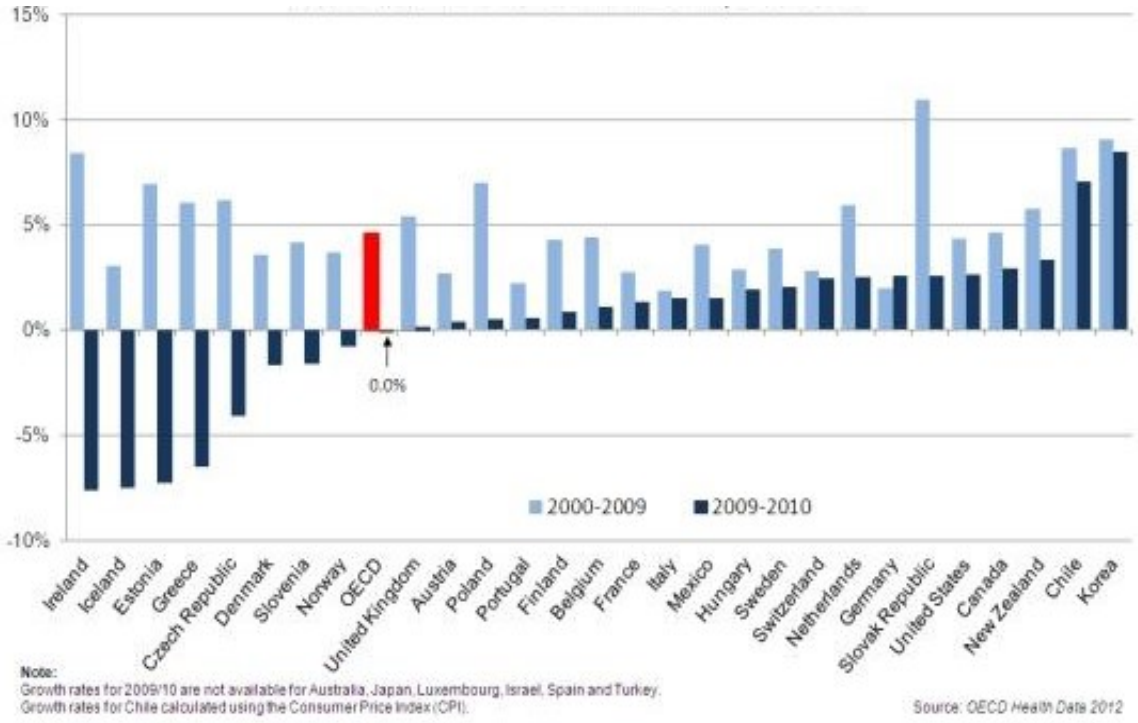


Figure 2. Average Annual Growth in Health Spending across OECD Countries (2000 to 2010)



Note:
Growth rates for 2009/10 are not available for Australia, Japan, Luxembourg, Israel, Spain and Turkey.
Growth rates for Chile calculated using the Consumer Price Index (CPI).

Source: *OECD Health Data 2012*

Figure 3. Annual Health Expenditures for NHI covered services

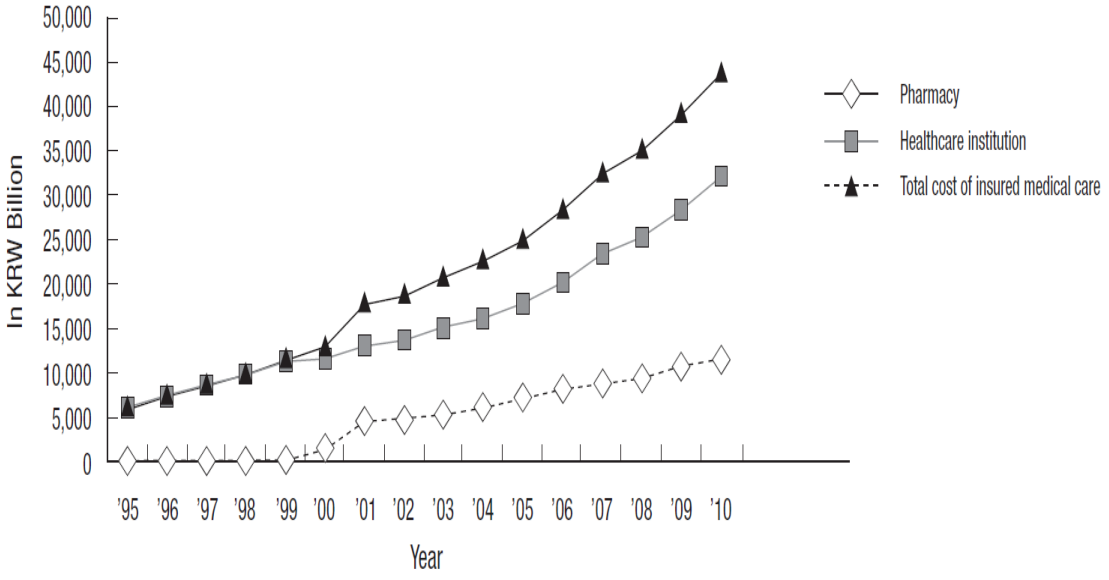


Table 1-1. NHI Policy Structure for NHI covered services

<table>
<tr><th colspan="3" rowspan="2">Benefit Categories</th><th colspan="4">Korean NHI Coverage Structure</th></tr>
<tr><th>2007</th><th>2008</th><th>2009</th><th>2010~</th></tr>
<tr><td>Inpatient</td><td colspan="2">Co-insurance</td><td colspan="4">20%</td></tr>
<tr><td rowspan="4">Outpatient (Co-insurance)</td><td colspan="2">Physician Office</td><td colspan="4">30% (Over 65: Co-pay 1,500 under 15,000KRW)</td></tr>
<tr><td colspan="2">Community Hospital</td><td colspan="4">40% (Rural 35%)</td></tr>
<tr><td colspan="2">General Hospital</td><td colspan="4">50% (Rural 45%) *Tertiary 60% (‘09~)</td></tr>
<tr><td colspan="2">Prescription Medicine</td><td colspan="4">30%</td></tr>
<tr><td rowspan="5">Special Coverage Exception (Co-insurance)</td><td colspan="2">Cancer</td><td colspan="2">10% (In/Out)</td><td colspan="2">5% (In/Out)</td></tr>
<tr><td colspan="2">Rare Diseases</td><td colspan="2">20%(In/Out)</td><td colspan="2">10% (In/Out)</td></tr>
<tr><td colspan="2">Heart Disease & Cerebrovascular Disease</td><td colspan="3">10% (In/Out)</td><td>5%</td></tr>
<tr><td rowspan="2">Under 6 age</td><td>Out</td><td colspan="4">70% of Adult Co-Insurance</td></tr>
<tr><td>In</td><td>0%</td><td colspan="3">10% (New born 0%)</td></tr>
<tr><td rowspan="3">*Co-payment Ceiling</td><td colspan="2">Low Income (50%)</td><td colspan="2" rowspan="3">2,000,000 KRW (6 month)</td><td colspan="2">2,000,000 (1 year)</td></tr>
<tr><td colspan="2">Middle Income (30%)</td><td colspan="2">3,000,000 (1 year)</td></tr>
<tr><td colspan="2">High Income (20%)</td><td colspan="2">4,000,000 (1 year)</td></tr>
</table>

(Source: NHI Corporation, 2012)

Table 1-2. Leading Causes of death in Korea (2001~2011)

(Unit: per 100,000 population, person, %)

Rank	2001		2010		2011					
	Causes of death	Death rate	Causes of death	Death rate	Causes of death	Number of deaths	Percentage	Death rate	From 2001	From 2010
1	**Malignant neoplasms**	122.9	**Malignant neoplasms**	144.4	**Malignant neoplasms**	71,579	27.8	142.8	-	-
2	**Cerebrovascular diseases**	73.7	**Cerebrovascular diseases**	53.2	**Cerebrovascular diseases**	25,404	9.9	50.7	-	-
3	**Heart diseases**	33.9	**Heart diseases**	46.9	**Heart diseases**	24,944	9.7	49.8	-	-
4	Diabetes mellitus	23.8	Suicides	31.2	Suicides	15,906	6.2	31.7	↑	-
5	Liver diseases	22.2	Diabetes mellitus	20.7	Diabetes mellitus	10,775	4.2	21.5	↓	-
6	Transport accidents	20.9	Pneumonia	14.9	Pneumonia	8,606	3.3	17.2	↑	-
7	Chronic respiratory diseases	19.0	Chronic respiratory diseases	14.2	Chronic respiratory diseases	6,959	2.7	13.9	-	-
8	Suicides	14.4	Liver diseases	13.8	Liver diseases	6,751	2.6	13.5	↓	-
9	Hypertensive diseases	10.2	Transport accidents	13.7	Transport accidents	6,316	2.5	12.6	↓	-
10	Pulmonary tuberculosis	6.3	Hypertensive diseases	9.6	Hypertensive diseases	5,038	2.0	10.1	↓	-

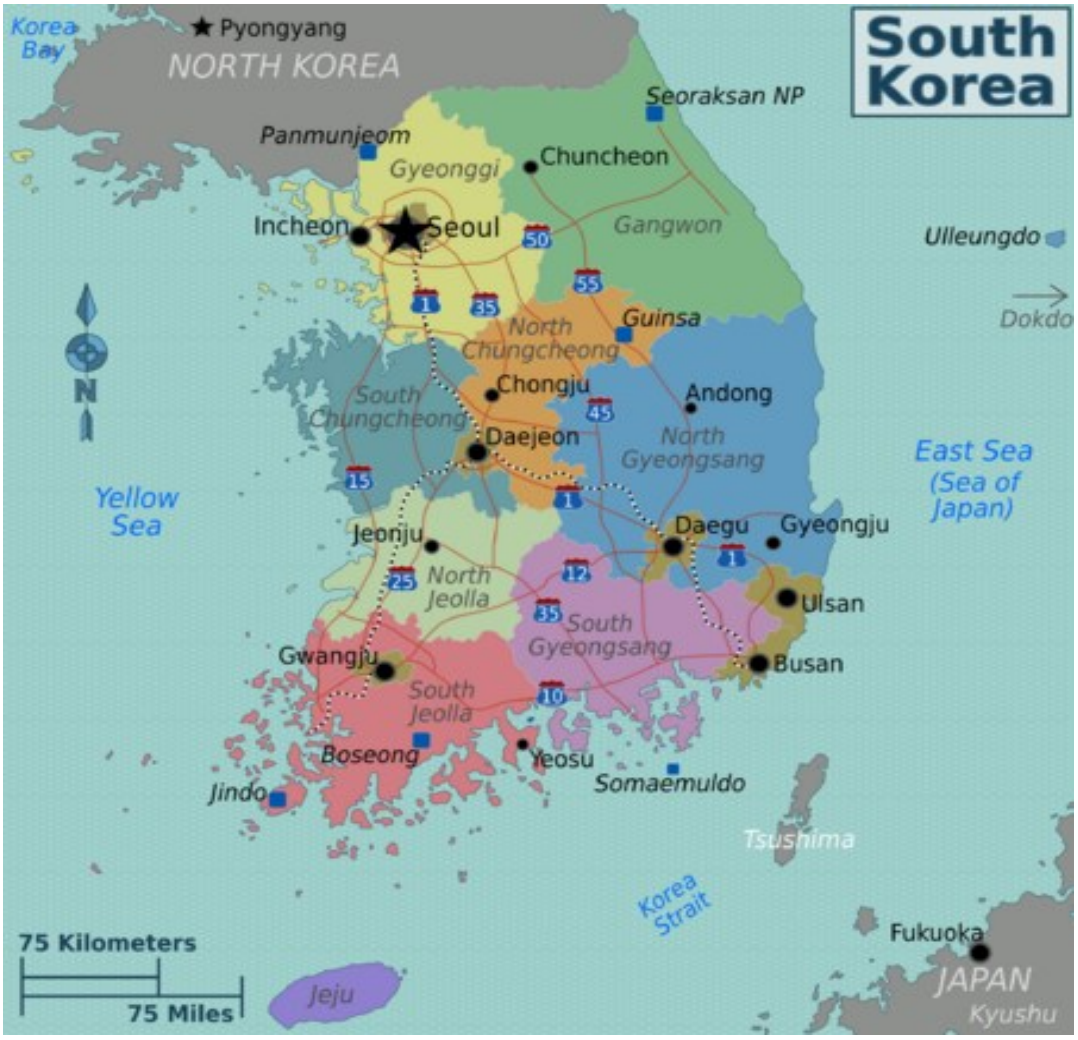
(Source: Korea National Statistics Office, 2012)

Table1-3. Population Change in Korea (Source: UN statistics)

Period	Live births per year	Deaths per year	Natural change per year	CBR[1]	CDR[1]	NC[1]	TFR[1]	IMR[1]
1950-1955	722 000	331 000	391 000	35.8	16.4	19.4	5.05	138
1955-1960	1 049 000	356 000	693 000	45.4	15.4	30	6.33	114.4
1960-1965	1 067 000	347 000	720 000	39.9	13	27	5.63	89.7
1965-1970	985 000	298 000	687 000	32.9	9.9	23	4.71	64.2
1970-1975	1 004 000	259 000	746 000	30.4	7.8	22.5	4.28	38.1
1975-1980	833 000	253 000	581 000	23.1	7	16.1	2.92	33.2
1980-1985	795 000	248 000	547 000	20.4	6.4	14	2.23	24.6
1985-1990	647 000	239 000	407 000	15.5	5.7	9.8	1.6	14.9
1990-1995	702 000	239 000	463 000	16	5.5	10.6	1.7	9.7
1995-2000	615 000	247 000	368 000	13.6	5.5	8.1	1.51	6.6
2000-2005	476 000	245 000	231 000	10.2	5.3	5	1.22	5.3
2005-2010	477 000	243 000	234 000	10	5.1	4.9	1.29	3.8

[1] CBR = crude birth rate (per 1000); CDR = crude death rate (per 1000); NC = natural change (per 1000); TFR = total fertility rate (number of children per woman); IMR = infant mortality rate per 1000 births

Figure 4. Map of South Korea



Chapter 2: Literature Review[4]

2.1. Assessment of Korea's NHI & Health care system

Historically, Korea has been a good example of a country showing a positive relationship between economic development and the length and quality of life. (Sen, 1999) Life expectancy at birth has increased from just 62.3 years in 1972 to 81.3 years in 2012. The demographic transition in Korea has been ongoing since the beginning of the 1960s, mainly due to the rapid socioeconomic development including public health and the health care system.

The ongoing instruments to finance healthcare services in Korea are composed of the National Health Insurance System ('NHI' hereafter) funded by mandatory social insurance contributions and the Medical Aid Program (MAP) financed by a government budget for the poor as a Livelihood Protection Program. Currently, approximately 97 percent of the Korean population is

[4] For the literature review, comparative studies on regional variations and disparities of health outcomes, and health economics and studies of determinants of premature death and burden of disease were collected from the PUBMED by using the search engines like Google and Naver (a Korean Search Engine).

covered by NHI operated by the NHI Corporation ('NHIC' hereafter), and the remaining 3 percent by MAP.

Under the oversight of the Ministry of Health and Welfare (MOHW), NHIC is responsible for administering the NHI program including management of the eligibility qualifications of the insured and their dependents, collections of contributions, setting of medical fee schedules through negotiation with providers, provision of health insurance benefits through payments for medical services rendered to the insured, and the operation of other health-related projects such as health promotion and prevention activities.

At this point, only 63% of total medical care costs are reimbursed by the NHIC based on fee-for-service payments with a co-insurance payment structure controlled by the government, while 21% of medical costs are paid by patients in the form of coinsurance and copayments for the medical services covered by NHI and 16% of medical care costs are paid out of pocket for uncovered services like private rooms.

In the case of health care services for 4 severe disease categories, including cancer, heart, cerebrovascular, and rare diseases, the Korean government has recently increased the rate of NHI reimbursement to over 90% as we discussed

previously. However, only 76.1% of total health care costs for the 4 severe disease categories are reimbursed by the NHIC due to the increase in uncovered cancer care services (NHIC, 2012). According to a recent study done by the NHIC in 2012, 11.6 trillion KRW was funded for newly expanded coverage from 2005 to 2010, and 25.8% of this was used for the coverage expansion of cancer treatment (Lee at al., 2012). Also according to the recent NHIC annual survey of the NHI coverage rate of total treatment costs, the average coverage rate for all treatments is 63.0%, while the average coverage rate for treatments of the 4 severe disease categories is 76.1% (NHIC, 2013). Many health experts have also pointed out that the recent NHI has focused too much on the 4 severe diseases like cancers, and these NHI policies have produced inequalities with other major causes of death and important diseases like other chronic diseases including hypertension and diabetes (Yoon, 2013).

The other health insurance administrative wing of MOHW, the Health Insurance Review and Assessment Service (HIRA), is in charge of reviewing claims transferred from health care organizations and evaluating the appropriateness of health care services provided to patients. In addition to reviewing and evaluating health care services, HIRA establishes and revises the standards of health care and fee schedules, implements quality improvement

initiatives for health care services, and conducts various health care research studies with regard to utilization, appropriateness, and comprehensive care management.

All health care organizations submit their claims to HIRA mainly through the NHI Electronic Data Interface (EDI) system. After completing its review, HIRA sends the reviewed results to NHIC. NHIC pays claims based on the results reviewed by HIRA.

Although the NHI has a single payment claim system under the control of the Health Insurance Review and Assessment Service (HIRA) to review inappropriate medical fee claims, there still may be a high possibility for medical care institutions to provide overuse of drugs and treatments, and claim overpayments in order to maximize their revenues under the NHI's fee-for-service payment system, and these claim problems might vary by region regardless of health outcomes. (Figure 5)

Even though Korea has a single universal healthcare insurance system in all regions, there have been many debates on the variations in total healthcare expenditures, access to care, health care resources, and health promotion at the local community level, resulting in possible health disparities and inequities

among communities. For example, according to a recent report by the Ministry of Health and Welfare, the life expectancies at birth in 16 local provinces were analyzed in a 2010 local health level study and the life expectancy gap between the highest and lowest provinces was about 3.55 years for men and 3.49 for women.

Recently, the regional health variations and inequity issues in Korea have also been recognized as one of the very important socio-economic issues, and it is considered that there may be some variations in the regional health outcomes that might be explained by various regional health determinants.

For example, in the case of the cancer care outcomes in South Korea, the deaths due to stomach cancer decreased from 10,134 (age standardized rate per 100,000 persons: 17.4) in 2009 to 10,031 (16.5) in 2010, and the deaths due to colorectal cancer increased from 7,105 (12.1) in 2009 to 7,701 (12.5) in 2010. In the case of incidence cases, the stomach cancer cases increased from 29,727 (age standardized rate: 44.8) to 30,092 (43.5) in 2010, and the colorectal cases increased from 24,986 (37.3) in 2009 to 25,782 (36.9) in 2010 overall. (NCIC, 2012)[5]

[5] But the age standardized incidence rate decreased due to the continuous increase of over 65 age population from 7.2% in 2000 to 11.3% in 2010. The crude cancer incidence rate of over

Overall, it can be assessed that the cancer care outcomes have been improved, but if we see the cancer mortalities by communities, we can find somewhat big variations of mortalities among communities. (Figure 6 & 7) Especially, according to the stomach cancer mortality rate data of each community from the National Statistics Office's cause of death database, and the smoking and high BMI population rates of each community collected from the MOHW's annual regional health level survey database, there was a positive relationship between the population smoking rate and the stomach cancer age-standardized mortality rates among 231 local communities in 2010. (Figure 6) Also there was a positive relationship between high BMI population rates and stomach cancer mortality rates. (Figure 7) From this, we can guess that different levels of behavioral and biological factors in the local communities might result in different levels of health outcomes in Korea.

Moreover, many experts have pointed out that if the Korean government effectively utilizes the NHI's health care data and personal health information, including medical statuses and histories, 5.5 to 8.2 trillion KRW could be saved since the big-data revolution in health care can make our health care system

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65 people in 2010 was 1559.5 per 100,000, which was almost 3 times higher than the rate of people who were 35 to 64 years of age (489.2). (NCIC, 2012)

focus on preventive care and well-coordinated care across providers. (NHIC, 2013)

Figure 5. NHI single payment claim system in Korea

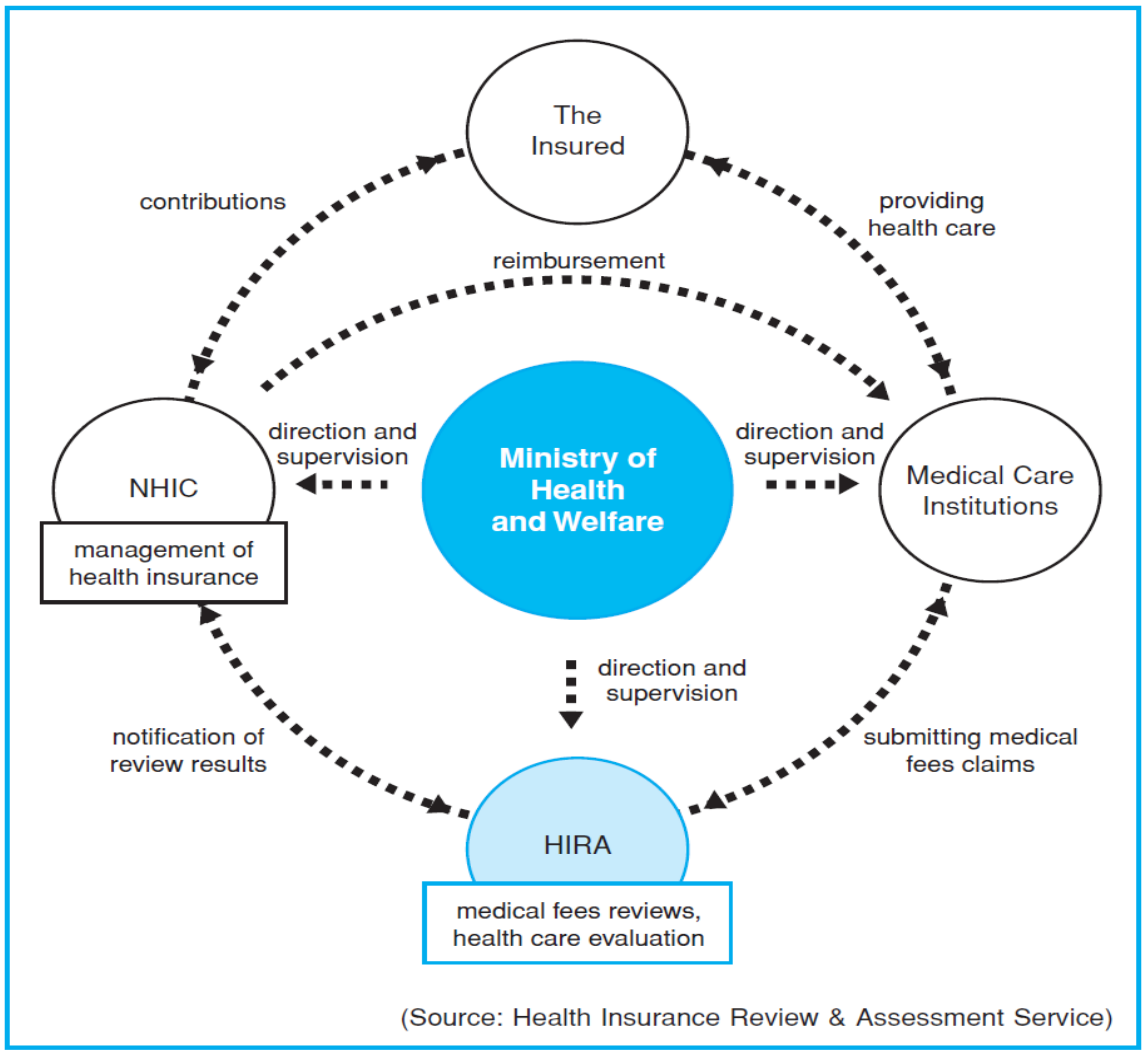


Figure 6. Stomach Cancer Mortality Rates and Smoking Population Rates

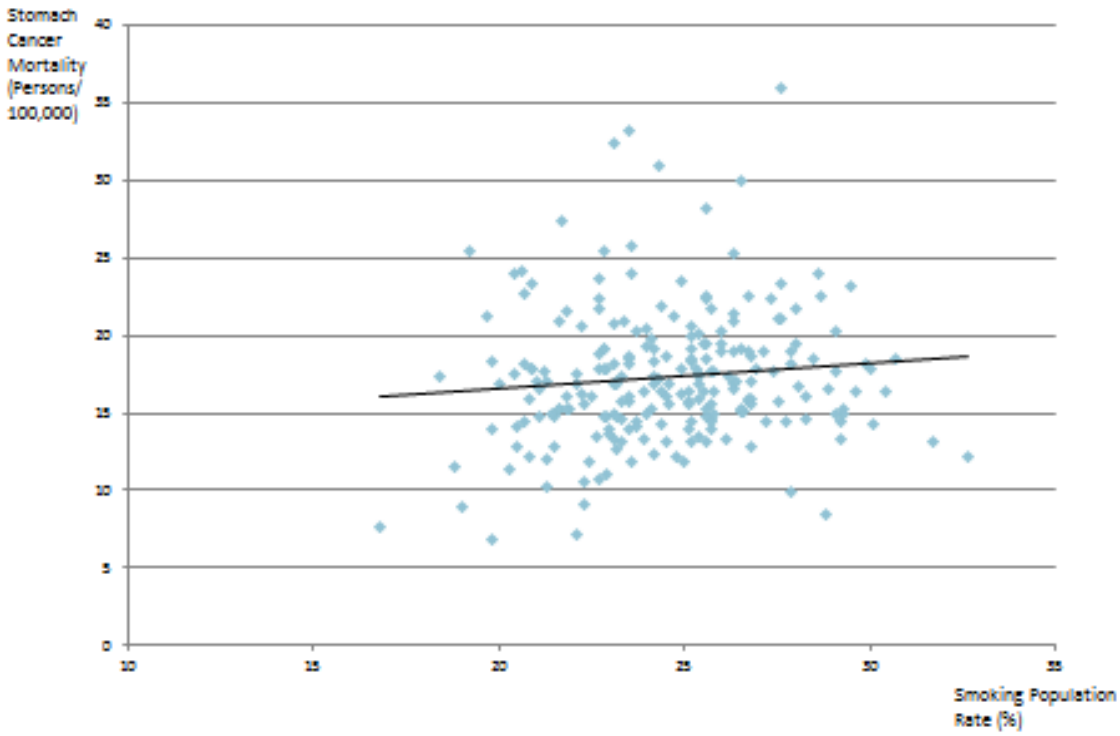
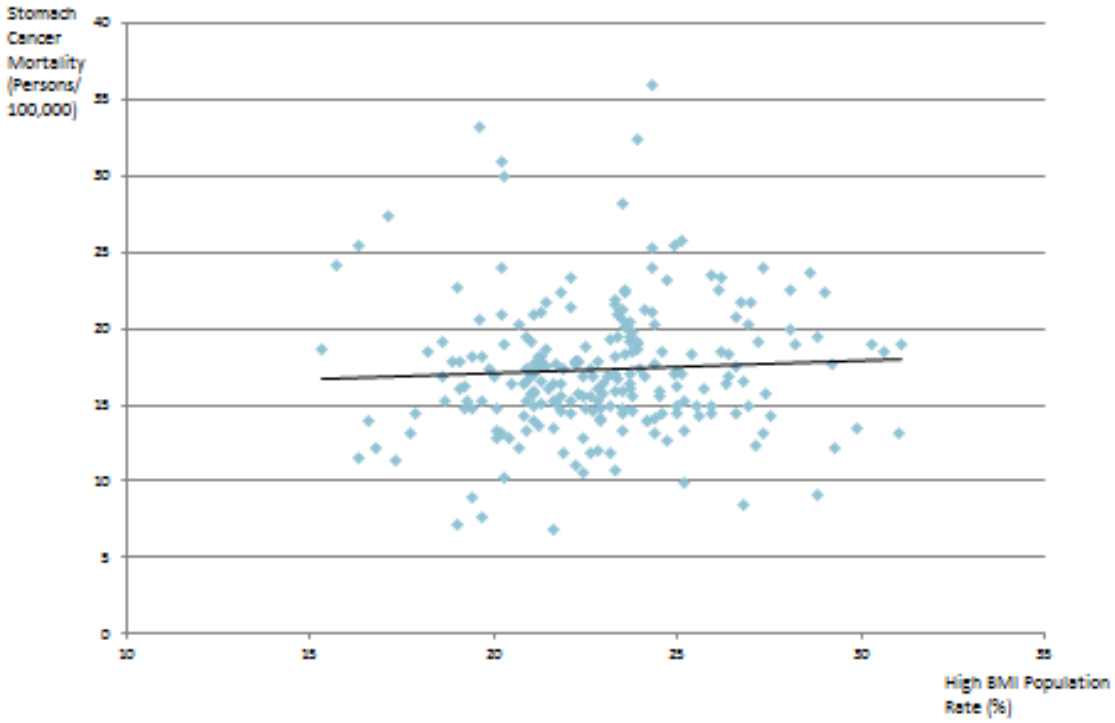


Figure 7. Stomach Cancer Mortality Rates and High BMI Population Rates



2.2. Predictors of Health Care Outcomes

Today improving health is recognized as a very important socio-economic development objective, and there is a growing consensus that improving health can have a large effect on national socio-economic growth and development.

According to a WHO report in 2001, improving crucial health care services can reduce poverty, and promote economic development and growth. A cross-country level study on life expectancy in 2000 also found that life expectancy is positively correlated to GNP per capita, population growth, fertility, enrollment, and access to safe water, and life expectancy is negatively correlated to AIDS, tuberculosis, and rate of deforestation. This study showed that life expectancy is meaningfully determined by economic factors, sanitation, and certain disease prevalence (Chen & Ching, 2000).

Although many cross-country level studies have shown strong relationships between life expectancy, reflecting the overall health outcome of a nation's citizens, and economic development and growth at the macro-level including the population increase effect, the causal relationship between them has not been established and remains unclear (Acemoglu & Johnson, p.925-926, 2004).

Cross-country level comparisons of predictors of better health outcomes have also been debated among public health researchers. According to OECD life expectancy studies, the U.S has shown lower scores compared with other developed countries like Japan and Sweden. Lower life expectancy in the U.S has provided the main reason to blame the poor health performance of the U.S. health care system in spite of the highest health care expenditure level in the world.

But considering the fact that the mortality rate from many factors including car accidents and homicides might affect life expectancy a lot, the comparison of life expectancy at the cross-country level cannot exactly tell us which country has a better health care system. Moreover, since healthcare insurance systems including private and public, ethnicities, cultures, and even education systems are different from each other among countries, comparing health outcomes directly at the cross-country level might have big limitations.

In fact, without the deaths from fatal injuries like car accidents and homicides which are not much related to health care service quality, the life expectancy in the U.S was analyzed with results suggesting that the mean score might rank first in the world. (Roy, 2011) Preston and Ho also pointed out in

their recent study in 2009 that the U.S has shown significantly faster declines in mortality from prostate cancer and breast cancer than comparison countries, and they concluded that the low life expectancy ranking of the U.S does not seem to be a result of a poorly functioning health care system. (Preston and Ho, 2009)

The recent study on the 2010 global burden of disease (GBD) led by WHO in 2012 also pointed out that global disease patterns affecting mortalities and disabilities are very different by regions and countries, and to obtain public health policy implications, studies on different risk factors by regions and countries also should be addressed more in the future. (Murray at al., 2012)

In this context, to obtain useful and robust policy evidence to determine predictors and risk factors that affect the variations of health outcomes like life expectancy, mortality rates, and QALYs (Quality Adjusted Life Years), country specific comparative studies should be highlighted. Since health outcomes can be affected by many different socio-economic factors like ethnicity, natural environments, dietary culture, the education system, health expenditures, and healthcare insurance systems, etc., comparative studies among different subgroups like local communities and races in a country or across different time periods in a country might be very useful to find robust predictors that affect the

level of health outcomes after taking into consideration many confounding factors which is not possible or is difficult in a cross country level study.

