The Effect of Long-Term Care Insurance on Medical and Long-Term Care Utilization: Focusing on Institutional Care Eligibility

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ABSTRACT

The Effect of Long-Term Care Insurance on Medical and Long-Term Care Utilization: Focusing on Institutional Care Eligibility

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Background: With the aging of the population, the increasing need for social care for older people has become a major policy agenda worldwide. South Korea was one of the first countries to introduce public long-term care insurance (LTCI) in 2008 to meet the growing demand for long-term care, and to contain drastically rising medical expenditures. As the importance of providing appropriate and affordable services for older people is growing, the long-term sustainability and stability of the two pillars, LTCI and National Health Insurance (NHI) systems, has become increasingly vital. The study aims to investigate the effects of LTCI on medical and long-term care (LTC) utilization with a focus on institutional care eligibility (LTCI level 2) among older people. We attempted to clarify the inter-

relationship among different types of care, and provide some insights for long-term LTC development.

Methods: This study used a representative sample from the National Health Insurance Senior Cohort Database between 2008 and 2013. A sharp regression discontinuity design was employed to estimate the treatment effect of expanded LTC benefits on medical and LTC utilization. The study sample was selected for treatment based on their preliminary LTC score. We used a non-parametric local linear regression estimates with triangular kernel weights and bandwidth of 3.0. We also conducted a series of falsification and sensitivity analyses to ensure the validity of the design.

Results: The final analytic sample included 8,036 LTCI recipients with LTCI levels 2 and 3 from 2009 to 2013. Among them, there were 2,908 recipients (36.2%) in the treatment group (i.e., above the cutoff), and 5,128 (63.8%) in the control group (i.e., below the cutoff). The results show that level 2 benefits lead to a reduction in total medical expenditure (a decrease of 1,778,700 won, 29.5%, p= <.0001). Between LTC hospitals and acute hospitals expenditures, we found a larger decrease in acute hospital care, of 1,576,300 won (a 49.2% decrease, p= <.0001) than in LTC hospital care, of 208,300 won (a 7.4% decrease, p=0.568), of which a

large share is accounted for inpatient care. For LTC utilization, the results show that institutional care increased by 3,178,600 won (a 100.7% increase, p=<.0001) with 93.8 days (a 103.1% increase, p=<.0001), whereas home care decreased by 711,600 won (a 22.8% decrease, p=<.0001) with 43 days (a 30.5% decrease, p=<.0001). Finally, the total expenditure for medical and LTC increased by 688,300 won (p=0.034) representing 5.6%.

Conclusions: This study examines the causal effect of LTCI on medical and LTC utilization, focusing on expanded LTCI benefits for institutional care. The study found substitutive relationships between 1) hospital inpatient and institutional care and 2) home and institutional care. The findings suggest that an increase in access and affordability of LTC may results in a rapidly increasing LTC expenditure among older people. Furthermore, a reduction in home care implies a high demand for institutional care. As we project further increasing in aging trends, policymakers should put efforts to better understand the aging population to develop an optimal design of LTCI programs, which will lead to improvements in efficiency and the health and well-being of older people.

Keywords: long-term care insurance, medical utilization, long-term care utilization, institutional care, home care

I. Introduction

1. Background

As we face a rapidly aging population worldwide, long-term services are in great demand for people with care needs. Globally, there were 703 million people aged 65 years or over in 2019, which is projected to reach over 1.5 billion in 2050.[1] Korea, for instance, is one of the fastest aging countries, and will become the world's most aged society by 2067 with older people comprising 46.5 % of the total population.[2] Hence, an increasing number of people with limitations require long-term care assistance in daily activities.[3] In Korea, 25.3% of the older population reported having limitations in activities of daily living (ADL) or instrumental activities of daily living (IADL) in 2017.[4] Moreover, we observed several major social changes including an increasing number of older people living alone and smaller families over the past years. As a consequence, theses demographic and social changes have added increasing social and economic burdens to individuals as well as governments.

Intensive medical spending by older people has become a