For example, in the U.S, many previous studies have shown that the life expectancy gap between the highest and lowest local counties is about 18.4 years for men and 14.3 years for women, with even larger disparities for race-county combinations; smoking and high blood pressure can explain some of the life expectancy disparities among different races and counties in the U.S. (Daniel et al., 2010). In the case of Australia, the increase of the smoking population resulted in large increases of mortality rates from lung cancer, heart disease, and respiratory diseases. In fact, these increases of the mortality rate affected life expectancy negatively, especially in the 1960s. (Australian Institute of Health and Welfare, 2012)

Even in cancer care, a lot of recent research studies have pointed out that health-related factors including cancer prevention, early detection, and coordination of suitable and timely cancer care, are very important to improve the efficiency of cancer treatment. (IARC, 2008; Yip et al., 2012; Sharma et al., 2011) In Korea, cases of unnecessary use of high priced screens, treatments, and

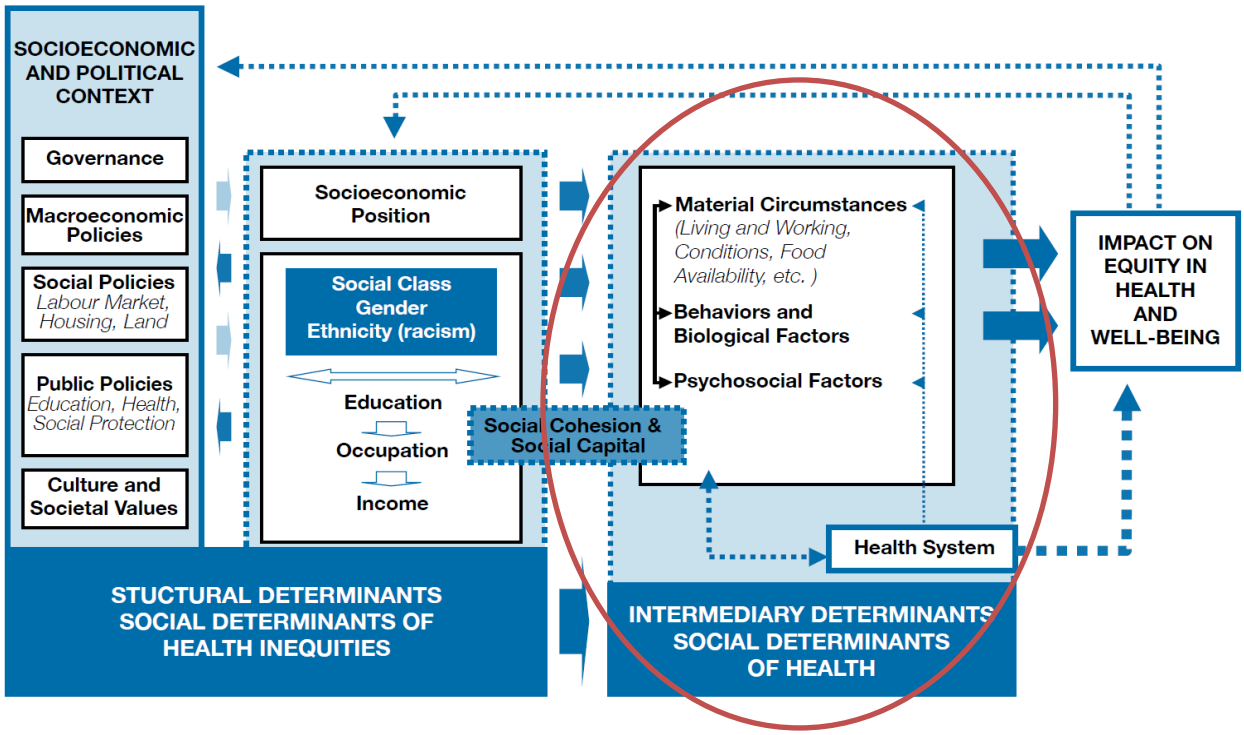
services have also been reported recently and this might result in the lower value of health services.

Moreover, the WHO has recently developed a conceptual framework of the social determinants of health, and according to the framework, health outcomes can be influenced and differentiated by many socio-economic and political contextual factors. (Figure 8) Especially, the comprehensive intermediary determinants of health, including material circumstances like neighborhood, social environmental factors like stress, behavioral and biological factors like smoking, and the health system play an important role in shaping the different health outcomes and their regional variations. (WHO, 2010, p.36-41) This framework will be very useful for highlighting the influences of the comprehensive intermediary health determinants which can affect more directly the variations of local health outcomes and the value of HS in Korea.

"America's Health Rankings" which started in 1990 to provide the state-by-state analysis of United States' health status and the factors that affect it, has provided a comprehensive framework of health determinants and health outcomes; health outcomes are understood as the result of our behaviors, the environment, policies and practices of our health care, governments, and other

prevention systems, and the clinical care we receive. As an important aspect of health outcomes, the authors have included premature death and in that sense they have used the sum of years of life lost due to death before age 75 which is the Centers for Disease Control and Prevention (CDC)'s Years of Potential Life Lost (YPLL-75) methodology. (United Health Foundation, 2012)

Figure 8. The Conceptual Framework of Social Determinants of Health



(Source: WHO, 2010. P.6)

2.3. Studies on the Value of Healthcare Services

Generally speaking, the definition of value in healthcare is considered as "the health outcomes achieved or gained per dollar spent." (Porter, 2010) Usually measuring value means assessing healthcare outcomes and healthcare costs jointly at the same time. (KPMG, 2013) (Figure 9) Many economists and agencies have made major efforts to understand the concept of efficiency[6] in economics under "the value equation (or quality/cost)" in the healthcare area since the achievement of greater efficiency under the given scarce resources would be a high priority in healthcare services as well. Cost-Effectiveness Studies are also recognized as one of these efforts and recently "person-centered outcomes" are becoming major directions to improve the definition of efficiency. (Burgess, 2012) Many studies of the different levels of value or efficiency in different healthcare settings have been performed at the country, community and individual levels.

Overall, many studies on the regional variations of health outcomes and

[6] Efficiency is defined as three dimensions – technical, productive, and allocative. The technical efficiency measures simply examine the relation between health outcomes and resource inputs. The productive efficiency means "the maximization of health outcomes for a given cost," or "the minimization of cost for a given outcome." And so the productive efficiency refers to "the relative value for money of interventions with directly comparable outcomes." The allocative efficiency measures the allocation of resources to maximize the welfare of the community or region. (Palmer & Torgerson, 1999)

healthcare spending have highlighted that a large part of variations in health care expenditures and outcomes can be linked to the variations in health determinants including behavioral and biological factors, community environment, and medical practices and utilization, and these variations have been tackled to improve value and equity of healthcare services as well.

In the U.S, although the methodologies of Cost-Effectiveness Analyses (CEA) on the individual medical interventions were developed in the mid 1990's, due to their private sector led health insurance systems, CEA studies have provided only general guidelines on which interventions might generally be preferable (Muennig, 2008, p.11). But many studies on the regional variations of Medicare spending have concluded that patients in high-cost areas often receive more expensive care which was not associated with more effective health care services and better health outcomes. Specifically, the lower-cost areas were using more efficient healthcare like programs to prevent or control smoking, and more effective preventive and follow-up services. Now these issues are requiring not only value studies on specific treatments, but also studies on what makes health care systems higher value and more broadly successful (Wennberg et al, 2002; Weinstein, 2010).

A study on the value of medical spending in the U.S. from 1960 to 2000, concluded that the increased spending on medical services since 1960 has resulted in reasonable increases in life expectancy on average, but for the elderly they showed somewhat higher cost per year of life gained. (Cutler et al., 2006) Recently, McKinsey & Company also concluded that the United States could save 300 to 450 billion dollars among total health expenditures by improving the health care services based on better preventive and more customized care if the country more fully utilized health-related "big data" on health care services and medical development. (McKinsey & Co., 2013)

Moreover, some studies have also addressed whether regional variations in health expenditures, whether or not they result in better health outcomes and satisfaction with care, can be explained by the more "inpatient-based" and "specialist-oriented" patterns of care which are observed in high-cost areas. (Fisher et al, 2003)

According to a study result from the famous Dartmouth Atlas Project in 2009, higher Medicare spending regions have more hospital beds, more physicians overall, and more specialists per capita, more hospitalizations, more time in the ICU, more physician visits, and more diagnostic tests, while high

spending didn't lead to better access to health care or better quality of care. They concluded that hospitals and physicians have been incentivized through expanding capacity and providing additional procedures by specialists, and patients with more physicians and treatments have higher possibilities of more medical errors and unnecessary procedures. (Fisher et al, 2009)

All these study results have suggested that healthcare reform efforts to achieve higher value healthcare systems should be highlighted continuously.

In the UK, with their National Health Service (NHS) system, they have also addressed the evaluation issue at the health care system level like interregional comparisons of health performance, as well as at the micro-economic evaluation level like CEA of specific treatments. Recently they have recognized that regional variations in healthcare outcomes and expenditures have happened widely although the individual cost-effectiveness of high priced treatments and pharmaceutical medicines have been tested by the NHS for a long time;, therefore more attention has been paid recently on the value of non-pharmaceutical interventions and innovations in the local health care delivery system (Smith & Laudicella, 2011; Sculpher, 2011).

Regarding the future health care strategy, the department of health in the

UK is recognizing that the analysis and comparisons of the variations among regions and hospitals might be well utilized to improve health outcomes by facilitating better health care practices at the local community level like earlier diagnosis and transforming inpatient care.

Moreover, in their recent (2010) white paper – "Healthy Lives, Healthy People: Our strategy for public health in England," they suggested a new public health strategy to address the wider determinants of health including mental health, tobacco control, obesity, sexual health, pandemic flu preparedness, health protection and emergency preparedness at the local community level in order to focus on more personalized and preventive services that are associated with the achievement of the best health outcomes. But still there might be many future issues that will need to be considered as part of the NHS Outcomes Framework and relevant data production. (Department of Health, 2011)

In the health economics perspective, issues on the global burden of disease have been widely addressed. Very recently, the global burden of disease (GBD) 2010 study results for 291 diseases and injuries in 21 regions globally were released based on a disability-adjusted life-years (DALYs) methodology which was based on their first 1990 study. They calculated the sum of years of life lost

(YLLs) based on the remaining life expectancy per death at each age which represented the sum of premature deaths, and calculated years lived with disabilities (YLDs) based on the mean duration of each non-fatal illness or impairment phase multiplied by disability weights for each health state.[7] They estimated that 2,490 billion years of healthy life were lost globally in 2010, and this was slightly up from the 1990's result (2,503 billion). They interpreted that GBD has continued to shift away from communicable to non-communicable diseases. (Murray at al, 2012). But in the case of the DALY study, people with different nationalities and cultures might have different perceptions of disabilities and suffering. Therefore the adaptation of disability weights has limitations in cross-country level comparisons. (Muennig, 2008, p.34)[8]

Economic "costs" of diseases also were analyzed. For example, in 2009 the global economic costs of cancer were analyzed based on new global cancer incidence and average treatment costs per case including medical costs, non-

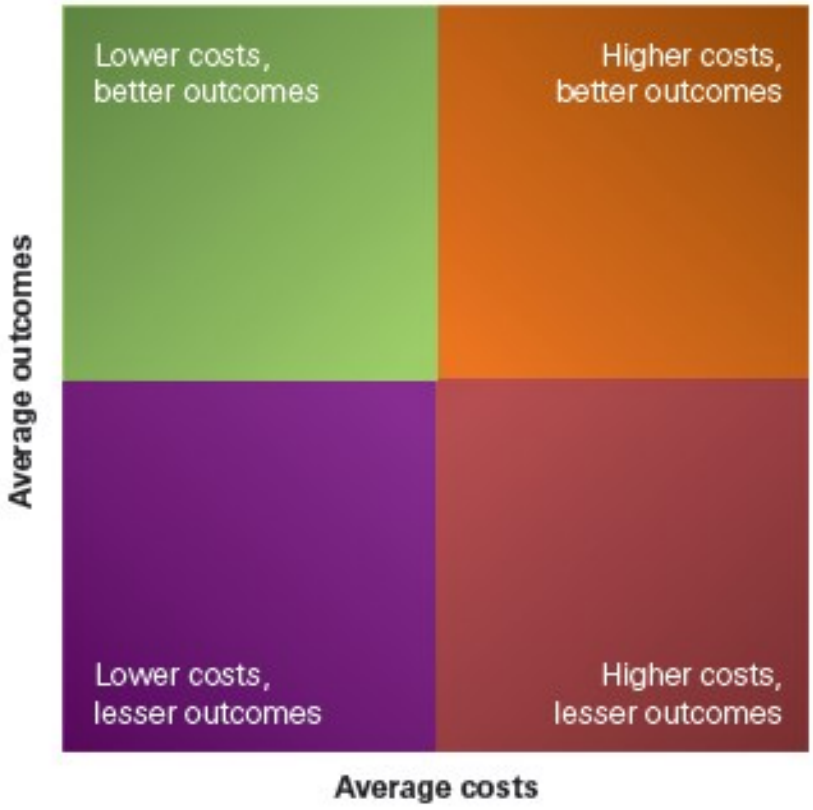
[7] Based on the DALYs methodology, a generalized CEA for national-level priority-setting in the health sector, namely WHO-CHOICE, was developed in 2003. Here, the DALYs methodology has been used to compare the effects of different interventions for leading causes of certain diseases in the specific context of individual countries. (Hutubessy et al, 2003)

[8] The global burden of cancer study results also vary by the research methodology. In the case of the Economist study based on "economic costs" of new cancer cases, they estimated US$305bn in 2009. In the global economic cost of cancer by the American Cancer Society and Livestrong in 2010 based on the economic impact of premature death and disability (DALYs) from cancer, they estimated US$895bn in 2008. (Economist, 2009; American Cancer Society, 2010)

medical costs, and productivity losses. In this study, the cancer treatment expenditure gaps between countries were calculated based on the gaps between each country's cancer case fatality rate and the global lowest cancer case fatality rate (Economist Intelligence Unit and Livestrong, 2009).

According to the International Monetary Fund's recent broad study on the efficiency of health expenditures, they pointed out that most previous cross-country level studies measuring the efficiency of health spending did not control for the various socioeconomic factors that influence health outcomes. In their new study, after controlling for some socioeconomic factors like educational achievement and urbanization, they found that African economies have the lowest efficiency and these economies could increase life expectancy up to nearly 5 years by just improving the efficiency or value of health expenditures. (Grigoli & Kapsoli, 2013)

Figure 9. Value Matrix: 4 quadrants



(Source: KPMG, 2013. P.6)

2.4. Korea's Studies on the Value of Healthcare Services

In Korea, due to the somewhat short NHI history, the first CEA methodology was introduced to evaluate new pharmaceutical drugs for NHI reimbursement as an evidence-based decision making methodology in the Korean health care system in 2007. Starting in 2008, the re-evaluations of already listed drugs in the NHI reimbursement list have been implemented, and in December 2011, the guidelines on CEA of pharmaceutical drugs were initiated by the HIRA.

Recently, the new National Evidence-based Healthcare Collaborating Agency (NECA) has been set up since 2009 under the MOHW, and the scope of economic analysis on health care has been expanded gradually. In 2010, the National Strategic Coordinating Center for Clinical Research (NSCR) was newly established under NECA by MOHW, and the Committee for New Health Technology Assessment (CNHTA) and the supporting center moved to NECA from HIRA at this point. (www.neca.re.kr)

Related to the study on the economic analysis of the burden of disease in Korea, DALYs based on 2002 data were analyzed in 2007 and the study results showed that diabetes mellitus was the leading cause of the burden of disease

(970 DALYs per 100,000 population) followed by cerebrovascular disease (937 DALYs) and asthma (709 DALYs) which were different from the leading causes of the burden of disease globally. In 2009, the study of DALYs of non-communicable diseases (NCD) using 2007 data showed that cirrhosis of the liver in males and cerebrovascular disease in females became the biggest causes of the burden of disease in Korea. But further improvement of the DALYs methodology is needed, and future studies combining cost-effectiveness analysis with burden of disease studies have been proposed for better health resource allocation (Oh et al., 2011).

As a study of the economic costs of disease, the economic burden of cancer using 2005 data was analyzed in 2009 which was a major study on the burden of cancer in Korea. In this study, the burden was divided into direct costs and indirect costs. Direct costs included medical and non-medical costs, and indirect costs included morbidity, mortality, and the caregiver's time costs (Kim et al, 2009) This study's methodology was utilized in the global costs of cancer study by the Economist in 2009 as we discussed before.

In 2011, the study on the impact evaluation of the change in medical services before and after the enhancement of NHI coverage of cancer treatment

was performed by the NECA since the NHI expanded the coverage of cancer patients including the reduction of patient out of pocket payment from 20% to 10% in 2005, and the reduction of patient out of pocket payment for inpatient and outpatient treatment from 10% to 5% in 2009. In this study, the survival rate for one year increased gradually from 66.46% in 2006 to 83.06% in 2010 among the patients who received a lung cancer operation only, and from 44.61% to 51.47% among the patients who received lung cancer chemotherapy only. (NECA, 2011)

In the case of comparative studies of regional health care services, the regional disparities of health care services among local provinces have been focused on since the NHIC started producing their regional health services statistics for 2006 in 2008. In 2010, related to the regional cancer care services, the disparities of cancer care resources between Seoul metropolitan areas and other areas, and somewhat big differences of death rates between cancer patients treated in the Seoul metropolitan area and in other areas were highlighted (NHIC, 2010). In 2012, the regional health care system approach to analyze the disparities in regional health care services was also recommended by the Korea Institute for Health and Social Affairs (KIHSA) for future health studies in Korea. This study suggested that the regional health care system approach based on WHO's conceptual framework on the Social Determinants of Health can help

define in the future the various regional determinants that generate differences and inequities in health outcomes. (KIHSA, 2012)

2.5. Conclusions and Implications

Under the framework of the social determinants of health, studies on the value of HS at the local community level might be very useful rather than the traditional CEA on a single health technology or medicine. Since the traditional CEA of a treatment focuses on the improvement of individual health utilities in the standardized clinical setting without considering various determinants of health outcomes, it is somewhat difficult to capture the real influences of various health determinants which are affecting health outcomes in the real world setting.

For example, the value of A treatment for patients in the B community and patients in the C community could be different in the real world setting due to the different levels of health determinants in each community. The value of HS approach at the local community level in this study would be more useful to address these health determinants in the real world setting, and can highlight the relationships between the value of HS and the health determinants.

In this regard, this study is important to define some health related factors in terms of the social determinants of health including health circumstances, behaviors and health systems which might be positively and strongly influencing lower premature death and better outcomes or higher values for healthcare in

the local community. This can help health policy makers in Korea to design better health care policies that take into consideration the various health determinants related to lower premature death under the given NHI system. It can also help improve "the value for money" within the given health care expenditure level, considering the future fiscal constraints and aging population problem in South Korea.

Chapter 3: METHODS

3.1. Research Questions and Hypotheses

Basically it is assumed that the recent National Health Insurance Health Expenditures (NHI HE) increase focusing on 4 severe disease categories in Korea might have contributed to lowering premature death which could be beneficial to help address the problem of a fast aging population in Korea. But it is not certain that the contributions have had widely reasonable value at the local community level and how much variation among communities has been produced.

In this context, the first research question in this study is "whether the NHI HE increases in Korea are associated with lowering premature death, and which local communities in Korea had the highest or poorest value of healthcare services in terms of premature death health outcomes?" The value of HS might vary by local communities although their health insurance policies of NHI and prices of individual healthcare services under NHI are the same in all 231 local communities in Korea. Even though the levels of NHI health care coverage and out-of-pocket costs are the same, the utilization of health care practices in the

actual health care settings might be different, and the various regional health circumstances and health behaviors can also affect the health outcomes in the local communities.

Secondly, these variations in the value of HS at the local community level can be examined based on the different determinants of health in the local communities. In this regard, the second research question is "which determinants of health in terms of health circumstances, health behaviors and health systems might positively or negatively be related to higher value of HS and better health outcomes at the local community level?" Here it is assumed that well-managed health risk factors and efficient health resource utilization in the local communities will positively increase the NHI HE's effect on premature death which means higher value of local HS and better health outcomes-- which is lower premature death- under the given NHI HE and health system. For example, a relatively lower smoking rate, lower obesity rate, and lower stress rate in a certain local community can be positively related to a higher value of HS in that community. Also efficient health utilization in terms of beds, physicians, and inpatient admissions and stays in a certain community can result in lower expenses of HS than in the communities with relatively excessive health utilization.

From this second question, this study will determine which health related factors and determinants can improve the value of HS and health outcomes in the local communities under the given NHI HE and Korean health care system.

Table 3-1. Main Study Hypothesis

	Hypothesis
1) The Effects of NHI HE on Premature Death	- The recent NHI HE increase focusing on 4 severe disease categories in Korea might have effectively contributed to lowering premature death, but the Value of HS would vary among regions - In the case of certain regions like Seoul Metropolitan Area, the Value of HS might be different from other regions (Non-Seoul Metropolitan Area)
2) The Modification of NHI HE effects on Premature Death by Local Health Determinants	- Well managed Health Risk Factors at the local community level might be positively related to lowering Premature Death or the Value of HS - NHI HE effects on Premature Death - Relatively higher health utilization in terms of physicians, inpatient stays, and high-priced medical equipment might be negatively related to the Value of HS in terms of NHI HE effects on Premature Death

3. 2. Conceptual framework

As a first step, this study will construct two conceptual frameworks to help analyze the relationships between the Value of HS and health determinants in the local communities.

First, a conceptual framework on how to measure local health outcomes in terms of premature death and the value of HS at the local community level (meso level) can be designed by using the concept of measuring value which is integrating the cost data and the health outcome data at the local community level. This local health outcome framework can be different from the country level comparison model which is used to compare the cost or the burden of disease at the cross-country level (macro level model), and the individual intervention level CEA model which is used to analyze the CE of new treatments or medicines in the clinical or experimental setting (micro level model).

Second, the local determinants of health outcome framework can be constructed based on the WHO's conceptual framework of the social determinants of health (SDH) reviewed in the previous chapter. Considering the study needs for a comprehensive analysis between health outcomes and various health determinants in Korea, this study framework will focus on the influences

of intermediary determinants in the SDH framework.[9] Based on this simplified SDH framework, I will highlight the fact that better health circumstances, better health behaviors with better preventive care, and better health utilization and resource allocation in the local community are very important and influential in the real health care settings to improve the value of HS and so to ensure value for money and greater efficiency in the local health care system.

3-2-1) Local Health Outcomes and Value of HS (Meso level approach)

To measure the health outcomes at the local community level in terms of Value of HS, various conceptual frameworks on regional health outcomes can be defined. According to the America's Health Ranking framework reviewed in Chapter 2, the health outcomes represent the result of what has already occurred in terms of people's health in the communities and the regions, and they categorized 10 indicators as components of health outcomes in their framework.

First, as core components of health outcomes, they used 8 indicators –

[9] The WHO's SDH framework includes a broader range of SDH including Structural Determinants like political context and socioeconomic position, and these structural determinants can influence the intermediary determinants of health. The relationship between the structural determinants and the intermediary determinants of health (IDH) will not be covered here, and can be performed by building on this study's results on IDH in the future.

Diabetes, Poor Mental Health Days, Poor Physical Health Days, Geographic Disparity, Infant Mortality, Premature Death, Cancer Deaths, and Cardiovascular Deaths. Second, as supplemental components of health outcomes, they used 2 indicators – Health Status and Suicide[10].

After considering which of these indicators are most related to the local health outcomes in Korea, this study will focus on "premature deaths" as the core component of "the overall health outcomes in the local communities"[11], since this variable can capture the total burden of premature deaths in each community as the number of years of life lost and controlling premature deaths should be one of the most important health policy agendas under the current fast aging population in Korea as we discussed previously. This indicator can also well represent the overall community health performance in economic terms and can be defined as the sum of years of life lost.

As another core component of the health outcomes for "specific disease categories", I want to focus on "deaths due to cancers and suicide" considering that these causes of death have recently been recognized as major and important

[10] http://www.americashealthrankings.org/About/SummaryDescriptionofallMeasures

[11] As we discussed previously, this premature death concept is also used in "DALY analysis" as a core component.

causes of death in Korea. Also these two specific causes of death can represent well the performance of various and important forms of healthcare services at the local community level like inpatient care and mental healthcare services.

Moreover, since higher cost sharing for the same health outcomes is not desirable in terms of efficiency considering the economic perspective and fiscal constraints, here we can define the local health outcomes together with the concept of costs invested for the population's health at the community level. In this context, we can use the value of HS concept to evaluate the local healthcare services under NHI system. As an example, in a CEA, analysts compare the incremental cost per QALY gained (Quality Adjusted Life Years) between different medical interventions (Muennig, p.12-14). But in the case of the overall health outcomes at the local community level, we need a broader value concept for the health of the entire population in the communities which will address the public health policy needs in the specific Korean context.

3-2-2-1) Value of HS for the Overall Community Health

To measure overall health outcomes of the population at the local community level in Korea, the overall premature death of the community

population can be the primary indicator. According to the America's Health ranking framework, "premature death measures the sum of years of life lost due to death before age 75 as defined by the CDC's Years of Potential Life Lost (YPLL-75) framework, and it can be expressed by the sum of years of potential life lost (YPLLs) per 100,000 standardized population"[12]. This methodology can be used in this study as well. In terms of the value of the HS concept, this premature death measure can be combined with the total health care expenditures paid for the overall healthcare services in the local communities during the same period.

First, based on the YPLL-75 methodology, the sums of years of potential life lost (YPLLs) in 231 local communities due to all causes of death can be calculated in 2007 and in 2012. The incremental differences between 2007 and 2012 in the 231 communities' YPLLs can be the denominator in this value equation. In the case of YPLLs, lower values would mean a better health outcome since higher YPLLs mean more and earlier deaths in the selected community. And so the denominator will be calculated as the change in the averted YPLLs from 2007 to 2012 which are the YPLLs in 2007 subtracting the

[12] http://www.americashealthrankings.org/About/Definition#Premature Death

YPLLs in 2012. This difference can be interpreted as the degree of improvement (or lack thereof) in YPLLs from 2007 to 2012, where improvement is defined as lower YPLLs in 2012 than in 2007.

Second, the incremental total health expenditures per 100,000 population between 2007 and 2012 for each of the 231 communities can be calculated by using the NHI's total healthcare expenditure data for each community and using this to construct the numerator in this value equation. In this equation, since the value is measured by the amount of expenditure per year of lost life averted, a smaller number will be higher value in terms of shortening YPLLs as well as saving NHI health expenditures.

- **<u>Value of Overall HS</u>**

  : (Total Health Exp $_{2012}$– Total Health Exp $_{2007}$) / (YPLLs $_{2007}$ – YPLLs $_{2012}$)

3-2-2-2) Value of HS for Cancer and Suicide

Considering differences of disease prevalence by local communities, the value of local HS for a specific disease would also be very useful in addition to the value of the overall HS. In this context, among the major 10 causes of death

in Korea, cancer and suicide are appropriate to utilize for this objective.

Using the approach similar to the overall community health outcome, YPLLs and related Health Expenditures per 100,000 population for each cause of death – Cancer and Suicide in 231 communities, can be calculated and used in value equations for each cause-specific health outcome.

- **Value of Cancer Care Services**

  : (Health Exp on Cancer Care $_{2012}$ – Health Exp on Cancer Care $_{2007}$) / (YPLLs due to Cancer $_{2007}$ – YPLLs due to Cancer $_{2012}$)

- **Value of Mental Health Care Services**

  : (Health Exp on Mental Health Care $_{2012}$ – Health Exp on Mental Health Care $_{2007}$) / (YPLLs due to Suicide $_{2007}$ – YPLLs due to Suicide $_{2012}$)

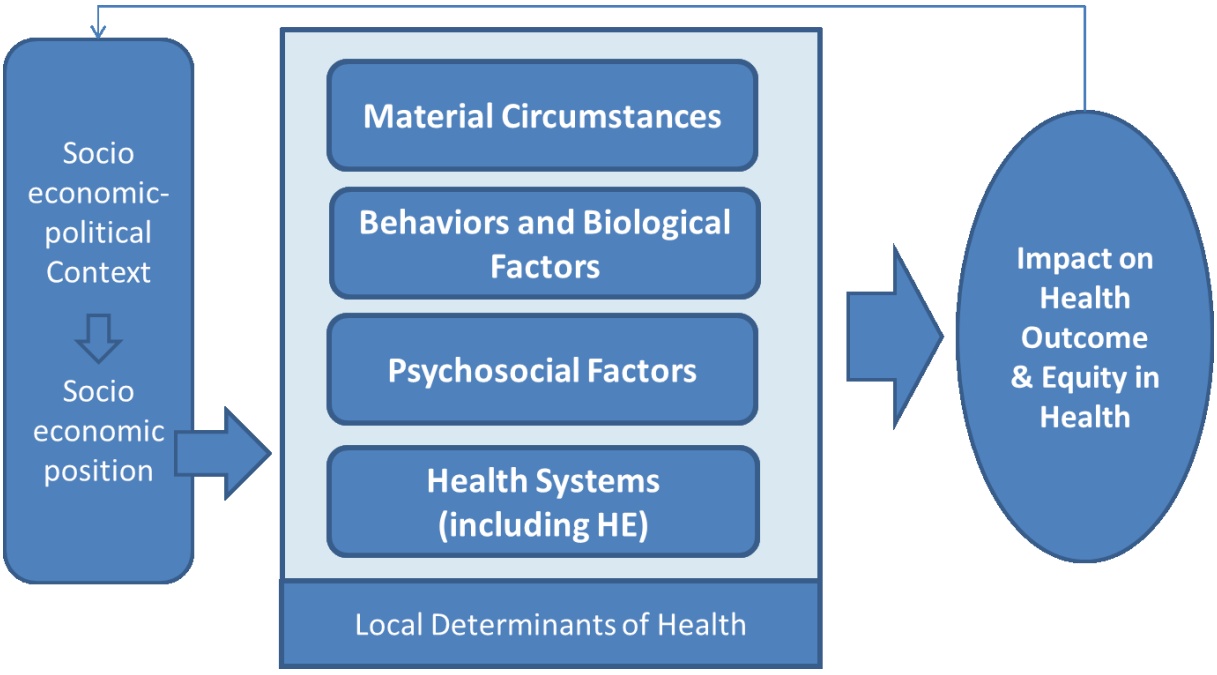
3-2-2) Simplified Local Determinants of Health

Although the Korean NHI provides the same insurance policy for health

care services to all patients in all local communities and patients in every region can get the same benefits for medical treatments and medicines under the NHI system in Korea, the outcomes of health care services might be different among the 231 local communities due to the various local determinants of health outcomes displayed in Figure 9. Since the type and level of the determinants including health circumstances, health behaviors, and health system characteristics like preventive care and efficiency of health services among communities might be different in Korea, the health outcomes and the values of HS in the local communities might be different as well. Here we can suppose that the various determinants of health can affect the health outcomes of the population at the local community level.

Based on this Local Determinants of Health (LDH) framework, the possible causal relationships in the local communities in Korea can be analyzed. From this comprehensive analysis of the various determinants of health and their influences on the local health outcomes and HS values, the direction for the optimization of local health circumstances, individual health behaviors, and health systems for higher value of local health care services in the policy perspective can be analyzed and formulated.

Figure 10. Local Determinants of Health



3.3. Study Design and Sources of Data

This is a retrospective study, and the study population will be all 231 local communities (n = 231) in South Korea. The 231 local communities will be regarded as the analysis and measurement units in this study, and I will mainly analyze how much values are produced by the local NHI healthcare services taking into consideration the given local determinants of health in the communities.

To analyze and compare the variations of local premature death, this study will focus on comparing the value of NHI HS in the 231 local communities based on the local health outcomes and value of HS framework, and analyzing the factors that affect the variations of values in South Korea. In this regard, this study will analyze the possible relationships in terms of value between premature deaths and NHI HE at the local community level, and possible local determinants of health that might affect the variations of the premature deaths and the value of HS among 231 local communities (n=231).

In the results, this analysis will determine which factors might influence fewer premature deaths or a higher value of NHI HS at the local community level in Korea. This might provide some important factors which can be used to

design more effective and efficient health policy in terms of healthcare expenditures and modifiable health determinants at the local community level.

As we see in the Table 3-2, the health expenditures have increased steeply from 2009 due to the coverage expansion focusing on 4 severe disease categories, and related to those treatments, inpatient days and expenditures have increased very steeply as well. According to a recent study done by NHIC in 2012, 11.6 trillion KRW was funded for newly expanded coverage from 2005 to 2010, and 25.8% of this was used for the coverage expansion of cancer treatment (Lee at al., 2012). Also according to the recent NHIC annual survey on the NHI coverage rate of total treatment costs, the average coverage rate for all treatments is 63.0%, while the average coverage rate for 4 severe disease treatments is 76.1% (NHIC, 2013).

To evaluate the recent NHI coverage expansion policy focusing on 4 severe disease categories in terms of health outcomes and value of NHI HS, it might be very meaningful to study the health outcomes related to the steep increase of health expenditures in 2009 and 2010. And therefore, I will set up the study period for 5 years from 2007 to 2012, and focus on the changes in the main variables between 2007 and 2012.

Considering the very recent debate on higher coverage expansion for 4 severe diseases among Korean politicians, this study period might also be helpful in assessing how the recent NHI coverage expansion policy focusing on 4 severe disease categories has produced higher value of HS in the perspective of public health policy as we discussed previously.

In order to calculate the value of cancer care services, we considered incidence rates by cancer site, total NHI payments, treated patients, mortality rates, and annual payment growth rates in Korea. The decision made was to focus on five major cancers including stomach cancer, liver cancer, lung cancer, colorectal cancer, and breast cancer. (See Tables 3-3 and 3-4)

All local health care data and statistics were collected from the official health data sources in Korea which included the Korea National Statistics Office (NSO or KoStat), Ministry of Health and Welfare (MOHW), NHIC, National Cancer Information Center (NCIC), and 231 local governments.

Table 3-2. Trends of Health Indicators in Korea (2007 to 2011)

	2007	*2008*	*2009*	*2010*	*2011*
Nominal GDP (trillion won)	975	1,026	1,065	1,173	1,247
*Annual growth (real)		2.3	0.3	6.3	3.7
Population (1,000 persons)	47,820	48,160	48,614	48,907	49,299
Mortality Rate (per 100,000 standardized)	459	439	421	414	398
Mortality Rate by Cancer	127	124	120	119	113
Mortality Rate by Suicide	23.9	24.7	29.1	28.7	28.8
Infant Mortality Rate (per 1,000 persons)	3.8	3.5	3.3	3.5	3.2
Total Fertiliy Rate (persons)	1.25	1.19	1.15	1.23	1.24
Health Expenditure	323,892	348,690	393,390	436,283	462,379
*Annual growth		7.66	12.82	10.9	5.98
Inpatient Expenditure	98,613	108,924	123,880	144,388	154,365
*Annual growth		10.46	13.73	16.56	6.91
Total Inpatient Days	74,980	83,920	92,626	103,638	108,487
*Annual growth		11.92	10.37	11.89	4.68
Over 65 Health Expenditure	91,190	107,371	124,236	141,350	153,768
*Annual growth		17.74%	15.71%	13.78%	8.79%
Health Exp per Capita (KRW)	677,319	724,027	809,218	892,071	937,904
*Annual growth		6.90%	11.77%	10.24%	5.14%
Over 65 Health Exp per Capita (KRW)	2,078,608	2,334,373	2,574,079	2,839,059	2,965,989
*Annual growth		12.30%	10.27%	10.29%	4.47%
Health Exp for Neoplasm(C00-D48)	26,255	33,624	37,703	42,409	46,007
*Annual growth		28.07%	12.13%	12.48%	8.48%
Health Exp for Mental Disease(F00-F99)	9,885	13,095	14,996	17,482	19,711
*Annual growth		32.47%	14.52%	16.58%	12.75%
CPI	2.5	4.7	2.8	3.0	4.0
NHI Treatment Price Increase	2.3	1.94	2.2	2.05	1.64
NHI premium Increase	6.5	6.4	0	4.9	5.9
NHI Annual Profit/Loss	-2,847	13,667	-32	-12,994	6,008
NHI Benefit Policy Rate	64.4	62.0	63.6	62.7	63.0
(Scale: 100,000,000 KRW, %)			(Source: NSO and NHIC Database)		

Table 3-3. Major Cancer Sites and NHI Benefit (NHIC)

Major Cancer Site (ICD-10)	Year	Treated Patients	Visits	Treatment Days	Treatment Amount (1,000 KRW)	NHI Benefit (1,000 KRW)
Stomach(C16)	2009	133,065	2,179,493	11,685,450	423,374,515	380,923,485
	2010	143,505	2,302,637	12,504,687	452,428,854	423,956,873
Liver(C22)	2009	54,334	1,434,200	9,462,484	364,333,664	328,185,849
	2010	58,417	1,517,775	10,734,921	409,253,669	384,329,780
Lung (C33-C34)	2009	54,558	1,694,953	7,100,347	407,033,409	365,921,875
	2010	59,011	1,862,203	7,952,676	459,786,820	431,144,959
Colorectal (C18-C20)	2009	103,679	2,202,427	9,140,397	477,861,186	430,517,250
	2010	113,604	2,409,379	9,895,856	524,226,070	492,362,109
Breast(C50)	2009	93,811	1,805,878	17,958,259	335,677,170	303,120,722
	2010	103,541	2,035,592	20,379,829	403,919,880	379,659,486
Cervix(C53)	2009	29,920	438,612	2,643,327	72,224,286	65,293,964
	2010	30,586	460,172	2,847,821	78,210,326	73,420,428

Table 3-4. Major Cancer Sites and Mortality Rates in Korea (2010)

(National Cancer Info Center, 2012)

Cancer site	Disease Code (ICD-10)	No. of Death (2010)	Proportion (%)	Mortality Rate (per 100,000 persons)
Total	C00-C97	72,046	100.0	144.
Lung	C33-C34	15,623	21.7	31.3
Liver	C22	11,205	15.6	22.5
Stomach	C16	10,032	13.9	20.1
Colorectal	C18-C21	7,701	10.7	15.4
Pancreas	C25	4,306	6.0	8.6
Breast	C50	2,018	2.8	4.0

3.4. Variables and Measures

A number of factors were considered in selecting and measuring all the specific variables for this study in order to increase its credibility and validity. Variable selection was guided by the study objectives to analyze values of HS and their variations by using the local health outcomes of premature death (dependent variables), NHI HEs (main independent variables), and the determinants of health (other independent variables and effect modifiers) based on the study framework. The availability and feasibility of accessing data from the official data sources in the Korean government agencies was also considered.

3-4-1) Dependent Variables (Health Outcomes)

First, to calculate and analyze the value of HS within the overall local health outcome framework, all averted premature deaths (averted YPLLs) before age 75 in 231 local communities between 2007 and 2012 are used as the main dependent variables. The mortality rate data for all age stratifications from 0 to 75 in 231 communities were obtained from the Korea Statistics Agency (KoSTAT) database, and the YPLLs in 231 communities were calculated by using these mortality rate

data for the 231 communities, average Years of Potential Life Lost before age 75 in all age stratifications, and the standardized population in all age stratifications, using 100,000 standardized population in each community. The final YPLL variable was calculated as the total sum of years of potential life lost in all age stratifications per 100,000 standardized population in each community.

Second, with regard to the local health outcome variables of cancers and suicides in the 231 communities, the averted YPLLs by 5 major cancers in Korea including stomach, lung, liver, colorectal, and breast cancers, and suicides between 2007 and 2012 were used as the main secondary dependent variables for specific disease health outcomes in this study.

All of these dependent variables for overall and specific disease health outcomes were compared among the 231 local communities and the variations among the local communities were also analyzed.

3-4-2) Independent Variables

To calculate values of overall HS and specific disease HS based on the local value of HS framework, the change of NHI HE per 100,000 population in each

community between 2007 and 2012 was divided by the incremental change of YPLLs between 2007 and 2012 in the community. Since we consider the averted YPLLs between 2007 and 2012 as the dependent variables, the incremental changes of NHI HEs per 100,000 population in the local communities are the main independent variables and their coefficients can represent the values of HS[13] in the linear regression analysis.

3-4-3) Potential Predictors and Effect Modifiers (Local Determinants of Health)

Assuming that potential health related predictors (health determinants) can not only influence the averted YPLLs (dependent variable) but also modify the influences of incremental NHI HEs (independent variable) on the averted YPLLs[14] in the linear regression model, the health determinants can be defined as effect modifiers of the NHI HEs.

Based on the Local Determinants of Health framework, various health-related predictors including material circumstances, health behaviors, and health

[13] In this case, the values (ΔNHI HEs/ΔYPLLs) will be 1/(coefficients of NHI HEs).
[14] In this case, the values can be bigger or smaller by effect modifiers.

system characteristics can be defined. To test potential relationships between the values of HS and health determinants at the local community level, many indicators related to health environments, health risk factors, and health utilization in the 231 communities have been collected and included from the official data sources.

First, for the material circumstance component, "Rate of Apartment Homes", "Average Community Income", and "Rate of Health and Welfare Budget" are considered. For the indicator of average community income, the average NHI premiums by local communities are used since the individual NHI premiums are mainly decided by individual monthly income.

Second, as variables for the behavioral and biological factors, "rate of smoking in the population", "obesity rate", "rate of hypertension in the population", and "diabetes rate in the population" in each local community have been included.

Third, for the psychosocial circumstances, "stress rate" and "depression rate" are chosen.

Lastly, for the health systems factors, “check-up rate”, “the number of physicians & beds per person”, “average length of stays (LOS) and average hospital visit days per person”, “number of high priced health care equipment (CT & MRI)” in each local community have been included as well. These variables measuring various dimensions of health systems might represent the level of health risk factor management and preventive care, health utilization, and health resource allocation in the local communities.

All of these 1**6** effect modifiers for 231 communities were collected from MOHW and NHIC databases for the analysis, and the level of the variables in certain years or the incremental changes between 2007 and 2012 were included in the analysis. In the case of all behavioral and psychosocial variables, both the levels of 2007 and 2012, and the incremental changes from 2007 to 2012 are analyzed. Here I suppose that some variables didn’t change a lot annually since some variables have the characteristics of “Stock” level data, and therefore they might have threshold effects and the level of certain years might be more important to measure their effects in the analysis.

3-4-4) Control variables

Age and gender can be considered as possible confounding factors. To consider the differences of age and gender distributions among local communities, the rate of people over age 65 and the rate of women among the total population in each local community have been added to the independent variables to control for and adjust for their influences. But since we use 100,000 standardized population in each community to calculate the dependent variable - YPLL, the influence of the possible confounding effects of the age factor might be limited.

Table 3-5. Dependent Variables

Category	**Variables**	**Definitions** (Scale)	**Type**
Overall Healthcare Outcome	Averted YPLLs of All Premature Deaths (Y_1)	The averted sum of years of potential life lost (YPLL) per 100,000 persons (average standard population) due to all deaths in the community between 2007 and 2012 (YPLL Change)	Continuous
Healthcare Outcome for Specific Diseases	Averted YPLLs of Premature Death due to 5 Major Cancers (Y_2)	The averted sum of years of potential life lost (YPLL) per 100,000 persons due to 5 major Cancers(Stomach, River, Lung, Colorectal, Breast) in the community between 2007 and 2012 (YPLL Change)	Continuous
	Averted YPLLs of Premature Death due to Suicide (Y_3)	The averted sum of years of potential life lost (YPLL) per 100,000 persons due to Suicide in the community between 2007 and 2012 (YPLL Change)	Continuous

Table 3-6. Main Independent Variables (NHI HEs)

Category	**Variables**	**Definitions** (Scale)	**Type**
Overall Health Care	Incremental NHI HE for overall health care	Incremental Total NHI Health Expenditures for overall health care services per 100,000 persons in the community between 2007 and 2012 (1 million KRW = about $1,000)	Continuous
Health Care for Specific Diseases	Incremental NHI HE for 5 Major Cancer care	Incremental Total NHI Health Expenditures for 5 Major Cancers (Stomach, Liver, Lung, Colorectal, Breast) care services per 100,000 persons in the community between 2007 and 2012 (1 million KRW)	Continuous
	Incremental NHI HE for Mental Health care	Incremental Total NHI Health Expenditures for Mental Health care services per 100,000 persons in the community between 2007 and 2012 (1 million KRW)	Continuous

Table 3-7. Other Independent Variables (Effect Modifiers) and Control Variables

Determinants	**Variables**	**Definitions** (Scale) *(Data Source)	**Type**
Material Circumstances (3)	Rate of Apartment Homes	Percentage of Apartment Homes among All housing types in 2010 (%) *(NSO)	Continuous
	Average Community Income	Average annual NHI premium in the local community (1,000 KRW) *(NHIC)	Continuous
	Rate of Health & Welfare Budget	Percentage of Local government Health and Welfare budget among total Local Government Budget (%) *(MOHW Budget Report)	Continuous
Behavioral & Biological Factors (4)	Smoking Rate	Percentage of Persons who smoked more than 100 cigarettes and are smoking now(%) *(MOHW Community Health Survey)	Continuous
	Obesity Rate	Percentage of Persons who are over 25 points in BMI (%) *(MOHW Community Health Survey)	Continuous
	Hypertension Rate	Percentage of Hypertension Patients (%) *(MOHW Community Health Survey))	Continuous
	Diabetes Rate	Percentage of Diabetes Patients (%) *(MOHW Community Health Survey)	Continuous
Psychosocial circumstances (2)	Stress Rate	Percentage of High Stressed persons (%) *(MOHW Community Health Survey)	Continuous
	Depression Rate	Percentage of persons who experienced the depression (%) *(MOHW Community Health Survey)	Continuous

*Health systems (7)	Physicians per person	Number of Physicians per 1,000 persons (persons) *(MOHW)	Continuous
	Hospital Beds per person	Number of hospital beds per 1,000 persons (beds) *(MOHW)	Continuous
	Average Length of Stay	Average number of days patients stayed in Hospital (days) *(NHIC)	Continuous
	Average Hospital Visit Days	Average number of days patients visited in Hospital (days) *(NHIC)	Continuous
	Number of High Priced Health care Equipment	Number of high priced health care equipment (CT and MRI) *(NHIC)	Continuous
	Check-up Rate	Percentage of Persons who did more than one check-up annually (%) *(NHIC)	Continuous
	*Normal Result Rate of Check-up	Percentage of Persons who were consulted normal condition among Persons who did more than one check-up annually (%) *(NHIC)	Continuous
* Control Variables	Over 65 people Rate	Percentage of over 65 people to total population (%) *(NSO)	Continuous
	Female Rate	Percentage of women to total population (%) *(NSO)	Continuous

Table 3-8. Results of Data Collection (Univariate Analysis)

Categories/ Determinants	Variables	Range of Data (n = 231)					
		Lowest	25%	50%	75%	Highest	Mean (SD)
Overall Health Outcome (Y)	Averted YPLLs for All Premature Deaths	-5611	447	1042	1809	6691	1131 (1583)
Health Outcome On Specific Disease	Averted YPLLs for Premature Death due to 5 Major Cancers (Y2)	-1087	60	187	283	958	176 (243)
	Averted YPLLs for Premature Death due to Suicide (Y3)	-1382	-204	-72	49	1802	-68 (304)
Overall Health Expenditure (X)	Incremental NHI HE for overall health care	-30195	31796	43931	62524	281492	48698 (27388)
	log(Expenditure)	9.6	10.4	10.7	11.0	12.5	10.7 (0.45)
Health Care for Specific Diseases	Incremental NHI HE for 5 Major Cancer care (X2)	-2185	1545	2102	2723	14174	2174 (1288)
	*Log(Cancer Exp)	6.0	7.4	7.7	7.9	9.6	7.6 (0.46)
	Incremental NHI HE for Mental Health care (X3)	-1753	2149	3301	5633	23272	4212 (2861)
	*Log(Mental Exp)	6.0	7.7	8.1	8.6	10.1	8.2 (0.60)
	Incremental NHI HE for Depression Health care (X3)	-686	42	85	117	672	79 (111)
	*Log(Depress Exp)	-1.6	4.1	4.5	4.8	6.5	4.4 (0.89)
Material Circumstances	Rate of Apartment Homes	0.2	21.2	48.8	65.3	89.9	44.2 (24.8)
	Average Community Income (NHI fee)	170	344	430	627	11717	634 (915)
	Log(NHI fee)	5.1	5.8	6.1	6.4	9.4	6.2

							(0.57)
	Rate of Health & Welfare Budget	4.6	15.5	22.6	35.0	58.9	26.4 (13.1)
	*Log(Budget)	1.5	2.7	3.1	3.6	4.1	3.2 (0.49)
Behavioral & Biological Factors	Smoking Rate	-10.1	-1	1	3	8.8	0.9(3.1)
	Obesity Rate	-11.2	-4.7	-2.5	-0.2	17.7	-2.5(3.4)
	Hypertension Rate	-10.4	-3.8	-2.2	-0.5	4.3	-2.2(2.3)
	Diabetes Rate	-5.4	-1.9	-1	-0.2	3.8	-1.1(1.5)
Psychosocial circumstances	Stress Rate	-20.1	-3.8	0.2	3.7	21.4	0.06(6.3)
	Depression Rate	-9.4	0.7	2.8	5.2	12.9	2.9(3.5)
Health systems	Physicians	0.7	1.5	1.8	2.3	20.6	2.3(2.1)
	*Log(Physician)	-.36	0.41	0.59	0.83	3.03	0.67 (0.47)
	Hospital Beds	0.3	7.2	11.0	15.9	43.9	12.4(7.3)
	*Log(Beds)	-1.2	2.0	2.4	2.8	3.8	2.3 (0.66)
	Average Length of Stay	5.6	6.6	7.0	7.5	9.5	7.1(0.7)
	*log(LOS)	1.7	1.9	1.9	2.0	2.3	2.0 (0.10)
	Average Hospital Visit Days	17.2	20.1	22.7	27.3	36.4	23.9(4.6)
	*log(Visit Days)	2.8	3.0	3.1	3.3	3.6	3.2 (0.18)
	Number of High Priced Health care Equipment	0	2	7	18	102	12.1(14.0)
	*Log(Equipment)	0	1.1	2.1	2.9	4.6	2.0 (1.16)
	Check-up Rate	62.4	69.9	72.4	74.5	81.7	72.2(3.5)
	*Normal Result of Check-up Rate	35.1	43.0	47.0	50.2	58.9	46.6(4.8)
* Control Variables	Over 65 people Rate	5.2	10.0	13.7	22.2	32.6	16.2(7.4)
	Female Rate	44.1	49.2	49.9	50.6	52.5	49.9(1.2)

3.5. Statistical Analysis Plan

3-5-1) Value Analysis and Simple Linear Regression

First, the Values of HS defined as the influences of NHI HEs increases on the averted premature deaths between 2007 and 2012 regarding the three healthcare services – Overall, Cancer care, and Mental Care, were analyzed in 231 local communities based on the local value of HS framework as we've discussed in Chapter 3.

Also, to compare associations and variations regarding the influence of NHI HE increases on the averted premature deaths (YPLLs-75) between 2007 and 2012 based on the value analysis in the three health services – Overall, Cancer Care, and Mental Care, simple linear regression models (n=231 local communities) were constructed separately for the three health services categories, assuming that the relationship between NHI HEs and YPLLs-75 is linear and subject to random error.

The results of value analyses in terms of the value gained per dollar spent were compared with the result of the simple linear regression models as well.

In the regression equation (1) below, β_1 represents the averted years of life lost per increased healthcare expenditure and bigger β_1 means higher value of NHI NE between 2007 and 2012.

Specifically, based on the local determinants of health framework as we've discussed previously, to analyze the influences of various determinants on health outcomes at the local community level, the simple linear regression model should be expanded to the multivariate linear regression model.

(1) averted YPLL-75_i

$$= \alpha + \beta_1 NHI\ HE_i + \varepsilon_i$$

3-5-2) Multivariate Linear Regression and Effect Modification of Local Determinants of Health

Second, to analyze the modifying effect of local determinants of health (LDH) in 231 communities on the value of HS as well as the influences of various determinants on health outcomes at the local community level, Multiple Linear Regression (MLR) models (n = 231 local communities) were constructed with the

various independent variables of the local determinants and the interaction terms.

$$
\begin{aligned}
\text{(2) averted YPLL-75}_i \;=\; & \alpha + \beta_1 NHI\ HE_i + NHI\ HE_i \\
& * \left(\beta_2 \text{Housing}_i + \beta_3 Average\ Community\ Income_i \right. \\
& + \beta_4 Smoking_i + \beta_5 Obesity_i + \beta_6 Hypertension_i \\
& \left. + \beta_7 Diabetes_i + \beta_8 Stress_i + \cdot\ \cdot\ \cdot \right) \\
& + \left(\beta_{17} \text{Housing}_i + \beta_{18} Average\ Community\ Income_i \right. \\
& + \beta_{19} Smoking_i + \beta_{20} Obesity_i + \beta_{21} Hypertension_i \\
& \left. + \beta_{22} Diabetes_i + \beta_{23} Stress_i + \cdot\ \cdot\ \cdot \right) + \beta_{32} Over\ Age\ 65_i \\
& + \beta_{33} Female_i + (\beta_{34} Seoul\ Metro_i) + (\beta_{35} City_i) + \varepsilon_i
\end{aligned}
$$

In this MLR health outcome model, it is assumed that the collection of 16 independent variables and effect modifiers exert an observable and significant influence on the values of HS in all 231 local communities. By using bivariate analyses, all the independent variables (16 potential effect modifiers) were also

tested to select significant independent variables that might have some influences on the averted YPLLs-75 directly at the local community level.[15]

Each independent variable and effect modifier was tested one by one during the process of exploratory analysis, and relevant variables whose modifying effects were somewhat bigger and significant were selected. Multi-collinearities and interactions among selected variables were also checked and the models were redefined through reorganization of selected independent variables and effect modifiers.

More specifically, to analyze the characteristics of communities in certain regions, I also compared the differences between the Seoul metropolitan area (3 provinces) and other areas (13 provinces) [16]. Here I suppose that although Korea is a small country, the characteristics of the Seoul metropolitan area might be somewhat different from other regions since there are somewhat big differences among regions in terms of health system characteristics, health utilization, and health risk management due to the different economic resources and capacities.

[15] In the bivariate analysis, if p-value of independent variable is less than 0.30, the variable will be selected to construct the final MLR model.

[16] 231 communities are located in and divided into 16 provinces in Korea. Among 16 provinces, 3 provinces including Seoul City, In-Cheon City, and Gyoung-Gi Province are called Seoul Metropolitan Area which is the most developed area in Korea.

To examine any association with city or rural region characteristics, the dummy variable on city area was added to the model as well.

Moreover, normality, leverage, influence, and residuals were checked separately and the model was improved through a fitting process and deleting extreme outliers. Both forward and backward selection methods were also used to select the final independent variables and effect modifiers to finalize the MLR health outcome models.

Based on these statistical analyses, several different local health outcome models were defined and in each model, the value of HS and the effects modification of various local determinants of health (effect modifiers) on the values were determined and interpreted based on the statistical significance and coefficients of the independent variables and effect modifiers.

3. 6. Protection of Human Subjects

Legally NHIC and other national health data sources in Korea don't provide any individual identifiers and private health and medical information. But using the de-identified information is allowed by law and so all the information were collected under the form of blinded status which doesn't have an enrollee's real name and identification number.

All information and data in this study were used for statistical analysis purposes only. The School IRB approved that this analysis is not human subjects research because this thesis is based on secondary data collected by the official agencies in Korea, and there are no data that could identify human subjects directly whose data are included in this study.

Chapter 4: Results

4. 1. Value of HS

The Value of HS in terms of the influence of NHI HEs increases on premature deaths (the averted YPLLs-75) between 2007 and 2012 regarding 3 health care services - overall health care, cancer care, and mental health care services, were calculated and compared in 231 local communities. Here the 2007 NHI health care services would be the baseline cases, and the 2012 NHI health care services would be the comparison cases.

In the traditional cost-effectiveness analysis, if an intervention is less expensive and more effective (improved health outcomes), the intervention is certainly dominant (preferred) compared with the baseline case. If the intervention is more expensive and less effective, it is dominated by the baseline case. If the intervention is more expensive and more effective, it should be decided whether the government is willing to pay the further expense to improve health by using the intervention. (Muennig, 2008, p.30)

Three scatter plots of the values of HS in terms of the association between expenditures and the averted YPLLs from 2007 to 2012 for the three healthcare services, were constructed. Inflation adjusted expenditures based on the consumer price index (CPI) in Korea from 2008 to 2012, were used and I also discounted the YPLLs in 2012 with the annual discount rate as 3% which is usual in the economic analysis design.

In examining the scatter plots (Figure 11, 13, and 15), all the expenditures were increased from the 2007 level except for only 1 or 2 communities which might be outliers. In the case of outcomes (the averted YPLLs-75), the averted YPLLs associated with overall healthcare services in 2012 were increased in 217 communities among 231 (93.9%), the averted YPLLs for cancer care services were increased in 214 communities (92.6%), and the averted YPLLs for mental care services were increased in only 132 communities (57.1%).

If we observe the North-East quadrant of scatter plots, the values of HS (slope of each point from 0-0 point) are plus numbers, but different and various levels among communities. Although there is no specific benchmark value or threshold level of value in the three health care services, it is difficult to divide strong values or weak values in the graphs.

But considering the distributions of values in the cumulative graphs (Figure 12, 14, 16), it is possible to check how strong the values are for the local health services. First, in the case of overall healthcare, most values are between $0 and $250,000 per 1 averted YPLL. Second, in the case of cancer care, most values are between $0 and $40,000 per 1 averted YPLL. Third, in the case of mental care, as over 40% of the communities are located in the North-West quadrant of the scatter plot which means worse outcomes and higher cost and dominated by the 2007 cases, nearly half of the values of HS are getting worse since 2007, and in the case of positive values of mental care, they are between $0 and $300,000 per 1 averted YPLL.

Based on the bootstrapping analysis method (O'Brien & Briggs, 2002), bootstrapped values for the 3 health care services were also constructed with 1000 repeated random samples[17] for each health care service (Figure 17, 18, 19). First, in the scatter plot for overall healthcare (Figure 17), only 62 plots are in the North-West quadrant out of a total of 1000 plots. These are undesirable

[17] These repeated random samples were calculated by using each Mean value and Standard Deviation of increased NHI expenditure and increased YPLLs on 3 health care services in 231 communities.

outcomes[18] (worse outcome and higher cost) since these cases are dominated by the baseline cases in 2007. Among 938 plots, the confidence intervals of the bootstrapped values for overall healthcare services are from 3,787 (2.5%) to 203,075 (97.5%).

Secondly, in the scatter plots for cancer care (Figure 18), there are only 28 plots in the North-West quadrant out of a total of 1000 plots. These represent undesirable outcomes (worse outcome and higher cost) since these cases are dominated by the baseline cases in 2007. Among 972 plots, the confidence intervals of the bootstrapped values in cancer care services are from -78 (2.5%) to 59,546 (97.5%).

Finally, in the scatter plots for mental health care (Figure 19), the 328 plots in the North-West quadrant out of a total of 1000 plots represent worse outcomes and higher cost signifying that these cases are a worse alternative than the baseline cases in 2007. In contrast to the overall and cancer care cases, 32.8% of the bootstrapped values are dominated by the baseline cases in 2007. Therefore,

[18] Instead, the plots in the South-East quadrant show that their minus values are less expensive (the increased NHI expenditures are minus values) and more effective (the averted YPLLs are plus values).

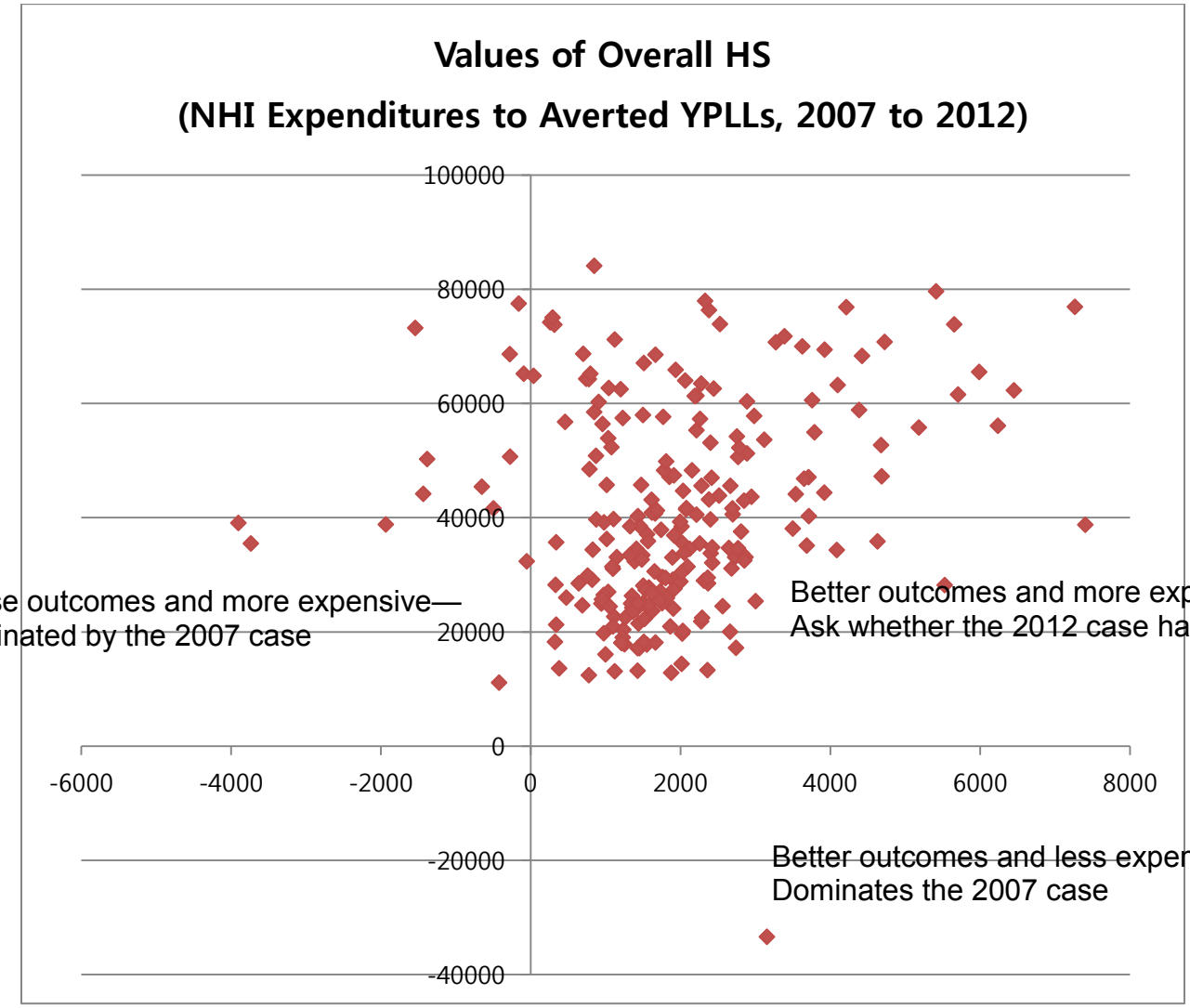
it could not be concluded that the mental health services in 2012 might have higher value compared with the mental health services in 2007.

With these results, in the case of overall health care and cancer care cases, it can be assessed that the NHI healthcare systems in 2012 might have produced higher values compared with the NHI systems in 2007 after NHI expenditure increases. But in the case of mental health care, I cannot assess that the 2012 NHI health care system compared with the 2007 system has or has not produced higher value after NHI expenditure increases, since the range of values are so wide in the study results.

In the next section, based on the value of HS models with the 2 variables here - the increased NHI expenditure and the averted YPLLs-75, simple linear regression models were tested to determine if higher increases of NHI expenditures are associated with greater decreases of YPLLs.

In addition, I constructed and analyzed "multivariate linear regression models" with other health determinants as well as NHI expenditures to find which determinants of health can result in variation of values or better averted YPLLs and higher values in overall healthcare, cancer care, and mental health care at the local community level in Korea.

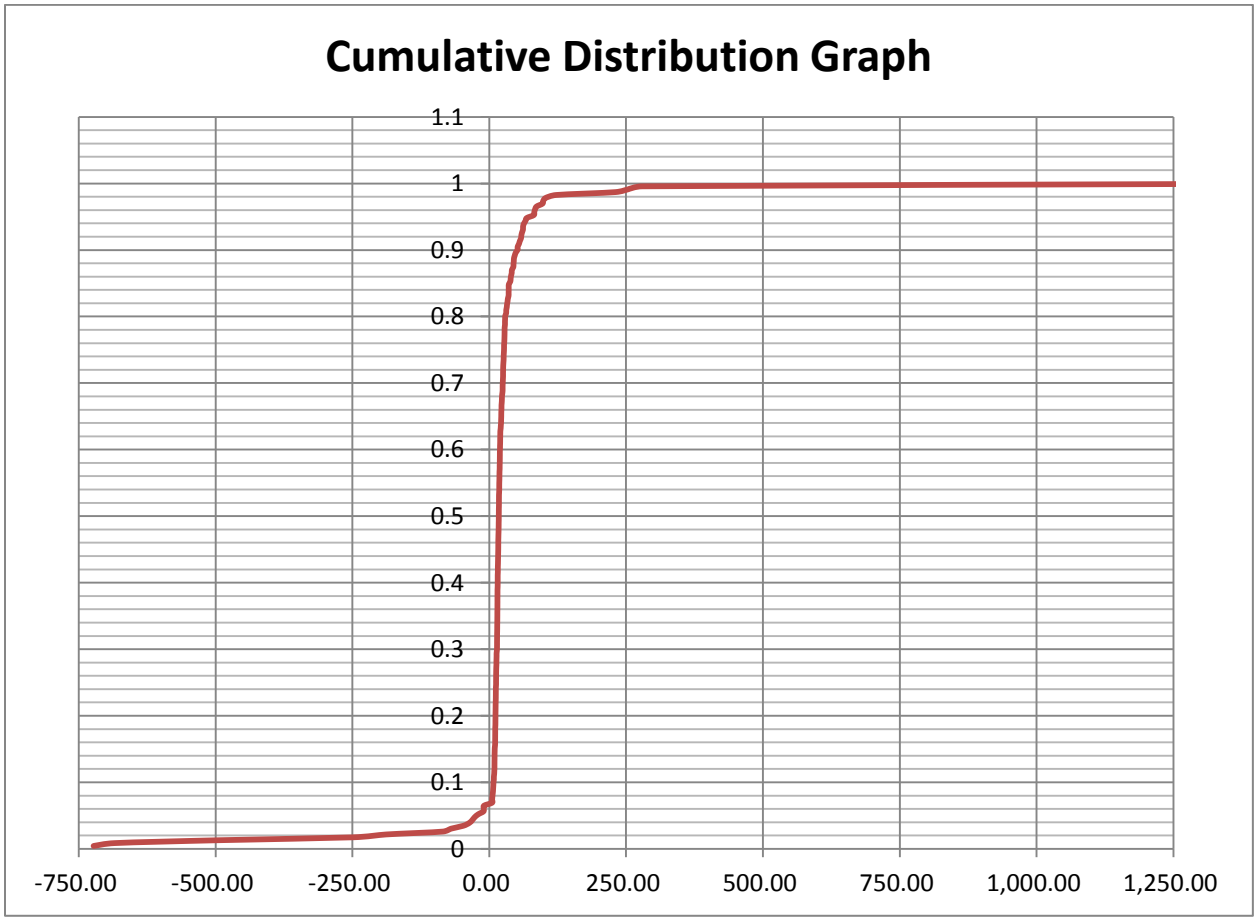
Figure 11. Values of HS in the Overall Healthcare



(1000$, Year)[19]

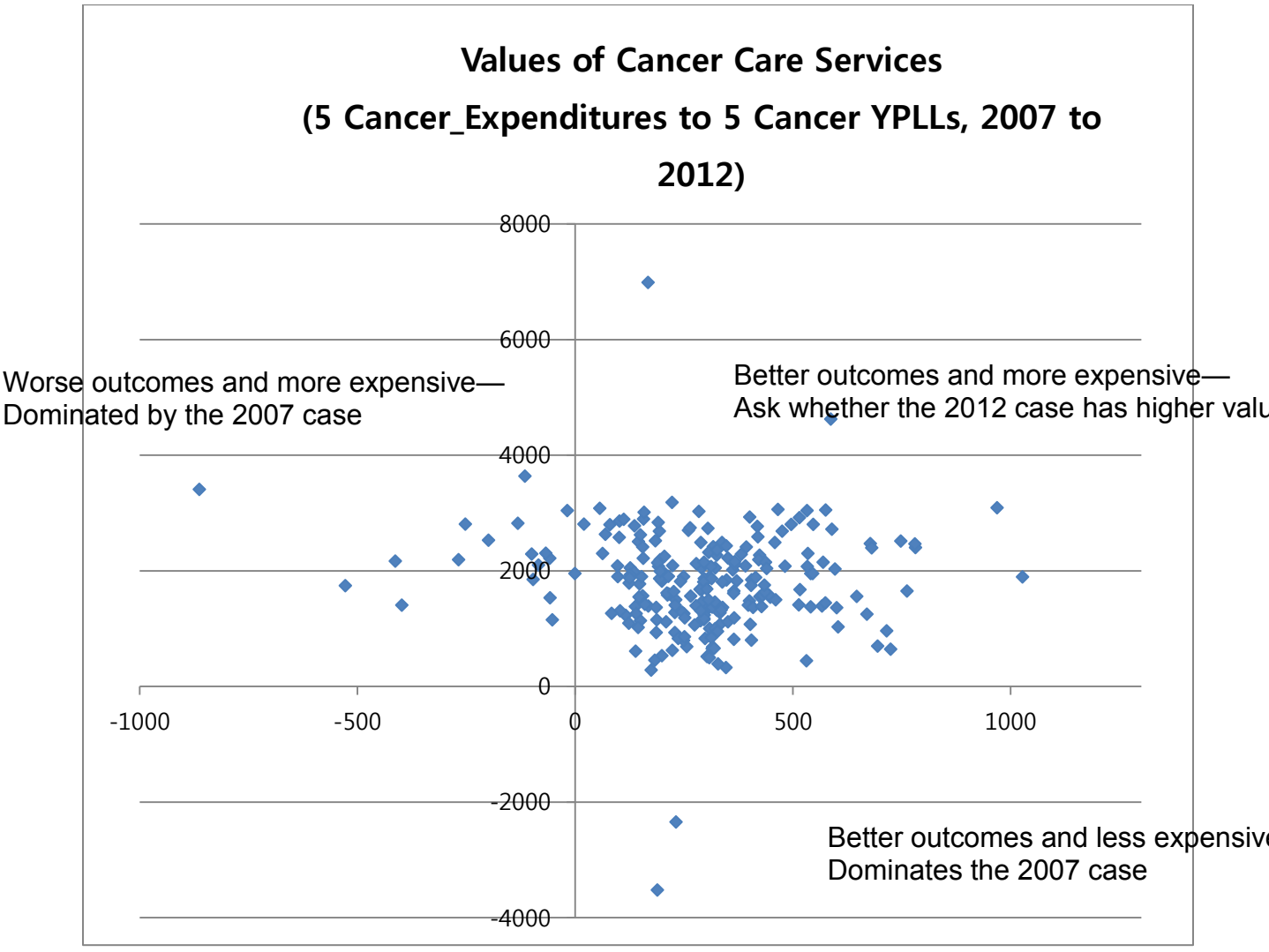
[19] In this scatterplot, the X axis represents the averted YPLLs (outcomes) between 2007 and 2012 per 100,000 standardized population in the communities and the Y axis represents the increased NHI expenditures (cost) between 2007 and 2012 per 100,000 population in the communities.

Figure 12. Cumulative Distribution Graph on Value of Overall Healthcare Services



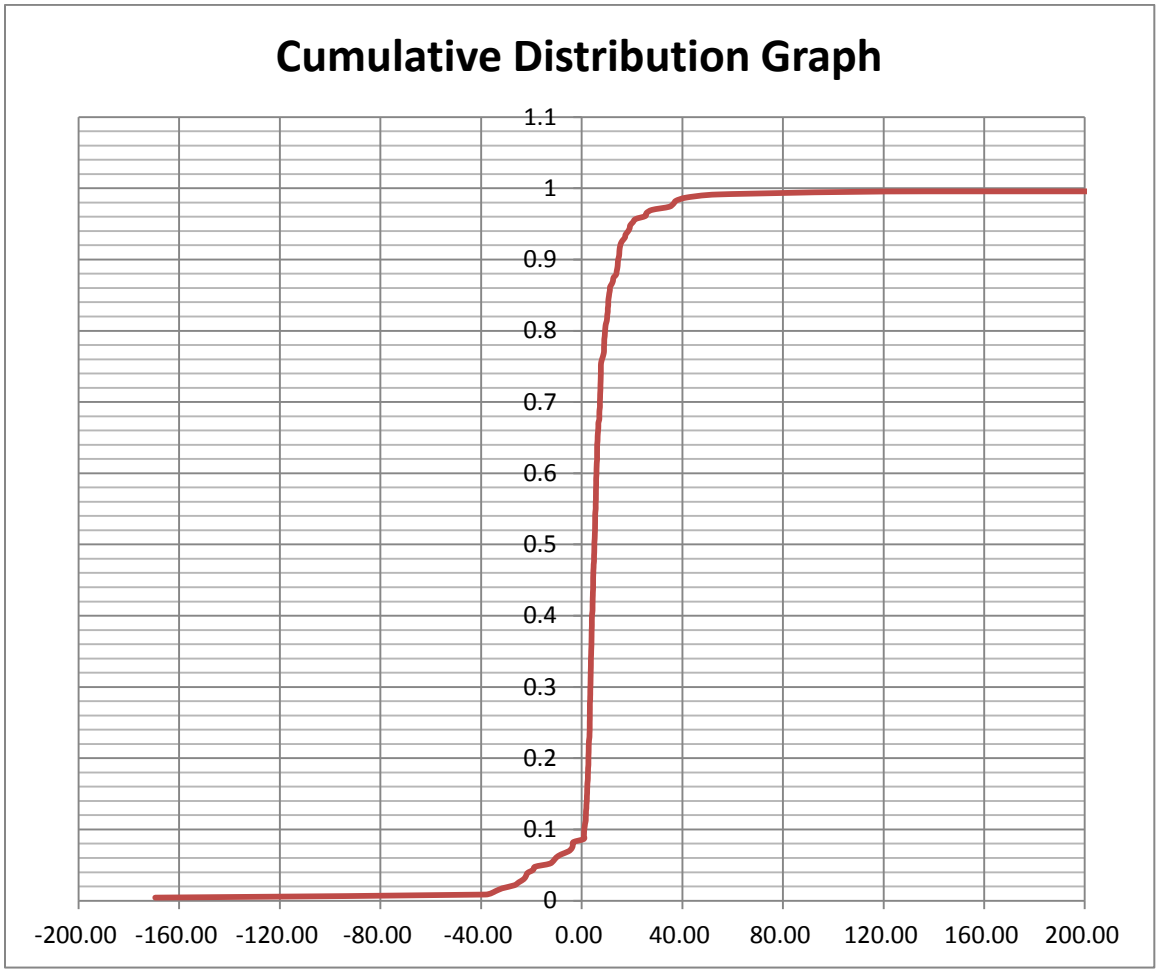
(1000$)

Figure 13. Values of HS for Cancer Care



(1000$, Year)

Figure 14. Cumulative Distribution Graph of Values of Cancer Care Services



(1000$)

Figure 15. Values of HS for Mental Health Care

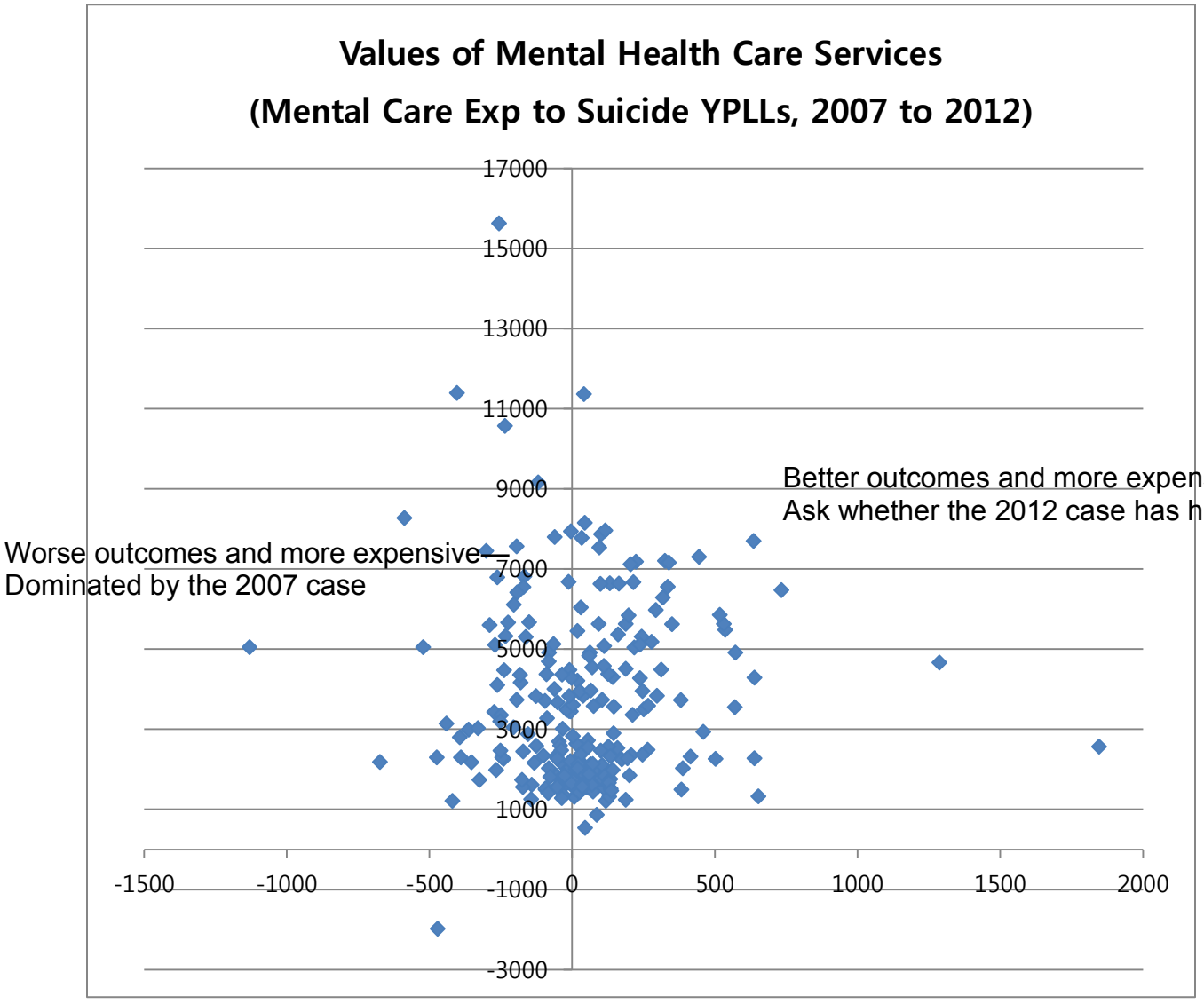
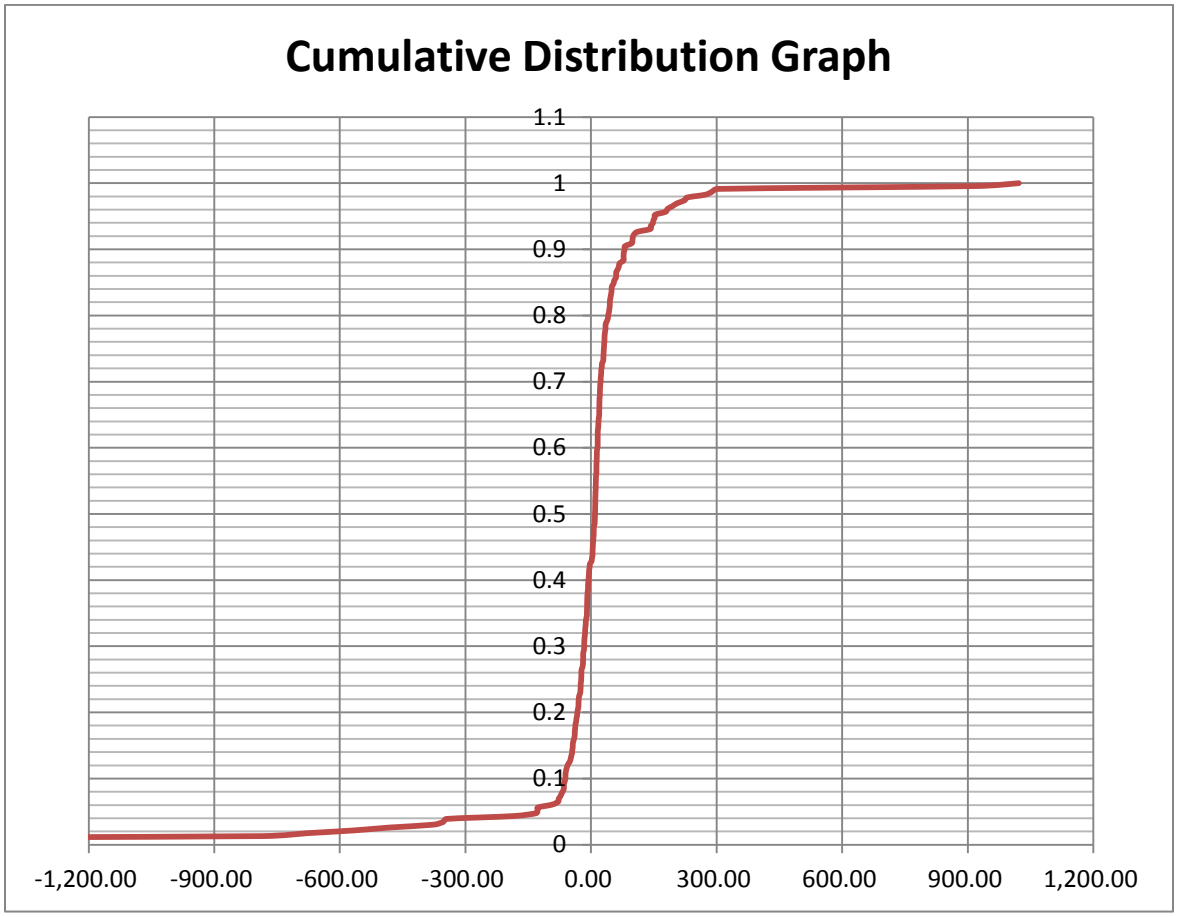


Figure 16. Cumulative Distribution Graph of Values of Mental Health Care Services



(1000$)

Figure 17. Bootstrapped Values of the Overall Healthcare Services

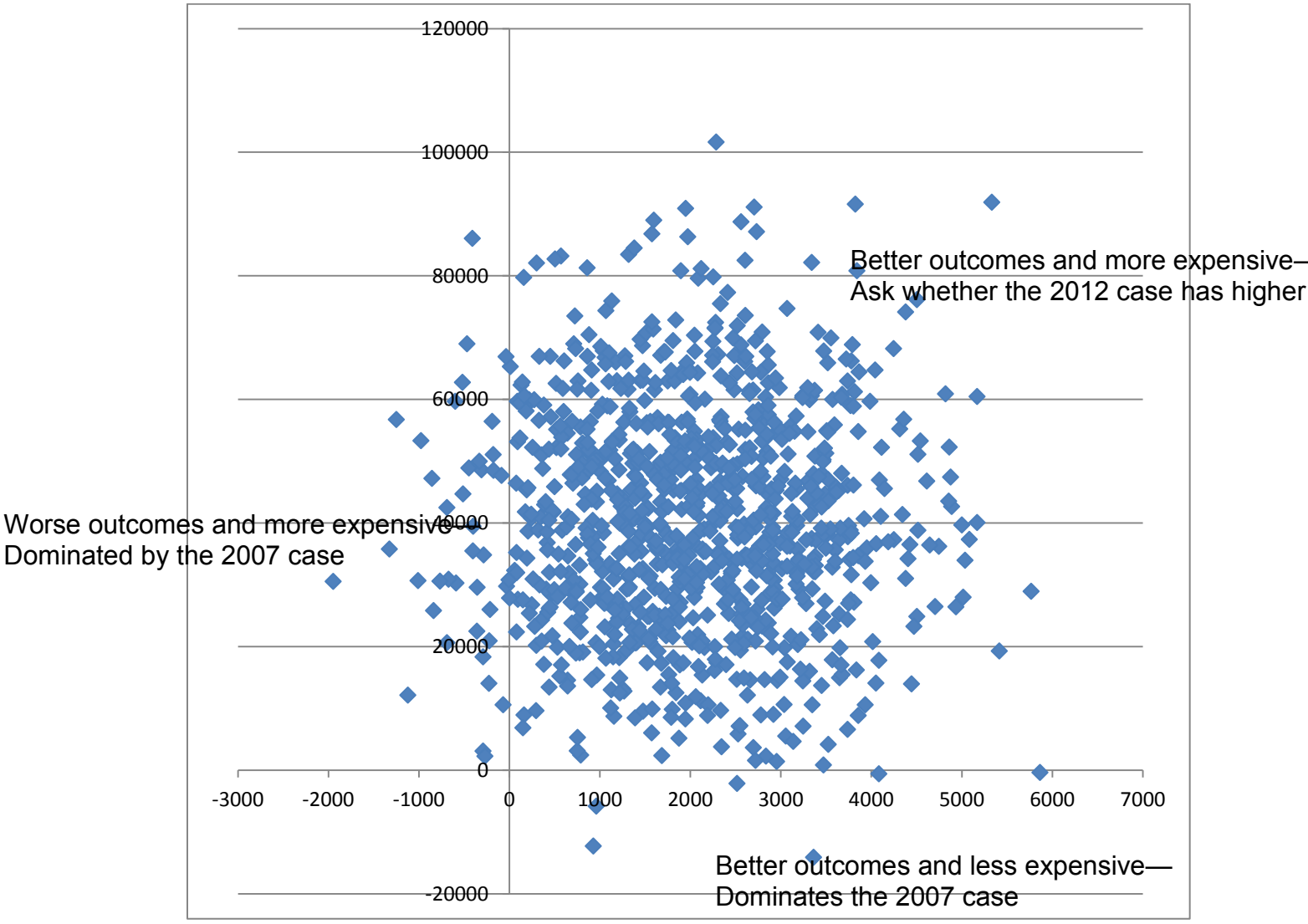


Figure 18. Bootstrapped Values for the Cancer Care Services

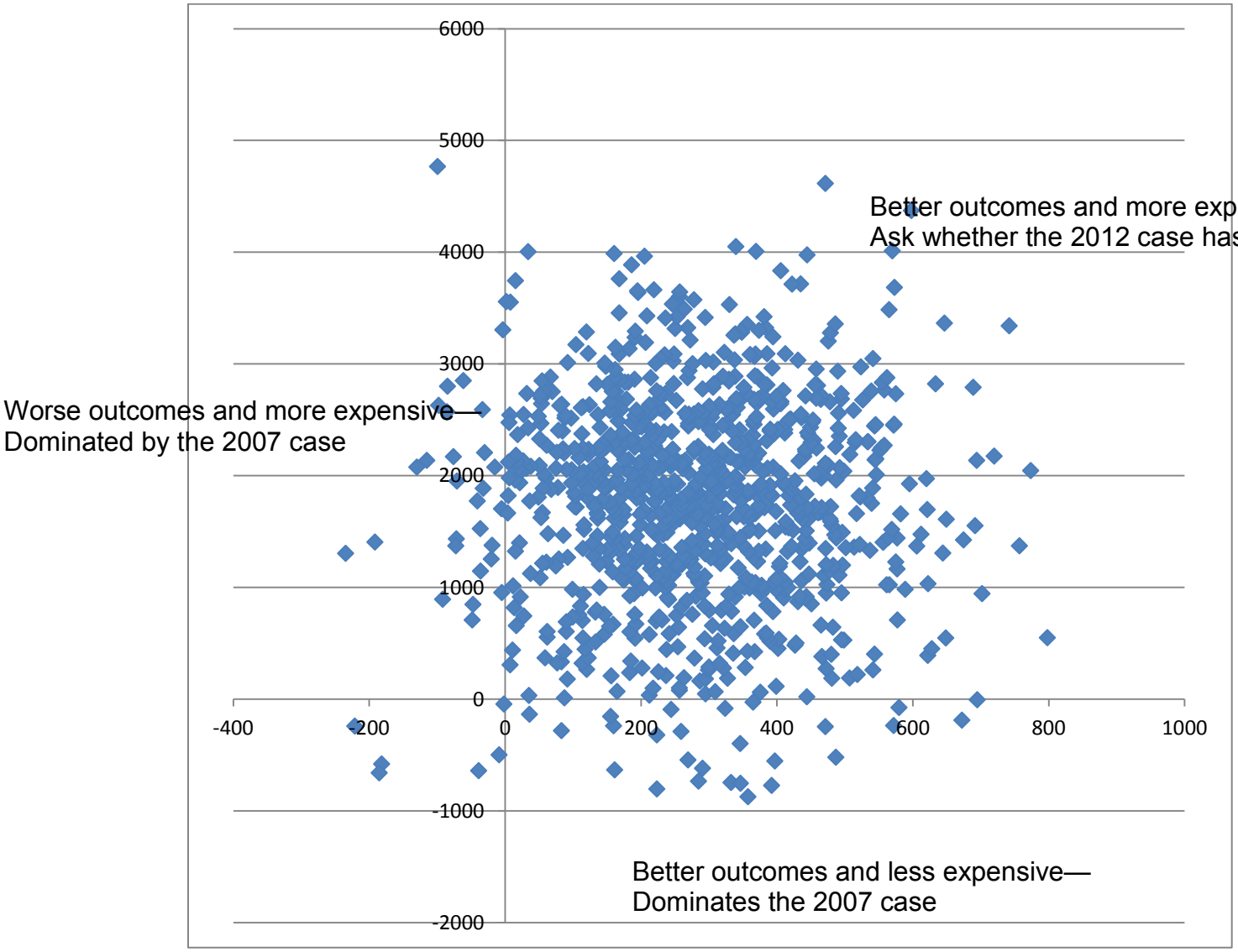
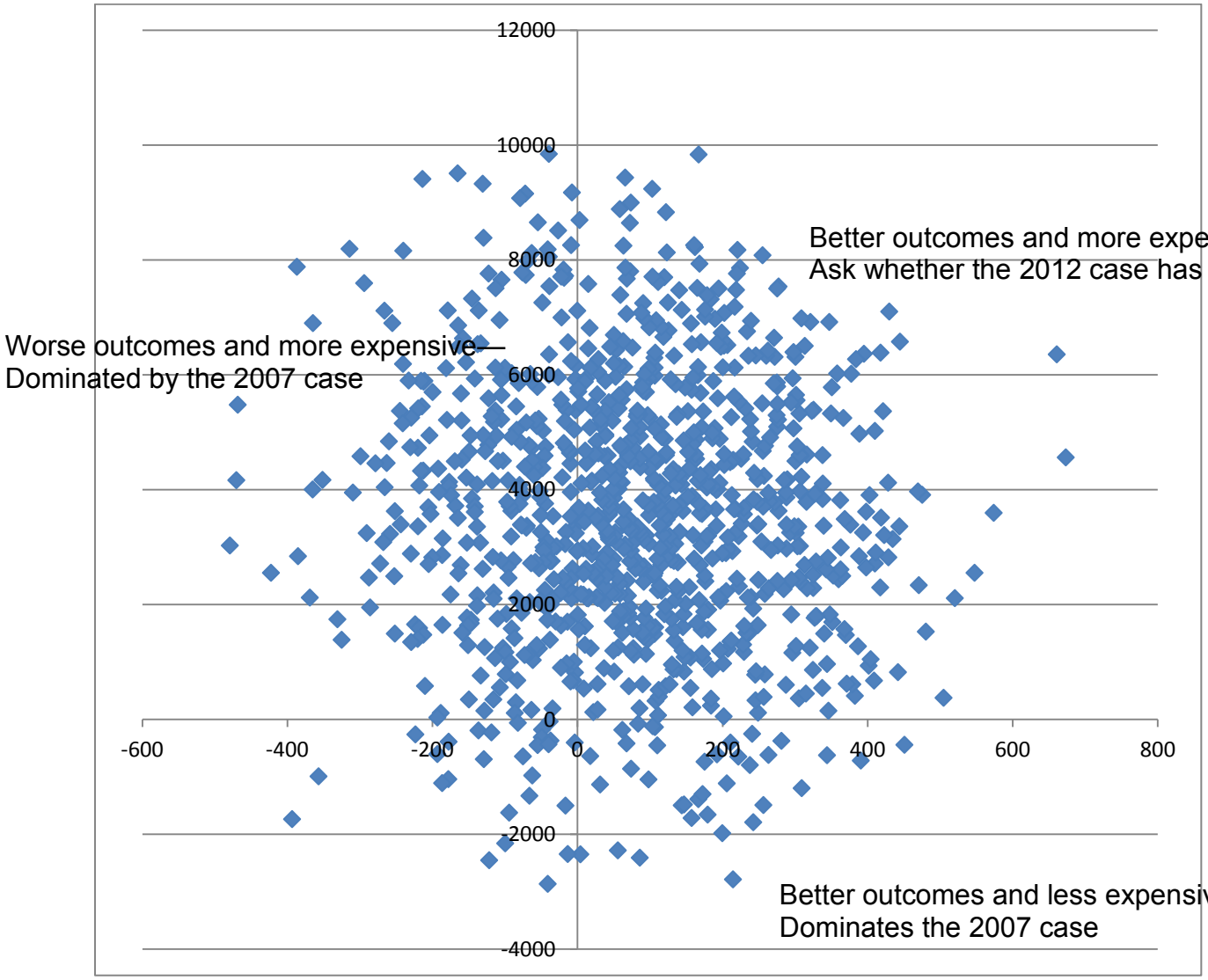


Figure 19. Bootstrapped Values for Mental Health Care Services



4.2. Value of Overall Healthcare Services Model

4-2-1) Bivariate and Multivariate Analysis

In the bivariate analyses (Table 4-1) examining associations between YPLLs and each of the 33 independent variables, including the main independent variable (Overall Health Care Expenditure) and 2 control variables (% female, % over age 65) in 230 communities[20], 18 independent variables were selected for the multivariate analyses since their P-values are higher than 0.300. (Table 4-2)

From the exploratory analyses, including the multi-collinearity analysis, and the selection processes in the multivariate analyses, 8 independent variables were selected, including **health expenditures, smoking rate in 2012, depression, number of physicians, number of beds, length of stay, number of high-priced equipment (CT & MRI), and check-up rate**. (Table 4-3)

[20] Among the 231 communities, 1 community which is negative regarding the incremental expenditures for overall health care, was excluded from the analysis since the community would be an extreme outlier in the analysis (see Figure 10).

The Multivariate Analysis with 8 independent variables was also tested with 7 interaction terms to finalize the MLR model of overall healthcare CE. (Table 4-4)

Table 4-1. Results of Bivariate Analyses (n = 230)

Independent Variables	Results (n = 230)			
	Coefficient			P-Value
	Mean	Lowest	Highest	
Expenditure	0.0195	0.0084	0.0306	0.001
*log(exp)	762	335	1190	0.001
Apartment	-12.6	-20.4	-4.8	0.002
Income	-0.119	-0.335	0.097	0.280
*log(NHI Fee)	-292	-643	58	0.102
Health Budget	-16.9	-31.9	-1.94	0.027
*log(Budget)	-506	-909	-103	0.014
Smoking	-62.9	-126.1	0.406	0.051
*Smoking_12	76	-4.0	156	0.062
Obesity	19.5	-39.4	78.4	0.514
*Obesity_12	-11.6	-83.0	59.9	0.750
Hypertension	-33.3	-118.6	52.1	0.443
*Hyper_12	-71.8	-162.3	18.7	0.119
Diabetes	-38.6	-173.04	95.9	0.572
*Diabetes_12	-45.9	-209	117	0.579
Stress	15.5	-15.9	46.9	0.331
*Stress_12	-39.5	-84	4.7	0.080
Depression	-32.5	-88.4	23.5	0.254
*Depress_12	-18	-115	78.7	0.713

Physicians	-132.6	-227.5	-37.6	0.006
*log(physician)	-493	-905	-81	0.019
Beds	7.1	-20.1	34.3	0.607
*log(beds)	161.4	-135.9	458.7	0.286
LOS	-152.2	-424.3	119.96	0.272
*log(LOS)	-1142	-3108	824	0.253
Visit Days	83.7	41.9	125.6	0.000
*log(Visits)	2133	1084	3183	0.000
CT/MRI	-21.9	-35.7	-8.0	0.002
*log(CTMRI)	-422	-584	-259	0.000
Check-up	-42.9	-98.9	13.1	0.133
*Check-up®	-45.7	-86.5	-4.9	0.028
Over 65	43.1	17.0	69.2	0.001
Female	29.5	-142.3	201	0.735

Table 4-2. Multivariate Analysis with 18 independent variables

Independent Variables	Results (n = 230) *P-Value=0.001, R^2=0.1901			
	Coefficient			P-Value
	Mean	Lowest	Highest	
*log(exp)	349	-985	1682	0.607
Apartment	3.4	-19	26	0.763
*log(NHI Fee)	-114	-527	299	0.587
*log(Budget)	318	-499	1137	0.443
Smoking	-3.7	-75	68	0.920
*Smoking_12	46	-51	142	0.352
*Hyper_12	-13	-124	98	0.820
*Stress_12	1.7	-49	52	0.949
Depression	-40	-97	17	0.169
*log(physician)	-492	-1048	64	0.083
*log(beds)	132	-381	645	0.613
*log(LOS)	-1843	-5885	2199	0.370
*log(Visits)	594	-3345	4533	0.767
CTMRI	-12	-31	7.3	0.222
Check-up	-93	-169	-16	0.018
*Check-up®	74	-3.9	152	0.062
Over 65	28	-75	130	0.597
Female	-169	-451	112	0.237

Table 4-3. Multivariate Analysis with 8 independent variables (after selection process)

Independent Variables	Results (n = 230) *P-Value=0.000, R^2=0.1479			
	Coefficient			P-Value
	Mean	Lowest	Highest	
*log(exp)	461	-67	988	0.087
*Smoking_12	65	-17	148	0.118
Depression	-44	-98	10	0.111
*log(physician)	-724	-1217	-230	0.004
*log(beds)	209	-171	589	0.279
*log(LOS)	-2762	-5000	-524	0.016
CTMRI	-10	-27	6.7	0.233
Check-up	-94	-155	-34	0.002

Table 4-4. Multivariate Analysis with 7 Interactions

Independent Variables	Results (n = 230) *P-Value=0.000, R^2=0.2289			
	Coefficient			P-Value
	Mean	Lowest	Highest	
*log(exp)	15686	-2925	34298	0.098
*Smoking_12	-1337	-3137	463	0.145
Depression	1859	533	3186	0.006
*log(physician)	7227	-4347	18803	0.220
*log(beds)	2920	-4052	9893	0.410
*log(LOS)	21683	-41179	84547	0.497
CTMRI	167	-165	499	0.322
Check-up	1678	134	3222	0.033
Exp*Smoking_12	130	-40	300	0.134
Exp*Depression	-179	-304	-54	0.005
Exp*Log(Physi)	-761	-1865	343	0.176
Exp*Log(Beds)	-249	-905	407	0.454
Exp*Log(LOS)	-2282	-8206	3643	0.449
Exp*CTMRI	-17	-50	16	0.311
Exp*Check-up	-169	-315	-23	0.024

4-2-2) Final MLR Model

In the final MLR model of overall healthcare Value in 230 communities, 1 main independent variable (NHI expenditure) and 6 other independent variables - **smoking rate in 2012, depression, number of physicians, number of beds, length of stay, and check-up rate,** were selected. To measure effect modifications between NHI expenditure and other independent variables, 4 interaction terms – **expenditure*smoking rate in 2012, expenditure*depression, expenditure *number of physician, and expenditure*check-up rate**, were included in the final model.

The overall p value of this model is 0.0000, and the overall explanatory capability (R^2) is 22.15%. In this model, 1 natural log of health expenditure increase is contributing to decrease the YPLLs-75 at a rate of 9574[21] between 2007 and 2012 (p value = 0.023). Also a 1% depression rate decrease is contributing to decrease the YPLLs-75 as 2041 between 2007 and 2012 (p value=0.002), and 1 natural log of length of stay increase is contributing to increase the YPLLs-75 as 2294 between 2007 and 2012 (p value = 0.042). In the case of the check-up rate, a

[21] Although the natural log was used for Health Expenditures, 8665 represents the value of HSs with the averted YPLL-75 and the NHI health expenditures.

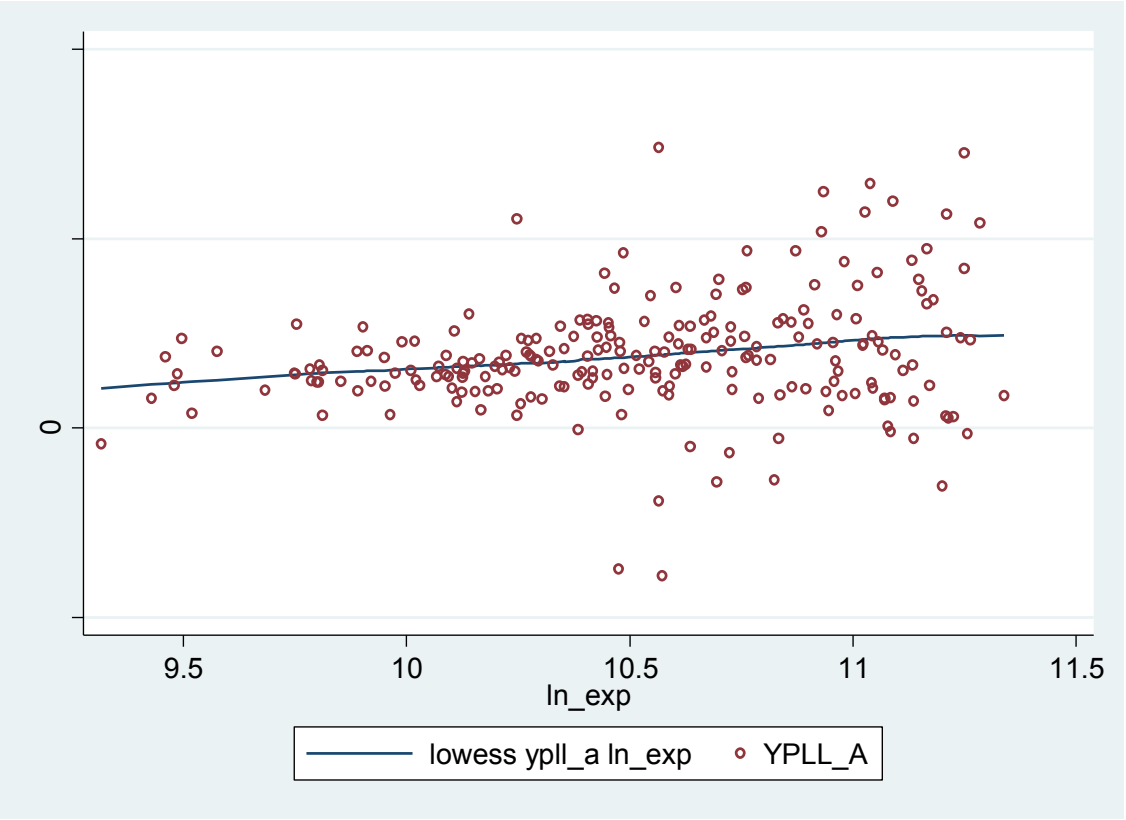
1 % higher rate for a community shows the 1419 decreased YPLLs-75 between 2007 and 2012. (p value=0.021)

Moreover, a 1% higher smoking rate produces an increase in YPLLs as 1157 between 2007 and 2012, but the p-value is not significant (p value = 0.164). Also more physicians and beds produce a decrease of YPLLs as 9383 and 259, but the p-values are not significant (0.058, 0.168)

Table 4-5. Multivariate Analysis with 4 Interactions
(Final Model for Overall Healthcare)

Independent Variables	Results (n = 230) *P-Value=0.000, R^2=0.2215			
	Coefficient			P-Value
	Mean	Lowest	Highest	
*log(exp)	9574	1311	17837	0.023
*Smoking_12	-1157	-2793	478	0.164
Depression	2041	760	3324	0.002
*log(physician)	9383	-327	19093	0.058
*log(beds)	259	-109	626	0.168
*log(LOS)	-2294	-4500	-88	0.042
Check-up	1419	220	2617	0.021
Exp*Smoking_12	114	-41	269	0.150
Exp*Depression	-196	-317	-76	0.002
Exp*Log(Physi)	-977	-1904	-31	0.039
Exp*Check-up	-145	-260	-31	0.013

Figure 20. Regression Two-way Line with lowess smoothing (ln_exp & YPLL)



4-2-3) Effect Modification

From the final model, the effect modifications for the 4 interaction terms – **expenditure*smoking rate in 2012, expenditure*depression, expenditure *number of physician, and expenditure*check-up rate**, are defined.

First, higher smoking rate is contributing to an increase in the effect of health expenditures on the decrease of YPLLs between 2007 and 2012. This means that in the higher smoking rate communities, the value of health expenditures for decreasing YPLLs is higher or better than in the lower smoking rate communities.

Second, little progress in the depression rate from 2007 to 2012 is contributing to increasing the effect of health expenditures on the decrease of YPLLs between 2007 and 2012. This means in the lower progress communities, the value of health expenditures for decreasing YPLLs is better than in communities where depression is improving.

Third, a higher number of physicians are slightly associated with lowering the effect of health expenditures on the decrease of YPLLs between 2007 and 2012. This means that in the communities with higher numbers of

physicians, the value of health expenditures in decreasing YPLLs is slightly lower than in the communities with lower numbers of physicians.

Finally, lower check-up rates are contributing to increase the effect of health expenditures decreasing YPLLs between 2007 and 2012. This means in the lower check-up rate communities, the value of health expenditures to the decrease of YPLLs is better than in the higher check-up rate communities.

Table 4-6. Interaction by Smoking Rate

Independent Variables	Results			
	Coefficient (Value of HS)			P-Value
	Mean	Lowest	Highest	
1) Low Smoking Rate Area: log(exp)	659	190	1127	0.006
2) High Smoking Rate Area: log(exp)	963	142	1784	0.022

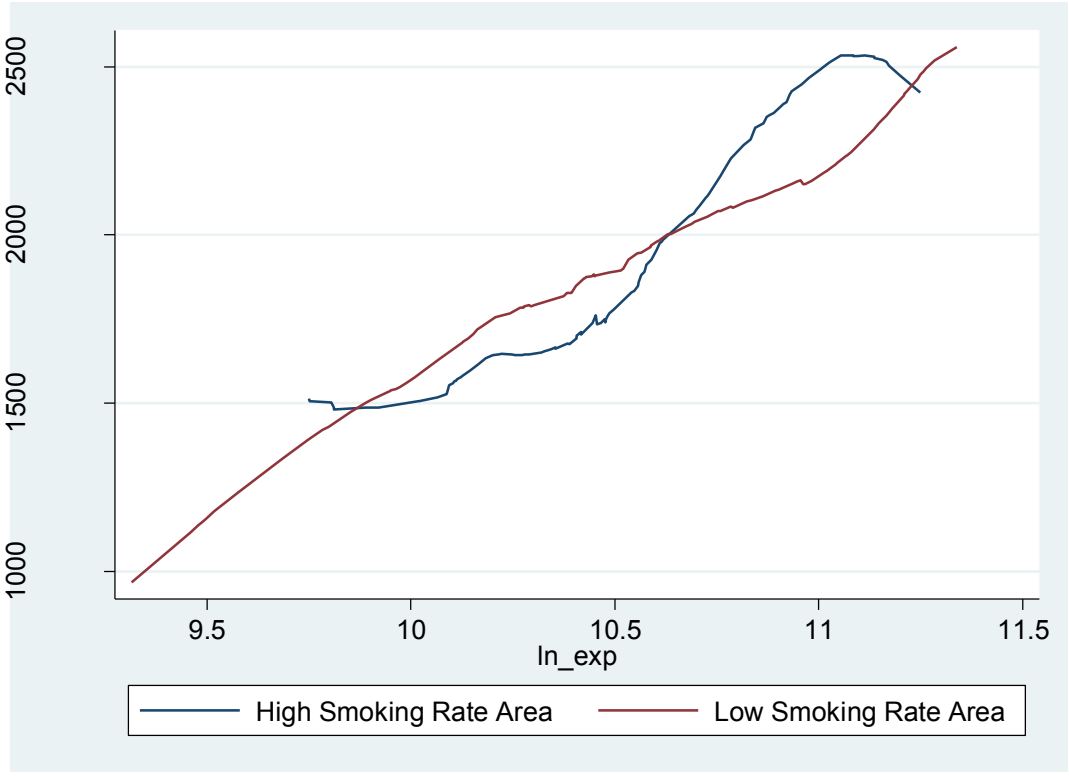


Table 4-7. Interaction by Depression Progress

Independent Variables	Results			
	Coefficient (Value of HS)			P-Value
	Mean	Lowest	Highest	
1) Low Progress Area: log(exp)	1299	655	1943	0.000
2) High Progress Area: log(exp)	218	-333	770	0.435

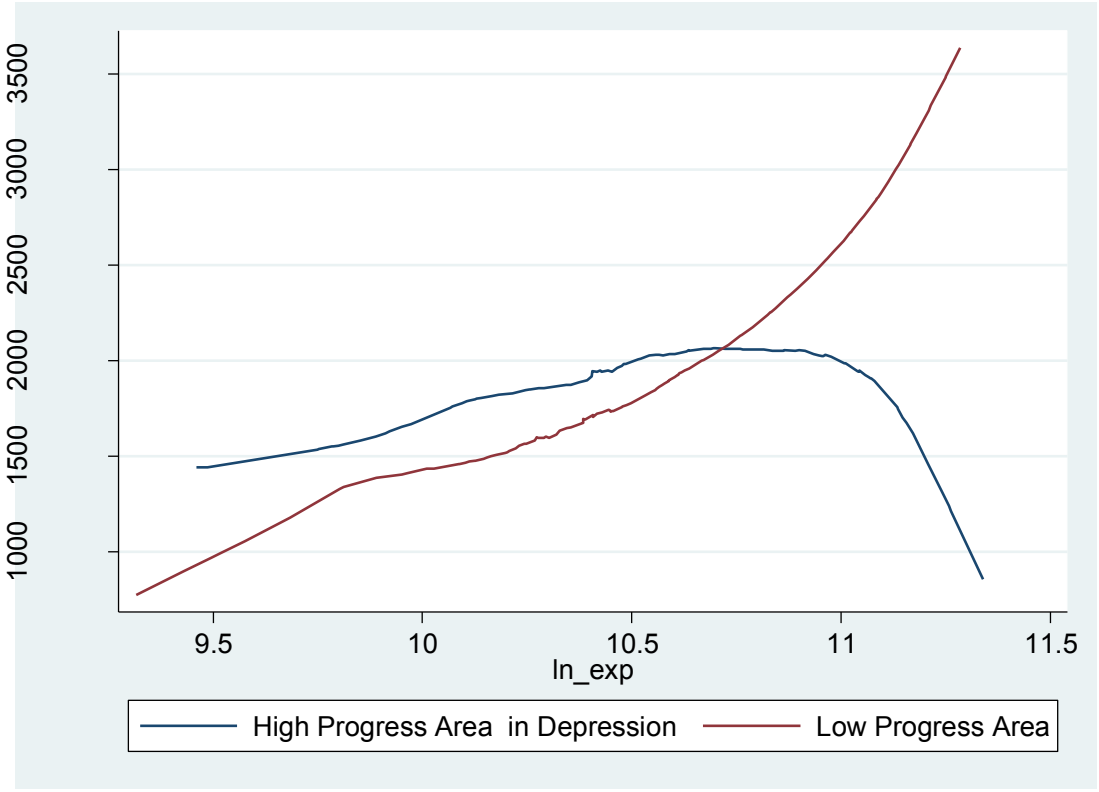


Table 4-8. Interaction by Number of Physician

Independent Variables	Results			
	Coefficient (Value of HS)			P-Value
	Mean	Lowest	Highest	
1) Low Number Area: log(exp)	824	135	1513	0.020
2) High Number Area: log(exp)	727	201	1253	0.007

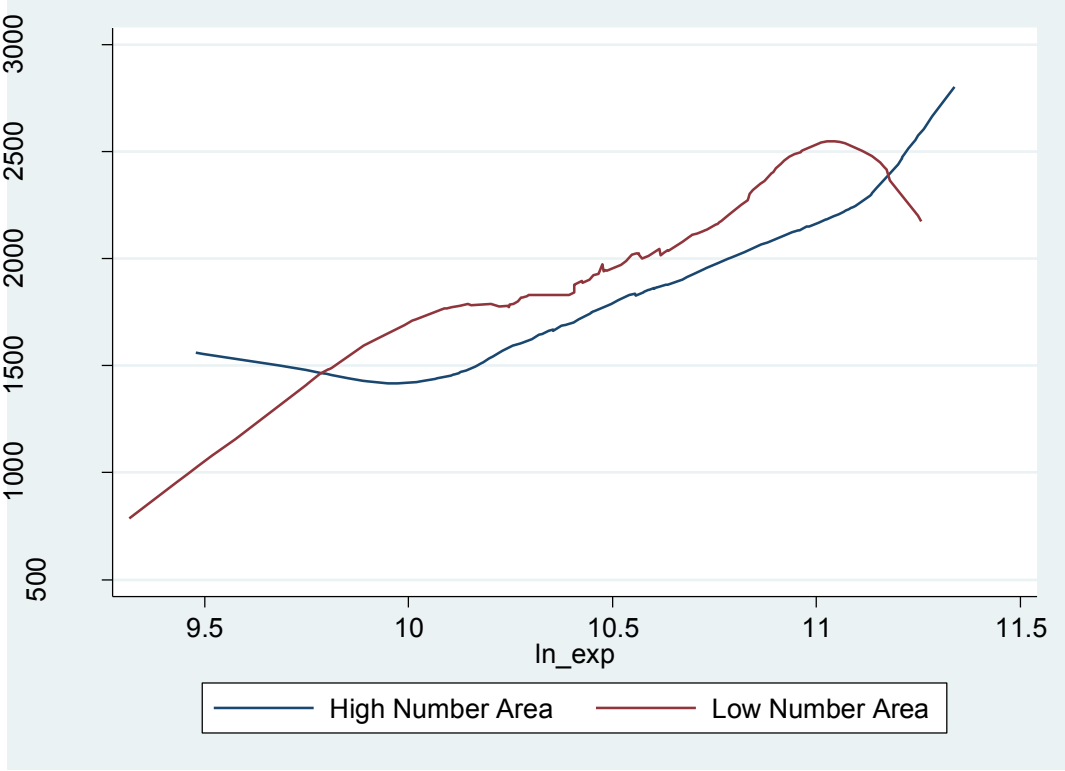
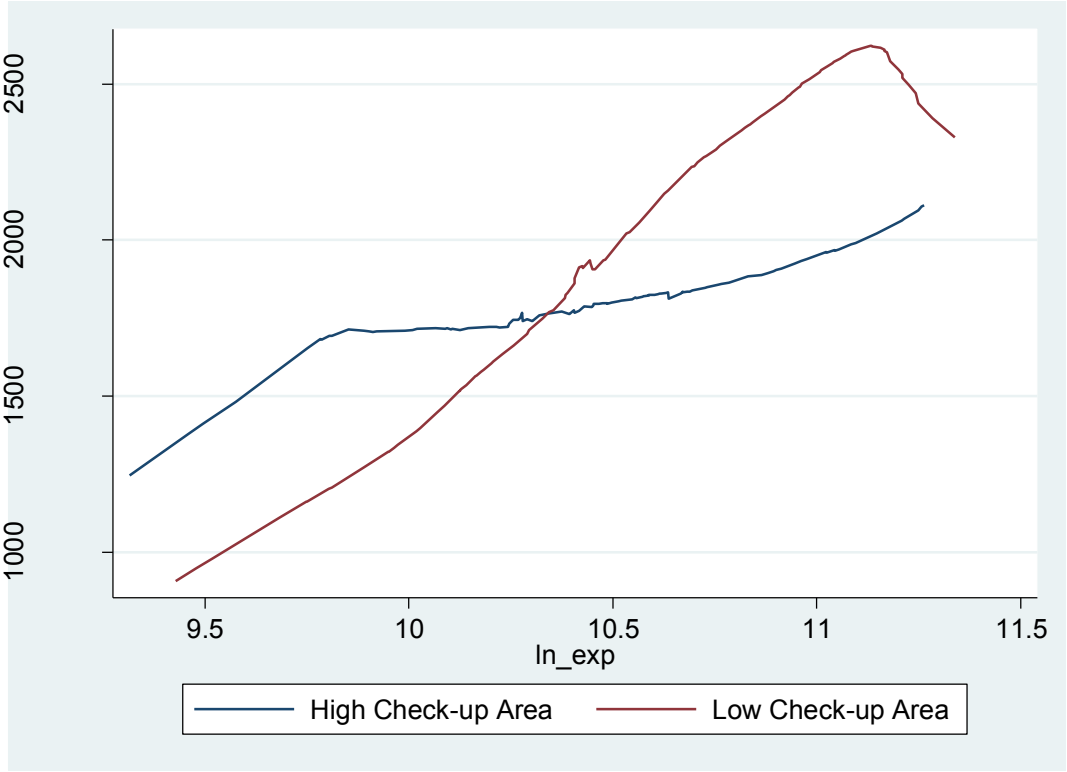


Table 4-9. Interaction by Checkup Rate

Independent Variables	Results			
	Coefficient (Value of HS)			P-Value
	Mean	Lowest	Highest	
1) Low Checkup Area: log(exp)	1094	471	1717	0.001
2) High Checkup Area: log(exp)	304	-284	893	0.308



4-2-4) Analysis of Regional Characteristics

To analyze the characteristics of the Seoul Metropolitan area and Non-Seoul Metropolitan area, both the values of HS for the separate Seoul Metropolitan (66 communities) and Non Seoul Metropolitan (164 communities) models were compared. The value of HS in the Seoul Metropolitan model (14020) is better than in the Non-Seoul Metropolitan model (11681). This result suggests that the NHI expenditure increase in the Seoul Metropolitan area is better in contributing to the decrease of YPLLs between 2007 and 2012 than in the Non-Seoul Metropolitan area. In the case of the Non-Seoul Metropolitan area model, the p-value is not significant. (p-value = 0.135)

In addition, both the values of HS in the separate City area (145 communities) and Rural area (85 communities) models were also compared. The Value in the City model (8247) is lower than in the Rural model (13637). The result suggests that the NHI expenditure increase in the City area is lower in contributing to the decrease of YPLLs between 2007 and 2012 than in the Rural area. But in the case of the rural area model, the p-value is not significant. (p-value = 0.429)

Table 4-10. Value of HS: Seoul Metropolitan vs. Other Area

Independent Variables	Results (n = 230)			
	Coefficient			P-Value
	Mean	Lowest	Highest	
1) Seoul Metro Area: log(exp) * 66 communities	14020	4002	24038	0.007
2) Non Seoul Metro Area: log(exp) * 164 communities	11681	-3689	27052	0.135

Table 4-11. Value of HS: City vs. Rural Area

Independent Variables	Results (n = 230)			
	Coefficient			P-Value
	Mean	Lowest	Highest	
1) City Area: log(exp) * 145 communities	8247	420	16075	0.039
2) Rural Area: log(exp) * 85 communities	13637	-20512	47787	0.429

4.3. Value of Cancer Care Services Model

4-3-1) Bivariate and Multivariate Analysis

In the bivariate analyses between YPLLs for 5 cancers and each independent variable among 229 communities [22] (Table 4-12), among 33 independent variables including the main independent variable (Cancer Care Expenditure) and 2 control variables (% female, % over age 65), 17 independent variables were selected for the next multivariate analyses since their P-values are higher than 0.300. (Table 4-12)

From the exploratory analyses including the multi-collinearity analysis and the selection processes in the multivariate analyses, 8 independent variables were selected, including **cancer care expenditure, income (NHI fee), smoking**

[22] Among the 231 communities, 2 communities which are negative in the incremental expenditure for cancer care, were excluded since the communities would be extreme outliers in the analysis (see Figure 11). Also since I use the log transform of the incremental expenditure variable for the reason of normal distribution transformation, the negative values should be excluded automatically.

rate in 2012, hypertension, diabetes, stress, depression rate in 2012, and number of beds[23]. (Table 4-14)

The Multivariate Analysis with 8 independent variables was also tested with 6 interaction terms (see Table 4-15) to select the final MLR model for cancer care services.

[23] Among 229 communities, two extreme values (out-liars) in YPLLs are excluded in the exploratory analyses. And so the final model is constructed among 227 communities.

Table 4-12. Results of Bivariate Analyses for Cancer Care Services (n = 229)

Independent Variables	Results (n = 229)			
	Coefficient			P-Value
	Mean	Lowest	Highest	
expense	-0.008	-0.040	0.023	0.610
*log(exp)	-25	-83	32	0.389
apartment	-0.63	-1.7	0.44	0.248
Income	-0.02	-0.05	0.01	0.245
*log(NHI Fee)	-30	-77	17	0.210
Health Budget	-0.22	-2.24	1.8	0.833
*log(Budget)	-11	-66	44	0.691
Smoking	-6.3	-14.7	2.2	0.146
*Smoking_12	12.2	1.6	22.8	0.024
Obesity	2.4	-5.5	10.3	0.549
*Obesity_12	4.6	-5.0	14.3	0.345
Hypertension	-12.0	-23.2	-0.71	0.037
*Hyper_12	15.8	3.7	27.8	0.011
Diabetes	-18.5	-36.4	-0.66	0.042
*Diabetes_12	14.4	-7.4	36.3	0.194
Stress	3.8	-0.4	7.9	0.076
*Stress_12	-0.56	-6.5	5.4	0.852
Depression	-9.8	-17.1	-2.4	0.009
*Depress_12	8.9	-4.0	22	0.176

Physicians	-5	-18	7.8	0.443
*log(physician)	-14	-69	42	0.632
Beds	0.4	-3.3	4	0.847
*log(Beds)	21	-19	62	0.302
LOS	3.6	-33	40	0.848
*log(LOS)	16	-248	281	0.903
Visit Days	1.1	-4.6	6.9	0.699
*log(Visits)	31	-113	176	0.673
CT/MRI	-0.9	-2.7	1.0	0.370
*log(CTMRI)	-18	-40	4.9	0.123
Check-up	-0.9	-8.4	6.6	0.806
*Check-up®	-5.3	-11	0.14	0.056
Over 65	0.17	-3.4	3.8	0.926
Female	-13	-36	10	0.277

Table 4-13. Multivariate Analysis for Cancer Care Services with 17 variables

Independent Variables	Results (n = 229) *P-value=0.0011, R^2=0.1628			
	Coefficient			P-Value
	Mean	Lowest	Highest	
*log(exp)	-95	-167	-22	0.010
apartment	-2.7	-5.7	0.25	0.072
*log(NHI Fee)	-22	-81	37	0.465
Smoking	1.6	-9.4	12.6	0.775
*Smoking_12	6	-8.1	20.2	0.401
Hypertension	-5.8	-21.7	10.2	0.477
*Hyper_12	2.4	-17.9	22.7	0.814
Diabetes	-7.0	-38	24	0.654
*Diabetes_12	-11	-50	28	0.569
Stress	5.9	1.2	11	0.014
Depression	-14.9	-25.7	-4.1	0.007
*Depress_12	-1.4	-22	20	0.895
*log(Beds)	58	-19	62	0.302
Check-up	-13	-24	-2	0.019
Physician	-2.2	-13	9	0.711
Over 65	-13	-24	-2.4	0.017
Female	11	-20	41	0.151

Table 4-14. Multivariate Analysis for Cancer Care Services with 8 independent variables (after selection process)

Independent Variables	Results (n = 227) *P-value=0.0156, R^2=0.0818			
	Coefficient			P-Value
	Mean	Lowest	Highest	
*log(exp)	-43	-104	17	0.162
*log(NHI Fee)	-27	-77	23	0.290
*Smoking_12	9.5	-1.5	21	0.091
Hypertension	-6.1	-19	6.8	0.352
Diabetes	-13.9	-34	6.6	0.182
Stress	3.9	-0.4	8	0.014
*Depress_12	9.4	-3.9	23	0.166
*log(Beds)	36	-8	79	0.109

Table 4-15. Multivariate Analysis for Cancer Care Services with 6 Interactions

Independent Variables	Results (n = 227) *P-value=0.0039, R^2=0.1368			
	Coefficient			P-Value
	Mean	Lowest	Highest	
*log(exp)	-290	-1326	746	0.582
*log(NHI Fee)	249	-672	1171	0.594
*Smoking_12	-41	-219	136	0.647
Hypertension	218	32	405	0.022
Diabetes	-13	-33	7.3	0.207
Stress	-10.6	-69	48	0.723
*Depress_12	-248	-498	1.3	0.051
*log(Beds)	-242	-987	504	0.523
Exp*Log(NHI fee)	-37	-163	88	0.558
Exp*Smoking_12	7	-17	31	0.568
Exp*Hyper	-30	-55	-5	0.019
Exp*Stress	2	-5.9	9.9	0.622
Exp*Depress_12	34	1.2	68	0.042
Exp*Log(Beds)	38	-62	137	0.454

4-3-2) Final MLR Model for Cancer Care Services

In the final MLR model for cancer care in 227 communities, 1 main independent variable (cancer care expenditure) and 6 other independent variables - **income (NHI fee), smoking rate in 2012, hypertension, diabetes, stress, depression rate in 2012, and number of beds--** were selected. To measure effect modifications between the cancer care expenditures and other independent variables, 2 interaction terms – **expenditure*hypertension, expenditure* depression rate in 2012 -** were included in the final model.

The overall p value of this model is 0.0005, and the overall explanatory capability (R^2) is 12.66%. In this model, 1 natural log of cancer expenditure increase results in the increase of YPLLs-75 as 293 between 2007 and 2012 (p value = 0.001). Also a 1% decrease in hypertension and stress rates are associated with decreases in YPLLs-75 as 192 and 4.4 between 2007 and 2012 (p value=0.035, 0,039), and a 1% higher depression rate in 2012 is associated with an increase in the YPLLs-75 as 277 between 2007 and 2012 (p value = 0.023).

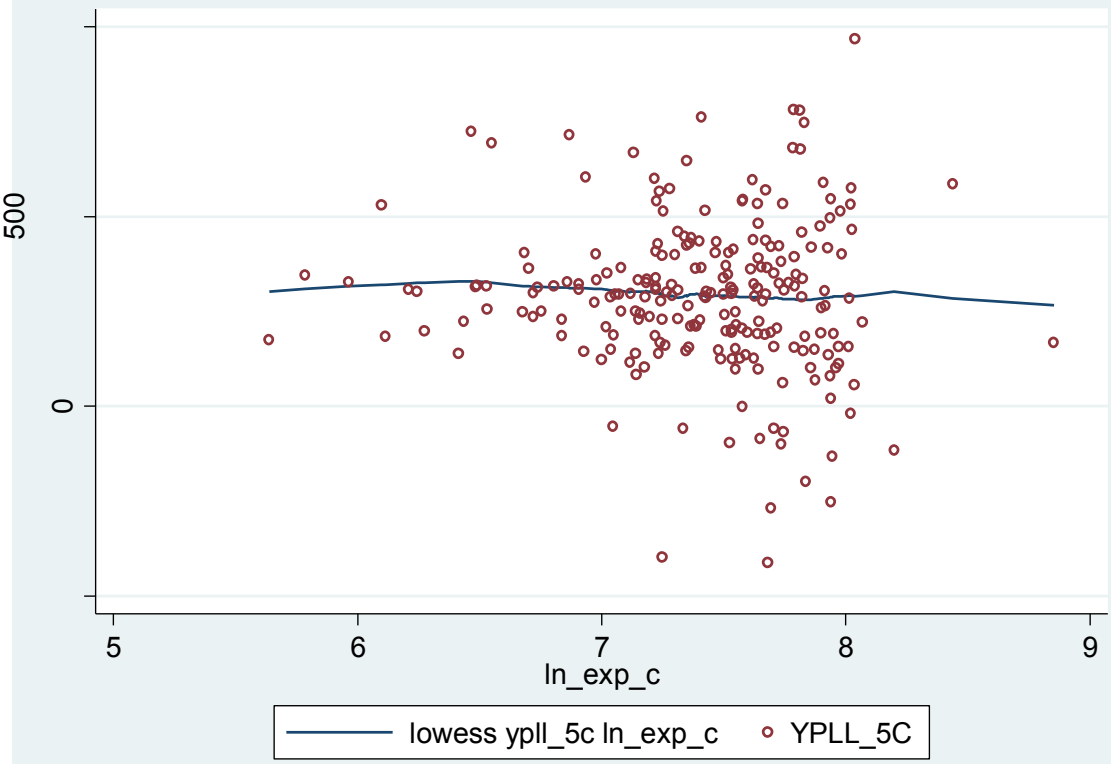
Moreover, a 1% higher smoking rate in 2012 and 1% diabetes rate increase is associated with the decrease of YPLLs as 8.8 and 13 between 2007 and 2012, but the p-value is not significant (p value = 0.109 and 0.190). Also more

beds are associated with the decrease of YPLLs as 35, but the p-values are not significant (0.104)

Table 4-16. Multivariate Analysis for Cancer Care with 2 Interactions (Final Model)

Independent Variables	Results (n = 227) *P-value=0.0005, R^2=0.1266			
	Coefficient			P-Value
	Mean	Lowest	Highest	
*log(exp)	-293	-415	-112	0.001
*Smoking_12	8.8	-2.0	20	0.109
Hypertension	192	13	370	0.035
Diabetes	-13	-33	6.7	0.190
Stress	4.4	0.22	8.7	0.039
*Depress_12	-277	-515	-39	0.023
*log(Beds)	35	-7.3	78	0.104
Exp*Hyper	-27	-50	-2.8	0.029
Exp*Depress_12	38	6.4	70	0.019

Figure 21. Regression Two-way Line with lowess smoothing (ln_exp_c & YPLL_5C)



4-3-3) Effect Modification

In the final model, the effect modifications in the 2 interaction terms – **expenditure*hypertension, expenditure* depression rate in 2012 -** were examined.

First, more improvement in the hypertension rate from 2007 to 2012 is associated with less effect of health expenditures on the decrease of YPLLs between 2007 and 2012. This means that in the higher progress communities in terms of the hypertension rate, the value of cancer care expenditures to the decrease of YPLL is worse than in the lower progress communities. But in the case of both higher and lower progress models, the p-values are not significant. (p-value = 0.169 and 0.943)

Second, a higher depression rate is associated with an increase in the effect of health expenditures on the decrease of YPLLs between 2007 and 2012. This means that in the communities with higher depression rates, the value of cancer care expenditure to the decrease of YPLLs is better than in the lower depression rate communities. But in the case of both higher and lower rate models, the p-values are not significant. (p-value = 0.253 and 0.063)

Table 4-17. Interaction by Progress in Hypertension Rates

Independent Variables	Results (n = 227)			
	Coefficient			P-Value
	Mean	Lowest	Highest	
1) Low Progress Area: log(exp)	-3.2	-92	86	0.943
2) High Progress Area: log(exp)	-50	-123	22	0.169

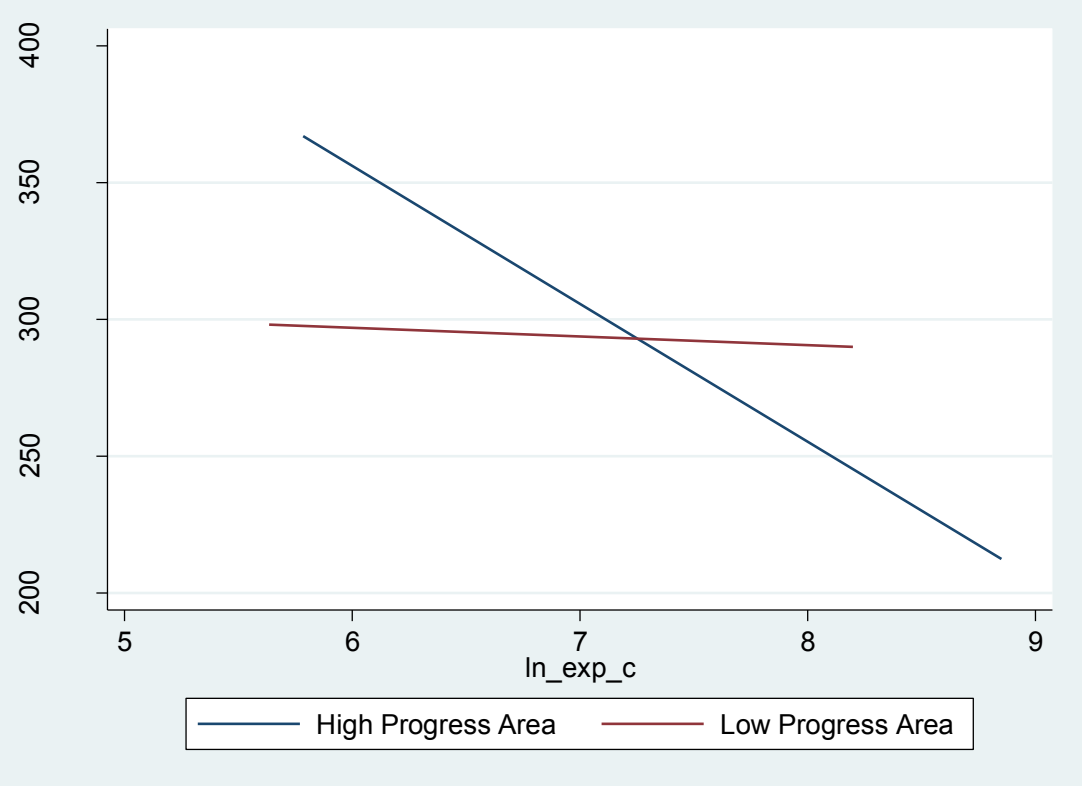
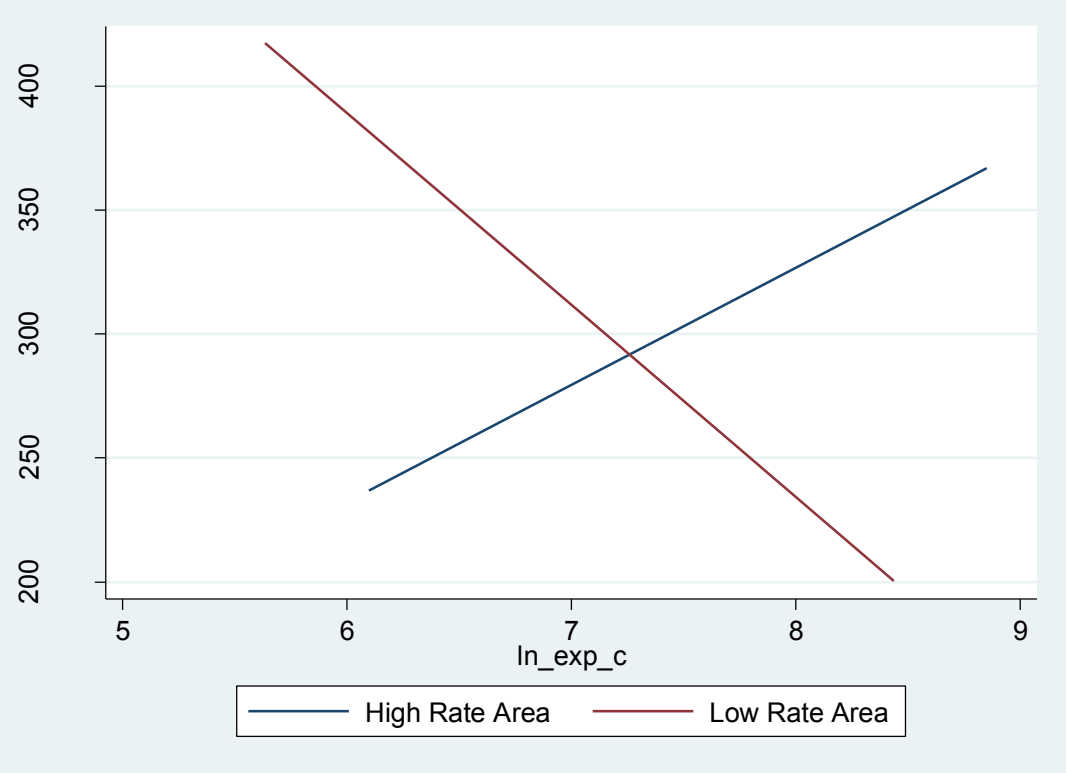


Table 4-18. Interaction by Depression Rates

Independent Variables	Results (n = 227)			
	Coefficient			P-Value
	Mean	Lowest	Highest	
1) Low Rate Area: log(exp)	-77	-159	4.2	0.063
2) High Rate Area: log(exp)	47	-34	129	0.253



4-3-4) Analysis of Regional Characteristics

To compare the characteristics of the Seoul Metropolitan area and the Non-Seoul Metropolitan area for cancer care, both the values of HS in the separate Seoul Metropolitan (66 communities) and Non-Seoul Metropolitan (161 communities) models were compared. The value in the Seoul Metropolitan model (-177) is relatively better than in the Non-Seoul Metropolitan model (-244). This result suggests that the cancer care expenditure increase in the Seoul Metropolitan area resulted in relatively less increase of YPLLs between 2007 and 2012 than in the Non-Seoul Metropolitan area. In case of the Seoul Metropolitan area model, the p-value is not significant. (p-value = 0.331)

In addition, both the values of HS in the separate City area (144 communities) and Rural area (83 communities) models were also compared. The value in the City model (-78) is better than in the Rural model (-556). The result suggests that the cancer care expenditure increase in the City area is resulting in relatively less increase of YPLLs between 2007 and 2012 than in the Rural area. The p-values in both areas are significant. (p-value = 0.039, 0.008)

Table 4-19. Value of HE: Seoul Metropolitan vs. Other Area

Independent Variables	Results (n = 227)			
	Coefficient			P-Value
	Mean	Lowest	Highest	
1) Seoul Metro Area: log(exp) * 66 communities	-177	-537	184	0.331
2) Non Seoul Metro Area: log(exp) * 161 communities	-244	-442	-46	0.016

Table 4-20. Value of HE: City vs. Rural Area

Independent Variables	Results (n = 227)			
	Coefficient			P-Value
	Mean	Lowest	Highest	
1) City Area: log(exp) * 144 communities	-78	-238	82	0.039
2) Rural Area: log(exp) * 83 communities	-556	-965	-148	0.008

4.4. Value of Mental Health Care Services Model

4-4-1) Bivariate and Multivariate Analysis

In the Bivariate analysis, all the independent variables were tested to find any individual relationship with the averted YPLLs-75 due to suicides at the local community level. But overall the P-values are much higher than 0.300 except for 5 independent variables – Beds, Obesity, Hypertension, Diabetes, and Stress rate in 2012. The Multivariate Analysis with the mental health care expenditures increase and those 5 independent variables was also examined.

Both in the Bivariate and Multivariate Analysis, the potential relationships between the averted YPLLs-75 and the mental health care expenditures increase from 2007 to 2012, were not significant, and many p-values for the relationships were large. (0.644, 0.773) These results suggest that there is no significant YPLLs decrease in Suicides between 2007 and 2012 although the mental health care expenditures by the NHI were increased from 2007 and 2012. The value of mental health care services in this model based on the multivariate

analysis could not be demonstrated in this exploratory analysis of the local mental health care services.

As an alternative approach, Longitudinal Analyses (LDA) were tested to examine relationships at the local community level between the level of YPLL by suicides and the level of mental care expenditures in each year - both 2007 and 2012.

Table 4-21. Results of Bivariate Analyses for Mental Health Services (n = 230)

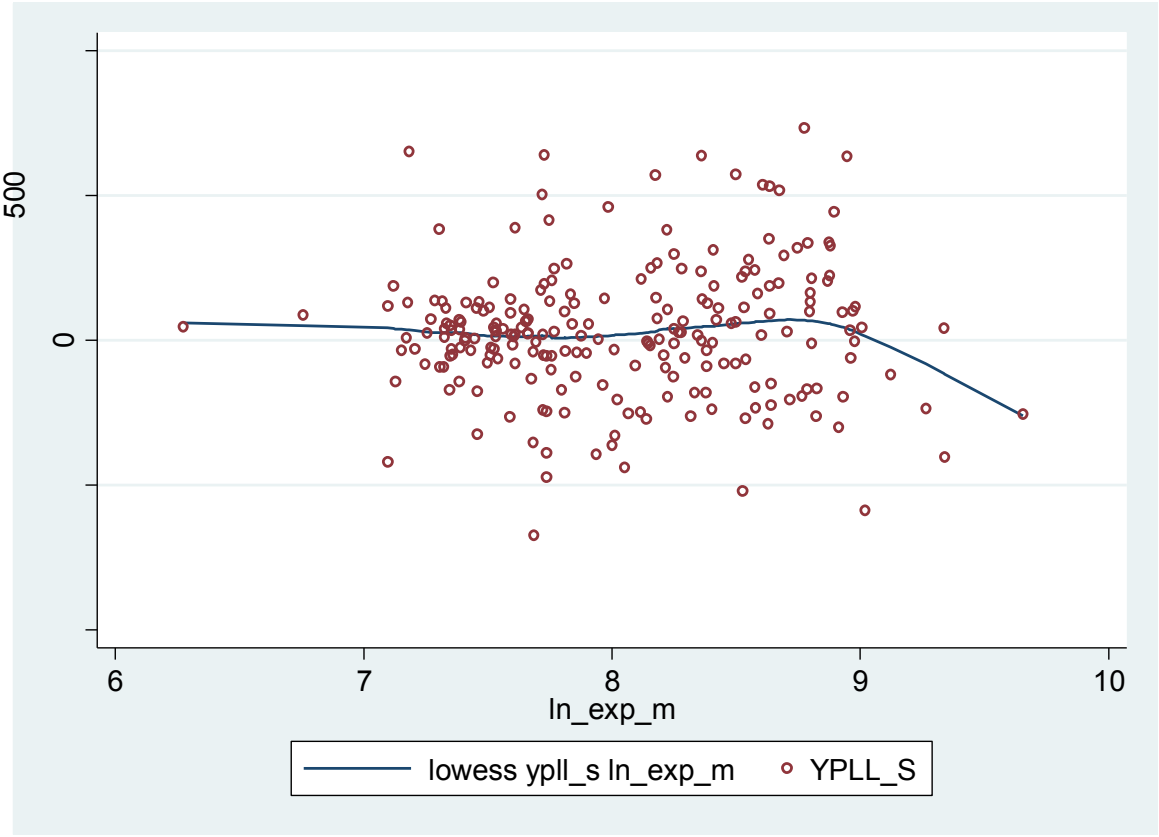
Independent Variables	Results (n = 230)			
	Coefficient			P-Value
	Mean	Lowest	Highest	
Mental expenditure	0.00005	-0.016	0.016	0.995
*log(mental exp)	15	-48	78	0.644
apartment	0.19	-1.3	1.7	0.796
Income	-0.009	-0.049	0.03	0.646
*log(NHI Fee)	9.6	-55	74	0.770
Health Budget	-0.78	-3.6	2.0	0.579
*log(Budget)	-12.8	-88	62	0.737
Smoking	3.1	-8.6	14.8	0.599
*Smoking_12	2.3	-12.5	17.1	0.760
Obesity	7.6	-3.2	18	0.169
*Obesity_12	-1.2	-14	12	0.856
Hypertension	11	-4.3	27	0.158
*Hyper_12	-5.6	-22	11	0.511
Diabetes	16	-8.6	41	0.202
*Diabetes_12	-15	-45	15	0.317
Stress	0.6	-5.2	6.3	0.849
*Stress_12	4.4	-3.8	12.5	0.294

Depression	3.0	-7.3	13.3	0.564
*Depress_12	2.3	-16	20	0.800
Physicians	3.8	-13.9	22	0.669
*log(physician)	-8.6	-85	68	0.826
Beds	4.7	-0.3	9.6	0.065
LOS	1.3	-49	51	0.959
*log(LOS)	4.6	-358	367	0.980
Visit Days	0.65	-7.3	8.6	0.871
*log(Visits)	27	-173	226	0.790
CT/MRI	-0.37	-2.97	2.2	0.781
*log(CTMRI)	-20.4	-53	12	0.213
Check-up	-0.20	-10.5	10.1	0.970
*Check-up®	3.3	-4.3	10.9	0.389
Over 65	-0.11	-5	4.8	0.964
Female	2.0	-30	34	0.899
Seoulmetro	70	-9.6	150	0.084

Table 4-22. Multivariate Analysis with 6 variables

Independent Variables	Results (n = 230) *P-value=0.2034, R^2=0.0371			
	Coefficient			P-Value
	Mean	Lowest	Highest	
*log(mental exp)	11.6	-67	90	0.773
Beds	4.1	-1.6	9.8	0.157
Obesity	8.1	-3.2	19.5	0.159
Hypertension	4.4	-13.5	22	0.630
Diabetes	9.1	-18.5	37	0.518
Stress_12	6.3	-3.0	15.6	0.184

Figure 22. Regression Two-way Line with lowess smoothing (ln_exp_m & YPLL_S)



4-4-2) Longitudinal Analysis (LDA)

Longitudinal Analyses (LDA) were designed to examine relationships at the local community level between the level of YPLL by suicides and the level of mental health care expenditures both in 2007 and in 2012. Based on Multivariate Analysis with the 8 independent variables[24] including the main variable – mental health care expenditures, a categorical variable regarding year – 2007 or 2012, was added to the model to perform the Longitudinal Analyses (LDA). To test the characteristics of Seoul Metropolitan Area and City Area, these two categorical variables were added to the model as well.

Among 11 independent variables, including the main independent variable (Mental Health Care Expenditure) and 1 control variables (% female), **Hypertension** was excluded after the bivariate analysis since the P-value (0.613) was higher than 0.05.

Following the Multi-collinearity analysis, **Depression and Seoul-Metro** area were excluded since the two independent variables showed high multi-collinearity with other independent variables. A Multivariate Analysis with 8

[24] In this Longitudinal Analysis, the variables obtained for both years – 2007 and 2012 were used, and the numbers of all samples were 462. (231 communities for each year)

independent variables was tested with a selection process to finalize the LDA model of mental health care. No interaction terms were found in this model.

Table 4-23. Bivariate Analysis with 11 variables for LDA

Independent Variables	Results (n = 462)			
	Coefficient			P-Value
	Mean	Lowest	Highest	
Mental Exp	0.016	0.011	0.022	0.000
*log(Exp)	132	92	172	0.000
Smoking	12	4.3	20	0.003
Obesity	16	9.2	23	0.000
Hypertension	2.4	-6.8	12	0.613
Diabetes	21	3.5	39	0.020
Stress	-4.2	-8.7	0.31	0.068
Depression	-8.1	-16	0.04	0.051
Year	68	22	114	0.004
Seoul-metro	146	96	196	0.000
City	166	120	212	0.000
Female	-9.4	-31	12	0.399

4-4-3) Final MLR (LDA) Model

In the final MLR(LDA) model of Mental Health Care (Table 4-24), one main independent variable (natural log of mental care expenditures) and 5 other independent variables were selected – **the Smoking Rate, the Obesity Rate, City, Year, and Female**. The overall p value of the model is 0.0000, and the overall explanatory capability (R^2) is about 17%.

First, 1 natural log of Mental care expenditure increase is associated with an increase of the YPLL as 105 (p value = 0.001) among communities. This suggests that the mental health care expenditure increase is not effective in terms of a YPLL decrease or Suicide decrease at the local community level in Korea.

Second, a 1% smoking rate increase is associated with a significant YPLLs increase by suicide (p value = 0.006), and a 1% obesity rate increase is associated with a significant increase in YPLLs by suicide (p = 0.033). Also in the rural area, YPLLs by suicide are 105 higher than in the city area. (p = 0.000)

Finally, the year change from 2007 to 2012 results in 13 YPLLs decrease by suicide, but it's not significant. (p = 0.711) The %female variable also did not

show any significant relationship with the level of YPLLs by suicide at the local community level in Korea.

Table 4-24. Final Multivariate Analysis for LDA

Independent Variables	Results (n = 462) *p value=0.000 (R^2=0.1671)			
	Coefficient			P-Value
	Mean	Lowest	Highest	
*log(Mental Exp)	105	42	169	0.001
Smoking	12	3.4	20	0.006
Obesity	9.0	0.7	17	0.033
Year	-13	-80	54	0.711
City	105	49	161	0.000
Female	-6.4	-30	17	0.595

Figure 23. Regression Two-way Line with lowess smoothing (ln_exp_m & YPLL_S)

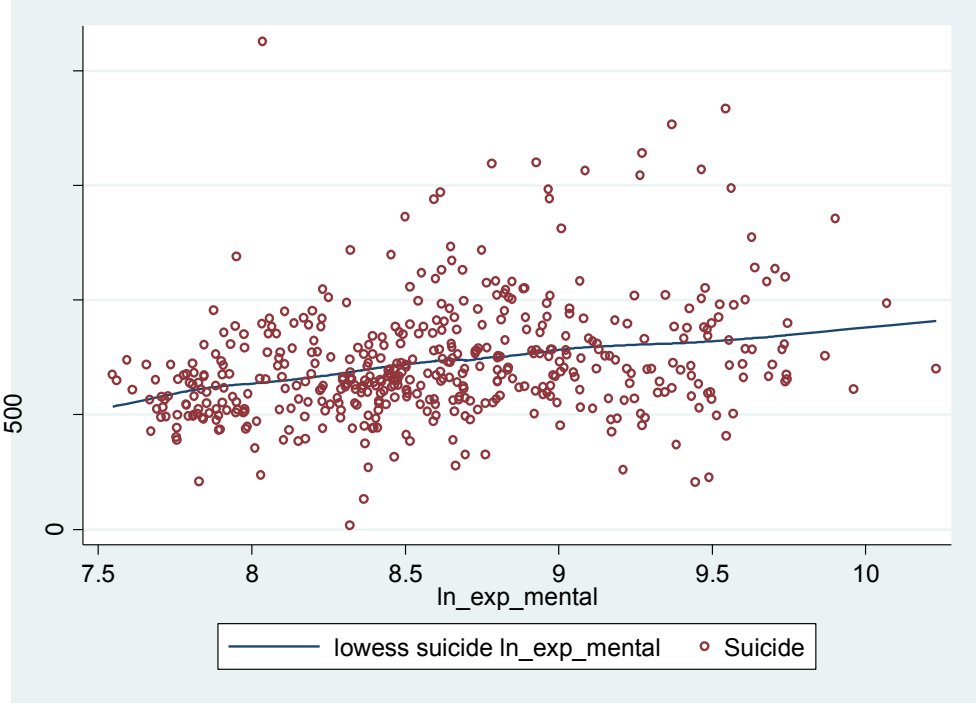


Table 4-25. Summary of Study Results

1) Effects of NHI Health Expenditure Increase on the averted YPLLs

Healthcare Services	Effects of NHI Health Expenditure (NHI HE) Increase	
	Increase of NHI HE ('07-'12)	Higher Increase of NHI HE among communities ('07-'12)
Overall	Positive averted YPLLs	Higher averted YPLLs
Cancer	Positive averted YPLLs	Lower averted YPLLs
Mental Health[25]	Increased YPLLs by Suicides	

2) Other Determinants of Health Contributing to More Averted YPLLs

Healthcare Services	Other Determinants of Health
Overall	Decrease of Depression Rate Lower LOS Higher Check-up Rate Higher Physician Rate
Cancer	Decrease of Hypertension Rate Decrease of Stress Rate Lower Depression Rate
Mental Health	Higher Smoking Rate (→ More YPLLs by Suicides) Higher Obesity Rate (→ More YPLLs by Suicides)

[25] LDA analysis on the relationship between NHI HE and YPLLs in each year – 2007 and 2012

3) Effect Modifiers Resulting in Higher Values of NHI HE on the Averted YPLLs

Health Services	Effect Modifiers
Overall	Communities with Higher Smoking Rates Communities with Lower Progress in Depression Rates Communities with Lower Physician Rates Communities with Lower Check-up Rates
Cancer	Communities with Lower Progress in Hypertension Rates Communities with Higher Depression Rates
Mental Health	-

4) Regional Characteristics Affecting Values of NHI HE on the Averted YPLLs

Health Services	Regional Characteristics
Overall	Seoul Metro Area (Higher Value) City Area (Lower Value)
Cancer	Non-Seoul Metro Area (Lower Value) City Area (Higher Value)
Mental Health	City Area (→ More YPLLs by Suicides)

Chapter 5: Discussion of Results and Implications

5.1. Discussion of Study Results

First, with the traditional value analyses based just on the relationship between the NHI HE increase and the averted YPLLs, we can tentatively conclude that in the overall and cancer care services, the NHI HE increase from 2007 to 2012 is associated with the averted YPLLs from 2007 to 2012. However the value ratios (NHI HE increase per 1 YPLL decrease) varied by communities and there was no specific threshold (ceiling ratio) to indicate if the ratios showed good values for money for achieving the adequate value of local health services under the NHI system in South Korea.

But in the mental health care services, I could not conclude if the NHI HE increase from 2007 to 2012 contributed to the averted YPLLs by suicides or not, since about 40% of all the communities showed an increase of YPLLs by suicides between 2007 and 2012 regardless of the NHI HE increase in the mental health care services between 2007 and 2012.

More specifically, from the main MLR analyses which expanded the number of independent variables from only the NHI expenditures to the additional 16 determinants of health at the local community level, I could find that there were various determinants of health which modified the values of HS as well as affecting the averted YPLLs directly. Also in the case of the values of HS adjusted by various determinants of health, the value ratios between the averted YPLLs and the NHI HE were somewhat different from the results of the traditional value analyses which didn't control for the effects of other health determinants on the averted YPLLs.

The discussion of the results of the main MLR analyses for the 3 health care services – overall, cancer, and mental health care are summarized below.

5-1-1) **Overall Healthcare Services in South Korea**

From the final MLR model of the value of HS in overall healthcare, it was found that the communities with bigger increases in the NHI HE showed better health outcomes in terms of the averted YPLLs compared with the communities with smaller increases in the NHI HE between 2007 and 2012. Considering that

the NHI HE increase means more utilization of NHI healthcare services, it can be concluded that the allocation of financial resources under Korea's NHI system at the local community level was associated with better health outcomes in terms of reducing premature death before age 75 between 2007 and 2012.

Regardless of the level of NHI HE for the overall healthcare, the communities with more improvement in the depression rate, a higher physician to population ratio, and higher check-up rate on average also showed more improvement in the averted YPLLs from 2007 to 2012. In contrast, the communities with longer average hospital LOS showed worse health outcomes in terms of the YPLLs-75 increase compared with the communities with shorter average LOS. Although it was not statistically significant, the communities with a higher number of hospital beds and lower smoking rates also showed higher decreases of YPLLs between 2007 and 2012.

Although these results regarding the relationship between specific determinants of health and the averted YPLLs should be tested at the individual level in follow-up studies, these results suggest that certain health determinants in terms of better health resources and individual biological factors might directly affect the variations of YPLLs at the local community level regardless of

the level of NHI HE. It can also be inferred that better health resources on average in terms of more physicians and more check-ups, and better improvement in mental health on average might be associated with better health outcomes in terms of less premature deaths at the local community level in South Korea. But there are certain limitations that need to be mentioned regarding the relationship between the specific determinants and the averted YPLLs from these study results since this study is a meso-level study based on the community level data as the unit of analysis.

From the final MLR model of overall healthcare, it was also found that some health determinants result in an effect modification on the value of HS expenditures on averted YPLLs. In the communities with lower physician rates, higher smoking rates (not statistically significant), lower improvement in depression rates, and lower check-up rates, this study showed that the value of HS improved. In fact, in the communities with lower health status and resources on average in terms of physician rates, depression, smoking, and check-up rates, the values of HS showed better ratios than in the communities with better health status and resources on average.

From these results with regards to the modification of the value of HS, it can be inferred that the value of HS for the overall healthcare might be less in the relatively high health performance communities on average. This result might also imply that in the relatively high health performance areas, there might be inefficient or excessive utilization of HS due to the NHI benefits without improving health outcomes in terms of less premature deaths.

According to the analysis of the regional characteristics for the overall healthcare services, in the Seoul Metropolitan Area, the association between YPLLs and NHI expenditures showed higher value compared with the non-Seoul Metropolitan Area. This might imply that the Seoul Metropolitan Area has a relatively efficient health care system compared with the non-Seoul Metropolitan Area on average. Also in the Rural Area, the value of HS was better compared with the City Area, although it was not statistically significant.

Generally speaking, relatively underdeveloped areas like the non-Seoul metropolitan area and rural areas might have relatively larger efficiency gaps in their health care systems. And so it might be inferred that the return on investment for NHI expenditures on the health performance might be lower in the underdeveloped areas. But this study showed unclear results for the rural

areas. More studies on these gaps and variations at the local community level should be conducted in the future.

5-1-2) Cancer Care Services in South Korea

From the final MLR model on the value of HS in cancer care, it might be assessed that the communities with larger increases in NHI cancer expenditures had worse health outcomes in terms of the averted YPLLs compared with the communities with smaller increases in the NHI cancer expenditures. Considering that an NHI cancer expenditure increase means more utilization of NHI cancer care services, it can be assessed that the allocation of financial resources under Korea's NHI cancer care system wasn't associated with better health outcomes in terms of reducing premature death between 2007 and 2012 at the local community level in South Korea.

This result is quite interesting and surprising because most communities showed fewer premature deaths by the 5 cancers when NHI cancer expenditures were increased from 2007 to 2012 in the traditional value of HS analysis just considering two variables – the averted YPLLs and NHI cancer expenditures.

This result suggests that as the NHI cancer expenditure were increasing among communities, the averted YPLLs-75 were decreasing, although the NHI cancer expenditure increases were associated with fewer premature deaths by cancers in most communities from 2007 to 2012.

Regardless of the NHI cancer expenditure increases, the communities with more improvement in hypertension and stress rates, and lower depression rates showed better progress in the averted YPLLs from 2007 to 2012. It was also found that the communities with higher numbers of hospital beds to total local population and higher smoking rates in 2012 had larger decreases of YPLLs between 2007 and 2012, but these associations were not statistically significant. The communities with more improvement in diabetes rates between 2007 and 2012 showed higher increases of YPLLs between 2007 and 2012, but this was not statistically significant either.

Although these results regarding the relationships between specific determinants of health and the averted YPLLs in cancer care should be tested at the individual patient level in follow-up studies, these results might imply that certain health determinants in terms of better biological and psychological factors might directly affect the variations of YPLLs at the local community level

regardless of the level of NHI HE in cancer cares. It can also be inferred that more improvement in health status including mental health might contribute to better health performance in terms of less premature deaths by cancers.

Although these results may suggest the importance of better management of biological and psychological health factors including stress and depression for cancer care outcomes regardless of the NHI cancer expenditures, there are limitations that should be mentioned. The relationships between the specific health determinants and the averted YPLLs from cancers based on these study results must be viewed with caution since this study is a meso-level study based on the aggregate data at the local community level as the unit of analysis. But it can be inferred that the averted YPLLs by cancers between 2007 and 2012 might not be caused by the NHI cancer expenditure increases, but by other determinants of health including better management and promotion of biological and psychological factors at the local community level in South Korea.

From the final MLR model for cancer care, it was also found that some health determinants resulted in the effect modification on the value of HS for cancer care. In the communities with increased hypertension rates from 2007 to 2012 and bigger depression rates in 2012, the negative effects of NHI cancer care

expenditure increases on the averted YPLLs by cancers were less. This implies that in the communities with lower health performance in terms of hypertension and depression, the value of HS for cancer care might show better outcomes. This result is in line with the case of overall HS so that there is a possibility that the return of NHI HE investment on relatively poor health performance communities might get bigger on average compared with high health performance communities.

According to the analysis of the regional characteristics for cancer care services, in the non-Seoul Metropolitan Area and rural areas, it was found that the value of HS for cancer care decreased. This might imply that in the case of cancer treatment under the NHI system, underdeveloped areas could show relatively less value of HS and more negative returns on investment. This is possibly due to certain environmental health factors like poor transportation between home and cancer centers and so they might tend to stay longer or use more or excessive services in cancer centers on average. But more studies on this should be conducted in the future.

In addition, significant relationships were not found between the value of HS in cancer care and some other health utilization variables like number of

physicians, number of high priced health equipment, LOS, and number of hospital visits at the local community level.

5-1-3) Mental Health Care Services in South Korea

From the traditional (bivariate) value analysis of mental health care services, it was found that the increase in the NHI HE between 2007 and 2012 may not be associated with the averted YPLLs by suicides between 2007 and 2012. Although the mental care expenditures increased between 2007 and 2012, the YPLLs by suicides have also increased in nearly 40% of all the communities between 2007 and 2012. And therefore Korea's mental HE or mental health services under the NHI system might not be effective in decreasing YPLLs by suicides between 2007 and 2012.

Both in the Bivariate and Multivariate Analyses of the values of HS in mental health care, no potential relationships between the averted YPLLs-75 by suicides and the mental HE increase from 2007 to 2012, were found. But a LDA analysis was also performed of the relationships between the levels of YPLLs by suicides and possible health determinants including the NHI mental HE at the

local community level. Based on the LDA model, including both 2007 and 2012 data, it was found that the communities with higher NHI mental HE, higher smoking rates to total local population, and higher obesity rates to total population showed higher YPLLs by suicides. The year change between 2007 and 2012 didn't show any significant influence on the level of YPLLs by suicide which is in line with the value analysis and the MLR analysis on the value of HS in mental health care.

In South Korea, it is quite surprising that the communities with the higher NHI mental HE had more premature deaths by suicides both in 2007 and in 2012. This result is in line with the result of the traditional value analysis on the value ratios between the mental HE and the averted YPLLs by suicides as we've discussed previously.

Moreover, it might also be of interest that certain behavioral and biological factors like smoking and obesity could have relationships with the averted YPLLs by suicides at the local community level. Although these results on the relationship between specific determinants of health and the averted YPLLs by suicides should be tested at the individual level in follow-up studies, these results show that there are some possibilities that worse behavioral and

biological status on average might be associated with certain psychological processes leading to more and younger deaths by suicides. More studies on these possibilities should be conducted in the future.

In the case of the City areas analysis, it was also found that the YPLLs by suicide were larger than those in rural areas. It might be interpreted that in the case of mental health care, city areas are more vulnerable to suicides, possibly due to psychological factors like highly competitive environments and workplaces in modern society. More studies on this should be conducted in the future as well.

5-1-4) Conclusion

Overall, the recently increased NHI HE at the local community level was associated with a decrease of premature deaths under the Korean NHI system. But the regional variations in the values of HS were somewhat large. Specifically, when the various determinants of health were considered and controlled in the MLR model, the influences of the NHI HE increases on the health outcomes (the averted YPLLs) were very limited. More specifically it was found that in the

very important healthcare service areas like cancer care and mental health care, the values of HS showed negative ratios and diminishing trends as the NHI HE increased among communities.

Regardless of NHI HE's increases, certain determinants of health including some biological and behavioral factors, affected the health outcomes directly and modified the values of NHI HE as well. Therefore, improving the indicators of biological and behavioral health status might be very important in South Korea in order to improve health outcomes in terms of YPLLs at the local community level.

Low health performance areas due to certain biological and psychological factors, showed higher value of HS both in overall healthcare and cancer care services. This might imply that health policies in terms of NHI HE should target the areas with lower health performance in the context of return on investment as well as equity. More targeted health policy under the NHI system should be addressed to decrease YPLLs in the future.

5.2. Policy Implications and Recommendations

This meso level study suggests that the local community level might be useful as a unit of analysis to assess present NHI HE policy and their outcomes, and therefore, to design more focused and efficient local health policies in Korea. This study can also be a first step to determine potential health predictors which can help explain and affect regional disparities and variations in the value of HS and health outcomes at the local community level in Korea.

From this meso-level study on the value of HS under the Korean NHI system, it might be inferred that the effects of HE increases on premature death are limited and vary significantly at the local community level. In fact, at the country level analysis on the value of HS, the results showed all positive effects of HE increases on premature death – Overall (Averted YPLLs: 444,366, HE increase: 9.4 trillion KRW), Cancer (Averted YPLLs: 66,037, HE increase: 413 billion KRW), Suicide (Averted YPLLs: 8351, HE increase: 843 billion KRW). But these meso-level study results showed that in the cases of cancer and mental health care, there were negative value ratios which might imply that the increased HE did not contribute to the averted YPLLs between 2007 and 2012 at the local community level. This study also showed that there are strong

possibilities that certain health determinants in terms of biological and behavioral factors might directly affect the averted YPLLs at the local community level regardless of the level of NHI HE. This result suggests that the effects of NHI HE by itself might have some limitations with regard to increasing health outcomes at the local community level, and so other public health policies to manage determinants of health should be addressed to improve health outcomes as well. Therefore, policy efforts to manage determinants of health at the local community level as well as to make the NHI system more efficient should be emphasized simultaneously in the future.

Another important implication of this study is that in the already high health performance communities, the value of HS might be lower than in the relatively poor health performance communities. In the perspective of value for money spent as well as equity, this might suggest that more financial resources should be allocated to the relatively poor health performance communities under the Korean NHI system.

Moreover, this study might provide important policy implications that simple health policies to increase NHI benefits for certain medical services may not be able to produce the improvement of health outcomes and performance

substantially. Especially, in terms of the value of HS perspective, the simple benefit increase policy for high priced medical services without suitable value analyses may not result in desirable health outcomes at the local community level in Korea. Therefore, from this study, other efficient ways, like better management of behavioral and biological health factors before implementing benefit increases in NHI policy, should be emphasized for the improvement of local health outcomes in order to produce higher value of HS at the local community level in Korea. A recent study also pointed out that in the advanced countries with already high life expectancies, further progress in the life expectancies might not be explained by more medical care resources but by better management of social determinants on chronic and non-communicable diseases. (Bishai & O'Neil, 2012)

Based on these policy implications, some important future health policy recommendations are summarized in the next sections.

5-2-1) Introduction of Periodic Assessment of the Value of NHI HE

Generally speaking, the increasing cost of medical care, limited financial

resources, and excessive and inappropriate utilization of high priced healthcare services and technologies are leading to debates on limiting healthcare services based on the associated health outcomes and values. Korea is not an exception. Therefore, it might be very useful to follow up on the assessment of outcomes and value of NHI HE periodically at the local community level in the future to optimize the outcomes of local health services together with the adoption of new high-priced medicines and treatment technologies in Korea.

The assessment could be expanded to various specific disease services and different age groups to obtain more information on the values of NHI HS. Although overall the NHI HS have contributed to better health outcomes and higher values at the local community level, the assessment of the various specific HS like cancer care, preventive care, and chronic care might not be efficient. And therefore the allocation of financial resources under the NHI system for different disease services and different age groups could be redesigned in the future based on their value assessment in order to increase their values for money spent in the NHI HS in terms of less premature death. This approach will make the NHI HS more targeted to tackle the Korea's ageing population problems in the future as well.

The main decision making on the coverage of certain medical services in the NHI benefit package should also be based on needs, effectiveness, safety, and costs. Sometimes, our political system doesn't allow reasonable discussion or decision-making processes here. The Korean government should be careful about the analyses of value assessment on NHI HE and the decision-making on the expansion of NHI benefits should be based on the results of reasonable value assessment and cost-effectiveness analysis, not by political philosophies and interests. (Rice & Unruh, 2009, p.365-367)

5-2-2) Public Health Policies to Manage Biological and Behavioral Factors

Considering that the NHI HS alone have certain limitations to produce better health outcomes and higher values, various health policies to manage the determinants of health including biological and behavioral health factors should be more emphasized in order to produce better health outcomes and higher value of HS at the local community level. While there are many debates about how much medical service can contribute to increase the life expectancy or other health outcomes, a lot of experts have suggested that better management of health determinants including preventing and controlling health risk factors can

directly contribute to less premature death under the NHI system regardless of the level of NHI HE.

According to a National Health Services (NHS) case study in the UK, most of the annual NHS expenditures to treat the patients with diabetes are used up by the costs of treating life-threatening complications which are the result of a failure to keep a patient's diabetes under control. Noting that the NHS will face a tremendous financial deficit in the diabetes treatment in the near future without a radical shift, now the NHS is attempting to change from hospital based care to preventing and controlling diabetes. (Financial Times, 2014)

Above all else, the NHIC and MOHW in Korea should provide more incentives for local healthcare institutions which operate better preventive services, and consider more insurance benefits at the local level for patients who manage their health risk factors well in the primary community health centers under the NHI system. Local government should also highlight various health promotion and education programs at the local community level which could result in suitable biological and behavioral change for better health outcomes in the future.

5-2-3) Innovation in the Cancer and Mental Health Care Systems under NHI

Considering the negative values of HS for cancer and mental health care in spite of the big increases in NHI HE between 2007 and 2012, cancer and mental health care systems in Korea may need to be reformed in the near future.

In the case of cancer care, many experts have pointed out that inpatient services based cancer care in Korea should be transformed to outpatient services based cancer care and recovery services in primary health centers or long term care centers in the local communities. But more generous NHI benefit policies might incentivize cancer patients to stay longer and get more inpatient services in hospitals. Although more studies on the inefficiency of cancer care in Korea should be conducted, certain policy directions which could increase the value of HS in cancer care should be considered by the NHIC and MOHW in the future.

Similar problems also have been pointed out in the mental health care system in Korea. According to a recent report from OECD, Korea is the only OECD country where the numbers of mental health care beds have increased steadily. They also pointed out that more mental health care beds and psychiatric hospitals have been used to treat less acute mental problems with longer stays and so hospitalized treatment in mental health care is too much of a

general trend in Korea, while most OECD countries usually manage mental health diseases in community settings, not in the hospital settings. (OECD, 2014) The hospital based treatment in mental health care with traditionally negative stigma in Korea might tend to move a lot of potential patients with mental illness away from mental health treatment at the local community level. In this context, these analyses can have very important implications for the direction of mental health care innovations to increase the value of HS in the Korean mental health care system.

5-2-4) More Targeted Health Policy for Low Health Performance Communities

These study results also suggest that in the low health performance communities in terms of certain behavioral and biological factors like smoking, hypertension, and depression rates, the value of every dollar spent in the NHI HS might be larger than in the high health performance communities. This result could be well supported by political interests in terms of the equity perspective. And therefore in the case of low health performance communities, health policies to increase access and exposure to NHI HS as well as more generous NHI

benefits focusing on those communities might be more effective in producing fewer premature deaths in Korea.

To increase access to care and utilization of NHI HS in the relatively poor health performance communities, the NHIC, MOHW, and local governments should implement various policy measures to build up well-functioning local community healthcare systems in those areas. Using well-advanced information technology in Korea might be a cost-effective option to increase access to the NHI healthcare services as well.

5. 3. Limitations

Regardless of the policy implications and recommendations, several limitations in this study should be mentioned.

First, this study used the averted YPLLs as the health outcome based on the premature death alone, but did not consider change in disabilities or quality of life. As we have seen in the literature review, a well-known method to measure the change in disabilities is the DALYs method. Since measuring the improvement in disabilities as a result of healthcare services depends on individual perceptions of disabilities or suffering, the DALYs method also has certain limitations in generalizability. At this point, reliable data on DALYs and YLDs (Years Lived with Disabilities) are not available at the local community level in Korea, and the DALYs method itself is still debated among researchers regarding how to calculate specifically in Korea as well. But since there must be improvement in disabilities or suffering as a result of healthcare services, this study on the health outcomes using YPLLs might underestimate the value of NHI HS. Moreover, although this study used the averted YPLLs as the health outcome, considering the aging population problem in Korea, various health

outcome models other than YPLLs might be better suited to provide evidence for specific health policies under consideration to address aging issues.

Second, the NHI HE in this study is calculated by total expenditures on medical services and prescription medicines based on the NHIC claim database from medical institutions and pharmacies. Although the NHI is the universal health insurance system in Korea, there are many unofficial medical services including private health care services and Over the Counter (OTC) medicines which are not registered in the NHI policy and these costs were not counted in this study. Also indirect costs like transportation cost from home to hospital and opportunity costs like time charge during hospital treatments were not considered. Therefore, the estimates on HE in this study are likely to underestimate the real costs of healthcare services. Moreover, although the average NHI HE per 100,000 population in all local communities were used in this study, the average cost data for all age stratifications at the community level between 2007 and 2012 were not available and not considered in this study. Since the incremental cost data between 2007 and 2012 were used in this study, the effects of using average cost data across all age stratifications on the value of the HS calculation might be limited. But in the future, if the average cost data for

all age stratifications are available at the local community level, it would be useful to calculate the value of HS for different age groups at the local community level and this might give more exact health policy implications to reform the present local healthcare system in Korea.

Third, since this study is based on a meso level analysis by using the communities as analysis units, the validity of the value of the HS model should be improved in follow-up studies based on individual patient level data. Since this study was not designed by the experiment study method based on individual patient level data, this study might have big limitations regarding generalizability. Especially, the various relationships between the averted YPLLs and each health determinant like depression and hypertension should be supported based on individual patient level data in order to define their exact relationships and avoid the problem of the so called "ecological fallacy". But it could still be meaningful to establish a meso-level value model in the real health care settings as a new frontier of public health policy study. Based on these study results, it might be more useful if more studies and policy actions could be focused on finding potential relationships between health outcomes and determinants of health based on individual level panel data in the future, and

highlight the outcome gaps and disparities among local communities in the country specific health care context.

Fourth, although 16 determinants of health were included in the MLR models, there might be other determinants of health like the economic growth rate, income growth rate, and education level which could affect the value of HS or the health outcomes – the averted YPLLs. And so more determinants of health should be considered when those variables are available at the local community level in the future. Since many determinants of health as well as NHI HE were recognized to affect the averted YPLLs at the local community level in this study, more potential health related factors could be defined and their influences should be controlled to obtain more exact study results regarding the value of NHI HS. For example, the incremental increase of YPLLs between 2007 and 2012 due to suicides in Korea might be influenced by the economic downturn in the aftermath of the global financial crisis. So if we include more socio-economic variables in the models, the internal validity and the explanatory capabilities could be improved.

Last but not the least, the study period - 5 years from 2007 to 2012 might be short and have certain limitations in measuring the exact value of HS. Since

the real effects of medical services on death would have certain time lags, the change of health outcomes in terms of the averted YPLLs by more healthcare services could be measured more precisely in the longer time frame. More specifically, the effects of cancer and mental health care on death could be realized some years later after the treatments in medical institutions or in the community. So longer time frames should be emphasized and used in future follow-up studies. It might be very useful to follow up on the value of HS at the local community level periodically in the future to utilize the value information to reform local healthcare systems and optimize the outcomes of local health services as an ongoing process of Korean healthcare innovation.

5. 4. Conclusion

In conclusion, the NHI HE has increased substantially from 2007 and 2012, and the money spent has provided overall fewer premature deaths and a positive value of overall HS at the local community level in Korea. But in the case of cancer care, the increased HE for cancer treatment has not provided fewer premature deaths at the local community level and the recent policy to increase cancer treatment benefits substantially in Korea might have big limitations in terms of the averted YPLLs, at least in the relatively short term. In the case of mental health care, the increased HE for mental health care was not associated with fewer premature deaths by suicides at the local community level in Korea in either 2007 or 2012. And so it was inferred that more healthcare services in cancer and mental health care has not provided fewer premature deaths at the local community level in Korea. We need to continue to track the trends in HE and associated health outcomes to ensure that the financial resources under the Korea NHI system can be allocated more wisely before we introduce more generous benefits for certain NHI HS.

This study also suggested that in addition to HE there are many predictors associated with health outcomes and the value of HS at the local community

level. Although the specific relationships between the determinants of health and health outcomes should be supported in follow-up studies based on individual patient level panel data, policy makers should consider those various determinants of health to reform the present health system toward greater efficiency. More specifically, better and more effective management of biological and behavioral health factors at the local community level should be considered one of the top priorities in local healthcare reform to increase desirable health outcomes.

Because of new developments in health technology and medicines as well as the aging population, most governments globally consider that their overburdened health systems should battle to contain their health costs and expenditures as well as to maintain health outcomes. This trend is not an exception to Korea. Specifically, I tried to construct a meso level theoretical model for how public health policies and interventions on determinants of health can increase the value of HS and health outcomes in the given local community health care context and situation, suggesting how to improve value for money and efficiency in the local health care system in South Korea. These meso level study results help supplement certain limitations of the country level studies and

cross-country level studies on the efficiency of health expenditures which have been used broadly, especially in the international organizations like WHO and IMF.

The results of this meso level study also suggest that the national health insurance policy with regard to better coverage and higher priced medical treatment utilization should be balanced by interventions not only to ensure the most efficient health utilization and resource allocation to optimize the health care delivery at the local community level, but also to address various determinants of health, such as suitable health promotion and prevention programs. Moreover, considering the budget constraints and restrictions to adopt new high-priced medical services, and to increase NHI benefits, the reallocation of financial resources within the NHI system in order to maximize the value of HS and quality of local health care services in the given health care situation should be highlighted.

In this context, more research studies on the relationships between local health outcomes and the determinants of health around the reality of local health care services under the Korean NHI system should be conducted in the future. In addition, more policy efforts should be focused on incentivizing local patients

and providers to utilize existing high-priced and inpatient-centered medical services like cancer and mental health care more efficiently and utilize more cost-effective health care services to decrease the burden of deaths as well as HE. These efforts will result in financially stable and sustainable efforts, and more importantly balanced and equitable health care services under the NHI system in Korea as well. I hope this study can also facilitate the health policy studies on the value of health care services at the local community level in the future so that policymakers and the public should have an informed picture of the value for money spent in health care services.

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Appendices

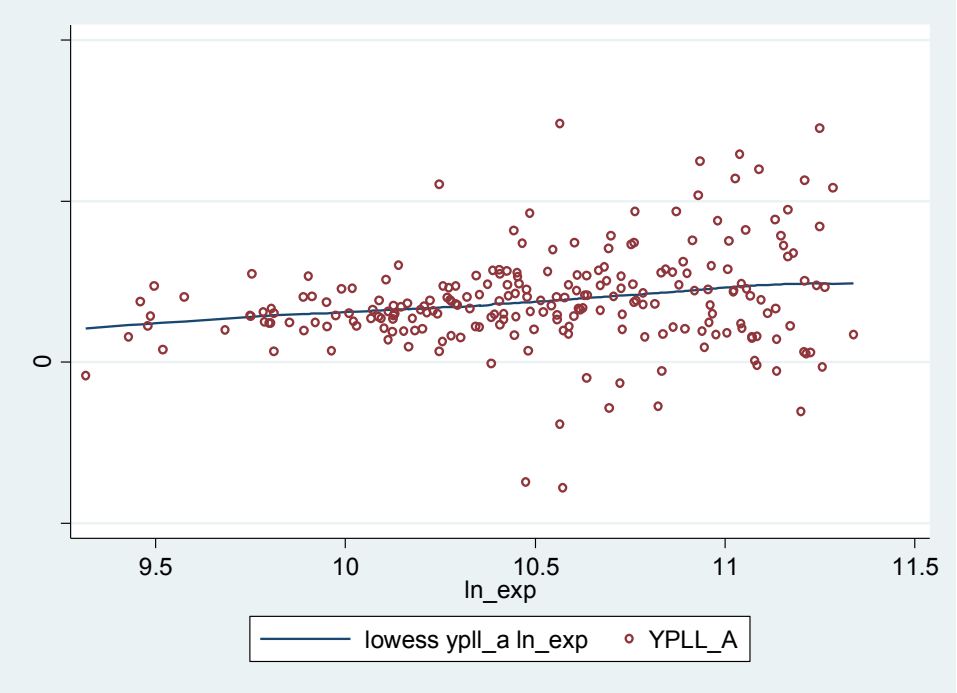
Annex 1. Stata Results

1) Final Model (Overall Health Care)

```
. reg ypll_a ln_exp smoke12 depression ln_physi ln_beds ln_los checkup_done_10 exp_depress exp_physi exp_chec
> p_smoking
```

Source	SS	df	MS		
Model	117642426	11	10694766	Number of obs	= 230
Residual	413555867	218	1897045.26	F(11, 218)	= 5.64
				Prob > F	= 0.0000
Total	531198293	229	2319643.2	R-squared	= 0.2215
				Adj R-squared	= 0.1822
				Root MSE	= 1377.3

ypll_a	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp	9574.348	4192.553	2.28	0.023	1311.221	17837.48
smoke12	-1157.302	829.679	-1.39	0.164	-2792.522	477.9166
depression	2041.991	650.5391	3.14	0.002	759.8401	3324.142
ln_physi	9383.286	4926.635	1.90	0.058	-326.6462	19093.22
ln_beds	258.5307	186.6901	1.38	0.168	-109.4179	626.4794
ln_los	-2294.301	1119.239	-2.05	0.042	-4500.215	-88.38756
checkup_done_10	1418.507	608.0465	2.33	0.021	220.1045	2616.909
exp_depress	-196.3642	61.10533	-3.21	0.002	-316.797	-75.93137
exp_physi	-977.0579	470.5241	-2.08	0.039	-1904.417	-49.69929
exp_check	-145.3249	58.16743	-2.50	0.013	-259.9675	-30.68242
exp_smoking	113.8026	78.75857	1.44	0.150	-41.42314	269.0283
_cons	-87299.24	44127.97	-1.98	0.049	-174271.3	-327.1756




```
. reg ypll_a ln_exp smoke12 depression ln_physi ln_beds ln_los checkup_done_10 exp_depress exp_physi exp_check ex
> p_smoking city seoulmetro
```

Source	SS	df	MS
Model	119756221	13	9212016.99
Residual	411442072	216	1904824.41
Total	531198293	229	2319643.2

Number of obs	230
F(13, 216)	4.84
Prob > F	0.0000
R-squared	0.2254
Adj R-squared	0.1788
Root MSE	1380.2

ypll_a	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp	9979.283	4366.896	2.29	0.023	1372.099	18586.47
smoke12	-1105.204	852.482	-1.30	0.196	-2785.453	575.044
depression	2092.529	653.635	3.20	0.002	804.2095	3380.848
ln_physi	9835.43	4961.956	1.98	0.049	55.37821	19615.48
ln_beds	239.1865	188.686	1.27	0.206	-132.715	611.088
ln_los	-1888.868	1189.093	-1.59	0.114	-4232.579	454.8439
checkup_done_10	1447.175	638.8606	2.27	0.024	187.9759	2706.374
exp_depress	-201.2395	61.40514	-3.28	0.001	-322.2695	-80.20948
exp_physi	-1023.812	474.6037	-2.16	0.032	-1959.259	-88.36413
exp_check	-149.2328	61.0693	-2.44	0.015	-269.6008	-28.86476
exp_smoking	109.0263	80.94048	1.35	0.179	-50.50795	268.5606
city	-205.2533	287.443	-0.71	0.476	-771.8056	361.2991
seoulmetro	260.9906	298.7984	0.87	0.383	-327.9432	849.9244
_cons	-91589.54	45893.61	-2.00	0.047	-182046.2	-1132.884

```
. reg ypll_a ln_exp smoke12 depression ln_physi ln_beds ln_los checkup_done_10 exp_depress exp_physi exp_check ex
> p_smoking city
```

Source	SS	df	MS		
Model	118302944	12	9858578.7	Number of obs	230
Residual	412895348	217	1902743.54	F(12, 217)	5.18
				Prob > F	0.0000
				R-squared	0.2227
				Adj R-squared	0.1797
Total	531198293	229	2319643.2	Root MSE	1379.4

ypll_a	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp	10251.66	4353.368	2.35	0.019	1671.36	18831.96
smoke12	-1229.841	839.9957	-1.46	0.145	-2885.436	425.7535
depression	2058.182	652.0947	3.16	0.002	772.9322	3343.432
ln_physi	9649.552	4954.682	1.95	0.053	-115.9091	19415.01
ln_beds	244.4768	188.4857	1.30	0.196	-127.0203	615.974
ln_los	-2123.982	1157.593	-1.83	0.068	-4405.548	157.5841
checkup_done_10	1520.32	633.0024	2.40	0.017	272.6999	2767.94
exp_depress	-197.8779	61.25094	-3.23	0.001	-318.6009	-77.155
exp_physi	-1006.937	473.9513	-2.12	0.035	-1941.075	-72.80024
exp_check	-155.2582	60.64529	-2.56	0.011	-274.7874	-35.72902
exp_smoking	120.8017	79.76629	1.51	0.131	-36.4142	278.0176
city	-167.3221	283.9885	-0.59	0.556	-727.051	392.4069
_cons	-94299.85	45763.58	-2.06	0.041	-184497.9	-4101.842

```
. reg ypll_a ln_exp smoke12 depression ln_physi ln_beds ln_los checkup_done_10 exp_depress exp_physi exp_check ex
> p_smoking seoulmetro
```

Source	SS	df	MS		
Model	118784970	12	9898747.48	Number of obs	230
Residual	412413323	217	1900522.23	F(12, 217)	5.21
				Prob > F	0.0000
				R-squared	0.2236
				Adj R-squared	0.1807
Total	531198293	229	2319643.2	Root MSE	1378.6

ypll_a	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp	9201.033	4223.925	2.18	0.030	875.8616	17526.2
smoke12	-1033.646	845.6147	-1.22	0.223	-2700.315	633.024
depression	2068.879	652.0577	3.17	0.002	783.7014	3354.056
ln_physi	9493.3	4933.189	1.92	0.056	-229.7988	19216.4
ln_beds	256.6862	186.8763	1.37	0.171	-111.6388	625.0112
ln_los	-2122.067	1142.075	-1.86	0.065	-4373.047	128.9132
checkup_done_10	1334.165	618.2481	2.16	0.032	115.6254	2552.705
exp_depress	-199.0098	61.25641	-3.25	0.001	-319.7435	-78.27611
exp_physi	-985.911	471.0935	-2.09	0.038	-1914.416	-57.40624
exp_check	-138.07	58.96782	-2.34	0.020	-254.293	-21.84696
exp_smoking	102.0908	80.26482	1.27	0.205	-56.10762	260.2893
seoulmetro	228.7566	295.035	0.78	0.439	-352.7446	810.2577
_cons	-83532.66	44434.74	-1.88	0.061	-171111.6	4046.264

```
.
```

Seoulmetro Area (n=66) vs. non-Seoulmetro (n=164)

```
. reg ypll_a ln_exp smoke12 depression ln_physi ln_beds ln_los checkup_done_10 exp_depress exp_physi exp_check ex
> p_smoking if seoulmetro==1
```

Source	SS	df	MS		
Model	13174373.2	11	1197670.29	Number of obs	= 66
Residual	20750847.3	54	384274.95	F(11, 54)	= 3.12
				Prob > F	= 0.0026
Total	33925220.5	65	521926.47	R-squared	= 0.3883
				Adj R-squared	= 0.2637
				Root MSE	= 619.9

ypll_a	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp	14020.05	4996.998	2.81	0.007	4001.671	24038.42
smoke12	-1331.555	1006.419	-1.32	0.191	-3349.303	686.1932
depression	-1350.225	905.0075	-1.49	0.142	-3164.655	464.2061
ln_physi	5416.952	4935.969	1.10	0.277	-4479.07	15312.97
ln_beds	359.2113	193.5042	1.86	0.069	-28.7412	747.1637
ln_los	2494.529	1778.304	1.40	0.166	-1070.755	6059.813
checkup_done_10	2437.43	771.3954	3.16	0.003	890.8752	3983.985
exp_depress	134.347	88.27626	1.52	0.134	-42.63623	311.3303
exp_physi	-575.7164	484.8132	-1.19	0.240	-1547.708	396.2755
exp_check	-236.3469	76.2034	-3.10	0.003	-389.1255	-83.56828
exp_smoking	124.7153	99.01588	1.26	0.213	-73.79958	323.2302
_cons	-147391.1	50180.27	-2.94	0.005	-247996.5	-46785.7

```
. reg ypll_a ln_exp smoke12 depression ln_physi ln_beds ln_los checkup_done_10 exp_depress exp_physi exp_check ex
> p_smoking if seoulmetro==2
```

Source	SS	df	MS		
Model	98456802	11	8950618.36	Number of obs	= 164
Residual	381175024	152	2507730.42	F(11, 152)	= 3.57
				Prob > F	= 0.0002
Total	479631826	163	2942526.54	R-squared	= 0.2053
				Adj R-squared	= 0.1478
				Root MSE	= 1583.6

ypll_a	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp	11681.75	7780.096	1.50	0.135	-3689.335	27052.84
smoke12	-208.4488	1357.047	-0.15	0.878	-2889.558	2472.66
depression	2372.737	1014.103	2.34	0.021	369.1799	4376.294
ln_physi	8683.991	10468.12	0.83	0.408	-11997.81	29365.79
ln_beds	271.7368	250.4483	1.09	0.280	-223.0723	766.546
ln_los	-2622.207	1441.529	-1.82	0.071	-5470.227	225.8126
checkup_done_10	1421.021	1000.672	1.42	0.158	-556.0016	3398.043
exp_depress	-227.7504	94.0907	-2.42	0.017	-413.6448	-41.85594
exp_physi	-916.6505	974.8975	-0.94	0.349	-2842.749	1009.449
exp_check	-146.7652	94.21209	-1.56	0.121	-332.8995	39.36904
exp_smoking	26.85602	126.7068	0.21	0.832	-223.4778	277.1898
_cons	-108682.8	83388.22	-1.30	0.194	-273432.4	56066.81

City Area (n=145) vs. Rural Area (n=85)

```
. reg ypll_a ln_exp smoke12 depression ln_physi ln_beds ln_los checkup_done_10 exp_depress exp_physi exp_check ex
> p_smoking if city==1
```

Source	SS	df	MS		
Model	35583816	11	3234892.36	Number of obs	145
Residual	96773247.7	133	727618.404	F(11, 133)	4.45
				Prob > F	0.0000
				R-squared	0.2688
				Adj R-squared	0.2084
Total	132357064	144	919146.276	Root MSE	853.01

ypll_a	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp	8247.794	3957.309	2.08	0.039	420.3906	16075.2
smoke12	-1587.823	772.8851	-2.05	0.042	-3116.559	-59.0859
depression	2051.416	691.2427	2.97	0.004	684.1642	3418.667
ln_physi	9982.022	3385.72	2.95	0.004	3285.198	16678.85
ln_beds	63.3894	196.0128	0.32	0.747	-324.3164	451.0952
ln_los	-1840.607	1094.482	-1.68	0.095	-4005.451	324.2359
checkup_done_10	1348.613	563.6121	2.39	0.018	233.8099	2463.416
exp_depress	-199.3762	66.64015	-2.99	0.003	-331.1878	-67.56454
exp_physi	-1028.818	325.6341	-3.16	0.002	-1672.91	-384.7263
exp_check	-134.7445	55.41175	-2.43	0.016	-244.3468	-25.14224
exp_smoking	153.5382	74.97087	2.05	0.043	5.248684	301.8276
_cons	-76349.16	40344.65	-1.89	0.061	-156149.3	3450.989

```
. reg ypll_a ln_exp smoke12 depression ln_physi ln_beds ln_los checkup_done_10 exp_depress exp_physi exp_check ex
> p_smoking if city==2
```

Source	SS	df	MS		
Model	92101973.5	11	8372906.69	Number of obs	85
Residual	286990289	73	3931373.83	F(11, 73)	2.13
				Prob > F	0.0283
				R-squared	0.2430
				Adj R-squared	0.1289
Total	379092263	84	4513003.13	Root MSE	1982.8

ypll_a	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp	13637.25	17135	0.80	0.429	-20512.76	47787.26
smoke12	7612.892	4300.756	1.77	0.081	-958.5032	16184.29
depression	4142.476	1910.861	2.17	0.033	334.1357	7950.817
ln_physi	6637.902	46433.35	0.14	0.887	-85903.64	99179.44
ln_beds	338.939	367.1344	0.92	0.359	-392.7589	1070.637
ln_los	-4282.391	2484.018	-1.72	0.089	-9233.033	668.2502
checkup_done_10	-1092.75	2586.14	-0.42	0.674	-6246.919	4061.419
exp_depress	-388.0808	175.3805	-2.21	0.030	-737.6137	-38.54786
exp_physi	-797.7044	4260.551	-0.19	0.852	-9288.971	7693.562
exp_check	80.12142	239.3315	0.33	0.739	-396.8656	557.1084
exp_smoking	-686.4458	393.8522	-1.74	0.086	-1471.392	98.50044
_cons	-125002.2	185858.7	-0.67	0.503	-495418.1	245413.7

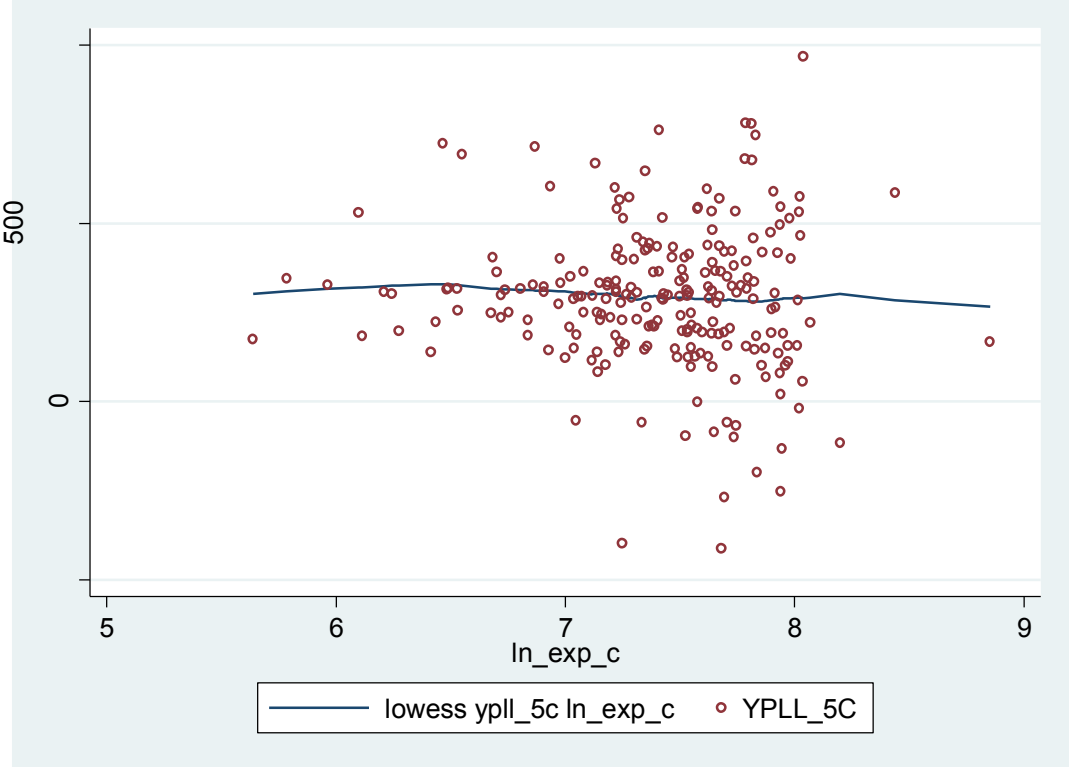
.

2) **Final Model (Cancer Care)**

```
. reg ypll_5c ln_exp_c smoke12 hypertension diabetes stress depress12 ln_beds exp_hyper exp_dep12
```

Source	SS	df	MS		
Model	1250887.77	9	138987.53	Number of obs	= 227
Residual	8632641.81	217	39781.7595	F(9, 217)	= 3.49
				Prob > F	= 0.0005
				R-squared	= 0.1266
				Adj R-squared	= 0.0903
Total	9883529.58	226	43732.4318	Root MSE	= 199.45

ypll_5c	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp_c	-263.3059	76.85295	-3.43	0.001	-414.7797	-111.8321
smoke12	8.837853	5.491976	1.61	0.109	-1.986591	19.6623
hypertension	191.9543	90.55428	2.12	0.035	13.47578	370.4328
diabetes	-13.42361	10.20528	-1.32	0.190	-33.53778	6.690557
stress	4.393298	2.115029	2.08	0.039	.2246676	8.561928
depress12	-277.3401	120.8215	-2.30	0.023	-515.474	-39.2061
ln_beds	35.29425	21.60771	1.63	0.104	-7.293593	77.88209
exp_hyper	-26.63786	12.1019	-2.20	0.029	-50.49017	-2.785551
exp_dep12	38.38279	16.22556	2.37	0.019	6.402927	70.36266
_cons	1879.746	587.2082	3.20	0.002	722.3838	3037.107



```
. reg ypll_5c ln_exp_c smoke12 hypertension diabetes stress depress12 ln_beds exp_hyper exp_dep12 city seoulmetro
```

Source	SS	df	MS	Number of obs	=	227
				F(11, 215)	=	3.06
Model	1339127.23	11	121738.839	Prob > F	=	0.0008
Residual	8544402.35	215	39741.4063	R-squared	=	0.1355
				Adj R-squared	=	0.0913
Total	9883529.58	226	43732.4318	Root MSE	=	199.35

ypll_5c	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp_c	-273.1391	77.10162	-3.54	0.000	-425.111	-121.1673
smoke12	7.996631	5.576994	1.43	0.153	-2.995953	18.98922
hypertension	180.9149	90.84251	1.99	0.048	1.858986	359.9709
diabetes	-10.16889	10.43145	-0.97	0.331	-30.72989	10.39211
stress	4.721184	2.125381	2.22	0.027	.5319321	8.910436
depress12	-294.8666	122.8691	-2.40	0.017	-537.0489	-52.68434
ln_beds	46.60918	22.92534	2.03	0.043	1.421985	91.79638
exp_hyper	-25.23406	12.13915	-2.08	0.039	-49.16105	-1.307074
exp_dep12	40.57715	16.43281	2.47	0.014	8.187113	72.96719
city	37.2776	32.8983	1.13	0.258	-27.5669	102.1221
seoulmetro	-45.77938	35.92831	-1.27	0.204	-116.5962	25.03744
_cons	1982.478	594.3676	3.34	0.001	810.9439	3154.011

```
. reg ypll_5c ln_exp_c smoke12 hypertension diabetes stress depress12 ln_beds exp_hyper exp_dep12 city
```

Source	SS	df	MS	Number of obs	=	227
				F(10, 216)	=	3.20
Model	1274604.98	10	127460.498	Prob > F	=	0.0007
Residual	8608924.6	216	39856.1324	R-squared	=	0.1290
				Adj R-squared	=	0.0886
Total	9883529.58	226	43732.4318	Root MSE	=	199.64

ypll_5c	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp_c	-265.3857	76.97199	-3.45	0.001	-417.0981	-113.6733
smoke12	8.077957	5.584672	1.45	0.150	-2.929473	19.08539
hypertension	187.4078	90.8303	2.06	0.040	8.380624	366.435
diabetes	-12.57788	10.27349	-1.22	0.222	-32.827	7.671242
stress	4.483865	2.120258	2.11	0.036	.3048199	8.66291
depress12	-269.2512	121.3882	-2.22	0.028	-508.5082	-29.99415
ln_beds	39.142	22.19562	1.76	0.079	-4.605729	82.88974
exp_hyper	-25.99292	12.14202	-2.14	0.033	-49.92494	-2.060906
exp_dep12	37.51527	16.27961	2.30	0.022	5.428042	69.6025
city	24.13275	31.28402	0.77	0.441	-37.52829	85.79379
_cons	1865.288	588.0556	3.17	0.002	706.2258	3024.35

```
. reg ypll_5c ln_exp_c smoke12 hypertension diabetes stress depress12 ln_beds exp_hyper exp_dep12 seoulmetro
```

Source	SS	df	MS	Number of obs	=	227
				F(10, 216)	=	3.24
Model	1288101.16	10	128810.116	Prob > F	=	0.0007
Residual	8595428.42	216	39793.6501	R-squared	=	0.1303
				Adj R-squared	=	0.0901
Total	9883529.58	226	43732.4318	Root MSE	=	199.48

ypll_5c	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp_c	-268.0803	77.02283	-3.48	0.001	-419.8929	-116.2677
smoke12	9.07769	5.498393	1.65	0.100	-1.759683	19.91506
hypertension	189.0579	90.61732	2.09	0.038	10.45046	367.6653
diabetes	-12.0186	10.3097	-1.17	0.245	-32.3391	8.301889
stress	4.528863	2.119985	2.14	0.034	.350356	8.70737
depress12	-298.9896	122.8959	-2.43	0.016	-541.2184	-56.76085
ln_beds	39.16773	21.979	1.78	0.076	-4.153053	82.48851
exp_hyper	-26.34395	12.10752	-2.18	0.031	-50.20796	-2.479933
exp_dep12	40.93159	16.44063	2.49	0.014	8.526989	73.33619
seoulmetro	-33.01323	34.13856	-0.97	0.335	-100.3006	34.27414
_cons	1969.934	594.655	3.31	0.001	797.8649	3142.004

Seoulmetro Area (n=66) vs. non-Seoulmetro (n=164)

```
. reg ypll_5c ln_exp_c smoke12 hypertension diabetes stress depress12 ln_beds exp_hyper exp_dep12 if seoulmetro =
> = 1
```

Source	SS	df	MS	Number of obs =	66
				F(9, 56) =	1.97
Model	317042.004	9	35226.8893	Prob > F =	0.0609
Residual	1003498.04	56	17919.6078	R-squared =	0.2401
				Adj R-squared =	0.1180
Total	1320540.04	65	20316.0006	Root MSE =	133.86

ypll_5c	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp_c	-176.5352	180.0669	-0.98	0.331	-537.2525	184.1822
smoke12	16.73398	7.931475	2.11	0.039	.8453299	32.62264
hypertension	213.6345	110.6622	1.93	0.059	-8.048563	435.3175
diabetes	-11.2281	14.31278	-0.78	0.436	-39.90003	17.44384
stress	.9218024	3.591361	0.26	0.798	-6.272558	8.116163
depress12	-205.33	244.3462	-0.84	0.404	-694.8142	284.1542
ln_beds	6.551359	33.44528	0.20	0.845	-60.44759	73.55031
exp_hyper	-28.96673	15.36853	-1.88	0.065	-59.75359	1.820127
exp_dep12	27.16113	33.17685	0.82	0.416	-39.30008	93.62235
_cons	1204.536	1343.1	0.90	0.374	-1486.017	3895.09

```
. reg ypll_5c ln_exp_c smoke12 hypertension diabetes stress depress12 ln_beds exp_hyper exp_dep12 if seoulmetro =
> = 2
```

Source	SS	df	MS	Number of obs =	161
				F(9, 151) =	2.35
Model	1049848.64	9	116649.849	Prob > F =	0.0165
Residual	7496491.87	151	49645.6415	R-squared =	0.1228
				Adj R-squared =	0.0706
Total	8546340.51	160	53414.6282	Root MSE =	222.81

ypll_5c	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp_c	-244.0698	100.3089	-2.43	0.016	-442.2601	-45.87951
smoke12	7.598784	7.33564	1.04	0.302	-6.894966	22.09253
hypertension	104.3586	151.1272	0.69	0.491	-194.2384	402.9556
diabetes	-10.60447	13.36624	-0.79	0.429	-37.01347	15.80454
stress	5.599805	2.653134	2.11	0.036	.357746	10.84186
depress12	-292.1619	159.8622	-1.83	0.070	-608.0174	23.69355
ln_beds	39.83664	29.2139	1.36	0.175	-17.88416	97.55743
exp_hyper	-15.53845	19.79938	-0.78	0.434	-54.65805	23.58115
exp_dep12	40.34815	21.35011	1.89	0.061	-1.835379	82.53169
_cons	1740.328	770.1954	2.26	0.025	218.577	3262.079

City Area (n=145) vs. Rural Area (n=85)

```
. reg ypll_5c ln_exp_c smoke12 hypertension diabetes stress depress12 ln_beds exp_hyper exp_dep12 if city == 1

      Source |       SS       df       MS              Number of obs =     144
-------------+------------------------------           F(  9,   134) =    1.50
       Model |  245414.692     9  27268.2991           Prob > F      =  0.1530
    Residual |  2431106.58   134  18142.5864           R-squared     =  0.0917
-------------+------------------------------           Adj R-squared =  0.0307
       Total |  2676521.27   143  18716.9319           Root MSE      =  134.69

------------------------------------------------------------------------------
     ypll_5c |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    ln_exp_c |  -77.85567   80.72542    -0.96   0.337    -237.5165    81.80515
     smoke12 |   4.884559   5.037532     0.97   0.334    -5.078802    14.84792
hypertension |   182.7469    76.5739     2.39   0.018     31.29711    334.1968
    diabetes |   9.704392   9.327651     1.04   0.300    -8.744077    28.15286
      stress |   .6429127   2.199044     0.29   0.770    -3.706413    4.992238
   depress12 |   60.09045    118.986     0.51   0.614    -175.2432    295.4241
     ln_beds |   28.85471   22.12799     1.30   0.194     -14.9106    72.62003
   exp_hyper |  -25.33485   10.47004    -2.42   0.017    -46.04276   -4.626937
   exp_dep12 |  -7.932112    16.1417    -0.49   0.624    -39.85758    23.99336
       _cons |   660.8039   588.8947     1.12   0.264    -503.9272    1825.535
------------------------------------------------------------------------------

. reg ypll_5c ln_exp_c smoke12 hypertension diabetes stress depress12 ln_beds exp_hyper exp_dep12 if city == 2

      Source |       SS       df       MS              Number of obs =      83
-------------+------------------------------           F(  9,    73) =    2.81
       Model |  1848463.75     9  205384.861           Prob > F      =  0.0069
    Residual |  5337362.56    73  73114.5557           R-squared     =  0.2572
-------------+------------------------------           Adj R-squared =  0.1657
       Total |  7185826.31    82  87632.0282           Root MSE      =   270.4

------------------------------------------------------------------------------
     ypll_5c |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    ln_exp_c |  -556.4524   204.9418    -2.72   0.008    -964.9009    -148.004
     smoke12 |   15.44358   12.12914     1.27   0.207    -8.729767    39.61692
hypertension |   329.4409    342.981     0.96   0.340    -354.1193    1013.001
    diabetes |  -34.35555   21.33883    -1.61   0.112    -76.88377    8.172675
      stress |   7.599059   3.974134     1.91   0.060    -.3213792     15.5195
   depress12 |   -871.557   304.9434    -2.86   0.006    -1479.308   -263.8056
     ln_beds |   66.56061   43.79447     1.52   0.133    -20.72164    153.8429
   exp_hyper |  -43.56894   44.14933    -0.99   0.327    -131.5584    44.42056
   exp_dep12 |   116.4153   40.07555     2.90   0.005     36.54487    196.2858
       _cons |   3877.978   1601.108     2.42   0.018     686.9749    7068.981
------------------------------------------------------------------------------

.
```

3) STATA results (Mental Health Care)

```
. reg ypll_s ln_exp_m beds_11 obecity hypertension diabetes stress12 ln_equip
```

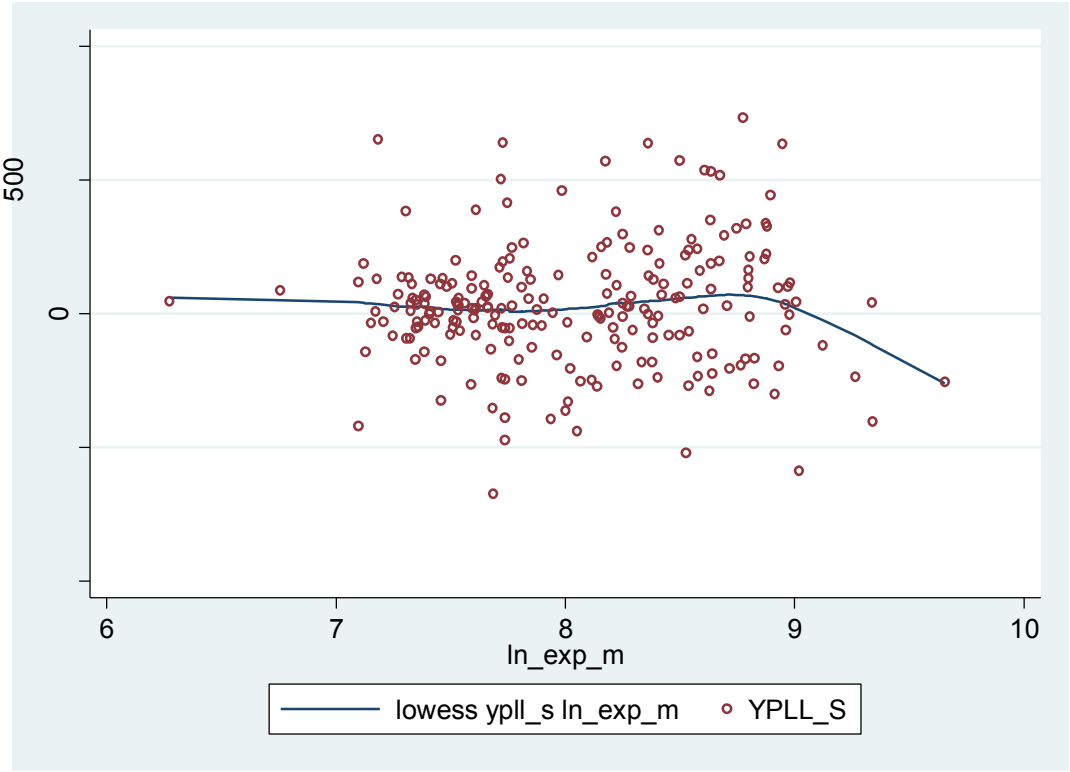
Source	SS	df	MS		
Model	1006779.58	7	143825.655	Number of obs	= 217
Residual	15639517.3	209	74830.2261	F(7, 209)	= 1.92
				Prob > F	= 0.0675
Total	16646296.8	216	77066.1891	R-squared	= 0.0605
				Adj R-squared	= 0.0290
				Root MSE	= 273.55

ypll_s	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp_m	-23.73652	44.77657	-0.53	0.597	-112.0081	64.53509
beds_11	5.897705	3.118029	1.89	0.060	-.2491126	12.04452
obecity	7.443003	5.801553	1.28	0.201	-3.994059	18.88006
hypertension	3.549164	9.183051	0.39	0.700	-14.55411	21.65244
diabetes	16.54679	14.24935	1.16	0.247	-11.54408	44.63767
stress12	8.802321	4.83622	1.82	0.070	-.7317036	18.33635
ln_equip	-43.17546	19.53483	-2.21	0.028	-81.68603	-4.664894
_cons	42.78717	415.8957	0.10	0.918	-777.1011	862.6754

```
. reg ypll_s ln_exp_m beds_11 obecity hypertension diabetes stress12
```

Source	SS	df	MS		
Model	665428.46	6	110904.743	Number of obs	= 230
Residual	17271334.4	223	77449.93	F(6, 223)	= 1.43
				Prob > F	= 0.2034
Total	17936762.9	229	78326.4754	R-squared	= 0.0371
				Adj R-squared	= 0.0112
				Root MSE	= 278.3

ypll_s	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp_m	11.55401	40.01175	0.29	0.773	-67.2955	90.40352
beds_11	4.103158	2.890364	1.42	0.157	-1.592764	9.79908
obecity	8.132563	5.758777	1.41	0.159	-3.216022	19.48115
hypertension	4.372449	9.066983	0.48	0.630	-13.49548	22.24038
diabetes	9.07099	14.00468	0.65	0.518	-18.52746	36.66944
stress12	6.274681	4.712095	1.33	0.184	-3.011253	15.56061
_cons	-237.1126	381.2604	-0.62	0.535	-988.4468	514.2215


500
0
6
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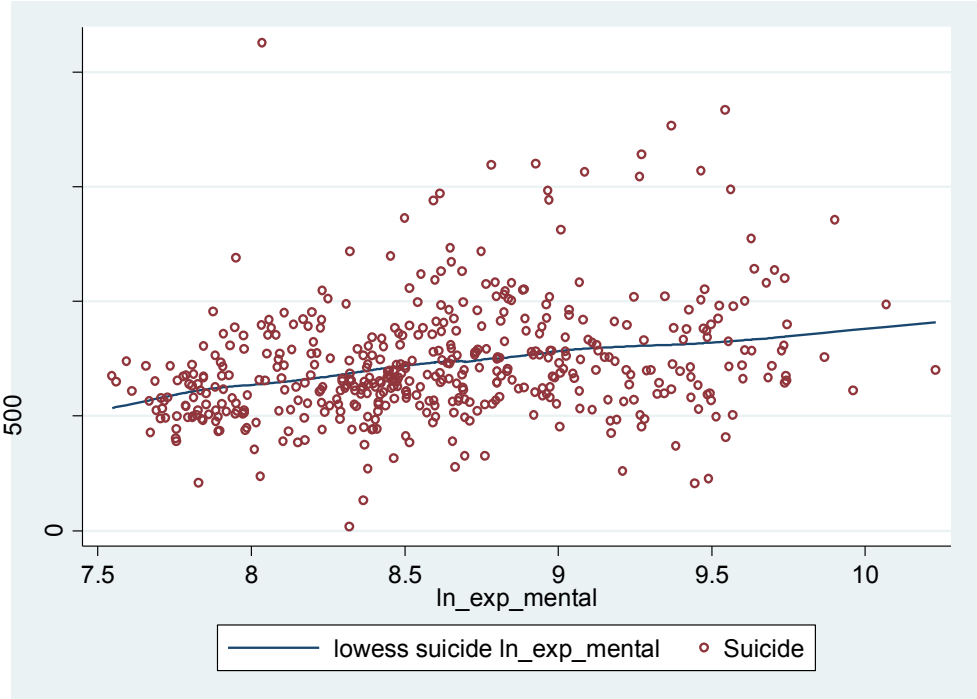
8
9
10
ln_exp_m
lowess ypll_s ln_exp_m
YPLL_S

Final LDA Model (Mental Health Care)

```
. reg suicide ln_exp_mental smoking obesity year city female
```

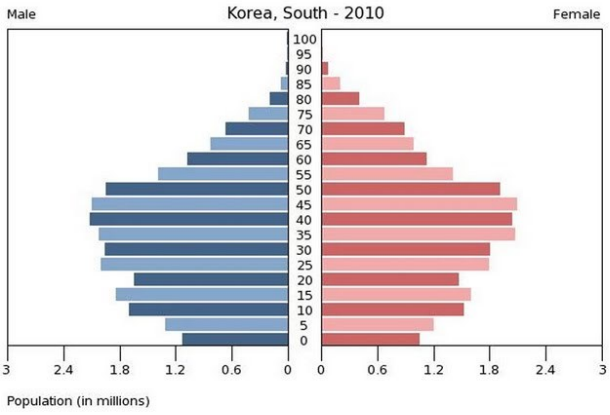
Source	SS	df	MS		
Model	5032381.99	6	838730.332	Number of obs	= 462
Residual	25089068.7	455	55140.8104	F(6, 455)	= 15.21
				Prob > F	= 0.0000
Total	30121450.7	461	65339.3725	R-squared	= 0.1671
				Adj R-squared	= 0.1561
				Root MSE	= 234.82

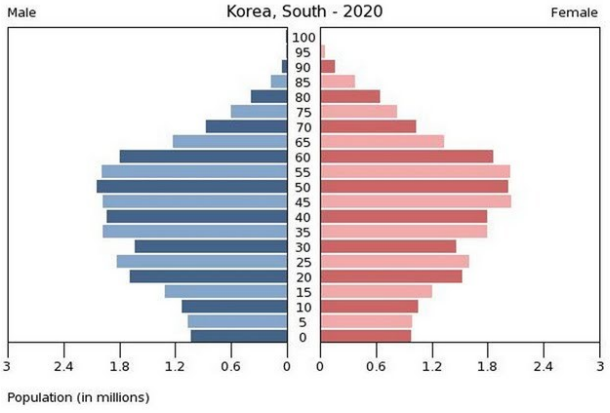
suicide	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp_mental	105.3287	32.19005	3.27	0.001	42.06909	168.5883
smoking	11.65913	4.219255	2.76	0.006	3.367487	19.95078
obesity	8.975681	4.193622	2.14	0.033	.7344101	17.21695
year	-12.66498	34.15584	-0.37	0.711	-79.78774	54.45777
city	104.8386	28.53	3.67	0.000	48.77173	160.9056
female	-6.379495	12.0015	-0.53	0.595	-29.96474	17.20575
_cons	-486.736	607.3515	-0.80	0.423	-1680.298	706.8259

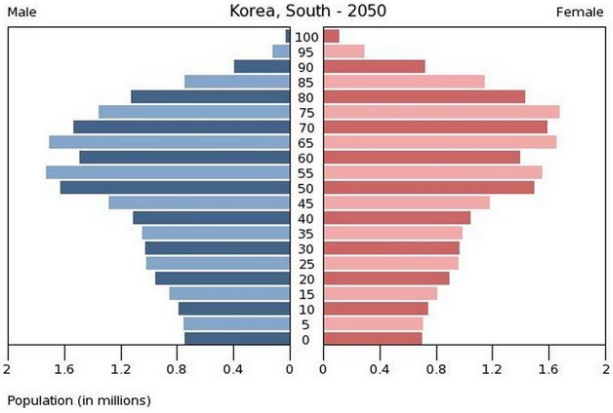


Annex 2.

Population Pyramids Showing South Korea's Aging Population







Source: US Census Bureau

Curriculum Vitae

WORK EXPERIENCE

May 13 – Present **MINISTRY OF STRATEGY AND FINANCE (MOSF), Korea**
Director, International Tax Division
- Plan and coordinate International Tax Policy and Tax Laws in Korea

May 10 – May 13 **World Bank Institute, the World Bank**
Senior Public Sector Specialist, Growth and Competitiveness Unit
- Planned and coordinated inclusive development policy programs

June 09 – May 10 **MINISTRY OF STRATEGY AND FINANCE (MOSF), Korea**
Head, Human Resources Management Team
- Planned and coordinated MOSF's HR management and development

June 08 – May 09 **Presidential Committee on Regional Development, Korea**
Director, Policy and Planning Division
- Planned and coordinated Regional Innovation System and Strategy
- Planned and coordinated Local Finance System

Jan 05 – Jun 06 **MINISTRY OF PLANNING AND BUDGET (MPB), Korea**
Senior Deputy Director, Organizational Innovation & Personnel Div.
- Planned and coordinated MPB's innovation and restructuring
- Planned and managed the "Best Place to Work" project

Mar 04 – Jan 05 **MINISTRY OF PLANNING AND BUDGET, Korea**
Senior Deputy Director, Education and Culture Budget Division
- Planned and managed annual education sector budget of FY 2005 including National Universities & their Academic Medical Centers

Mar 03 – Mar 04 **MINISTRY OF PLANNING AND BUDGET, Korea**
Deputy Director, Social Fiscal Policy Division
- Planned national agenda and mid-term fiscal expenditure plan for Social safety and security sector and regional development
- Planned and made a Balanced National Development Special Account Act

Jun 02 – Mar 03 **MINISTRY OF PLANNING AND BUDGET, Korea**
Deputy Director, Industrial Fiscal Policy Division
- Planned national agenda and mid-term fiscal expenditure plan for National Infrastructure development and SMEs promotion

Mar 99 – Jun 02 **Korea Air Force Operation Command, Osan AB, Korea**
Second Lieutenant, the Air Component Command
- Planned and managed the budget of the Office Automation project

Mar 98 – Mar 99 **PRESIDENTIAL PLANNING AND BUDGET COMMISSION**
Deputy Director, Government Innovation Office
- Planed measures to innovate public sector entities & enterprises (SOEs)

June 96 – Mar 98 **MINISTRY OF GOVERNMENT ADMINISTRATION, Korea**
Deputy Director, Government Innovation Planning Commission
- Planned measures to reform and restructure government

EDUCATION

Expected 15 **Johns Hopkins University, Bloomberg School of Public Health**
Doctor of Public Health (DrPH) in Health Policy & Management

May 08 **Johns Hopkins University, Bloomberg School of Public Health**
Master of Health Science (MHS) in Health Finance & Management

Feb 98 **SNU, Graduate School of Public Administration (GSPA), Seoul, Korea**
Master of Public Administration (MPA)

Feb 95 **Seoul National University (SNU), Seoul, Korea**
Bachelor of Arts (BA) in Political Science

OTHER

HONORS AND AWARDS

Award of Outstanding Knowledge Management Official from the Minister of Planning and Budget in Aug 2005.
Award of Outstanding Government Official from the Minister of Planning and Budget Commission in Dec 1997.
Award of Outstanding Student from the chairman of Alumni association of GSPA, SNU in Aug 1996.
Passed the 39th High Level Civil Service Examination for Administration in November 1995.
Passed the 13th High Level Civil Service Examination for National Assembly in Mar 1995.

PUBLICATIONS AND POLICY REPORTS

"The Medium-Term Fiscal Plan (2002-2004)," Ministry of Planning and Budget, 2002. (Co-author)
"A STUDY ON THE RESTRUCTURING OF THE MINISTRY OF HEALTH AND WELFARE - with emphasis on the readjustment of the government functions", Masters Thesis, GSPA, Seoul National University, 1998
"Government Innovation", Government Innovation Planning Commission, 1997. (Co-author)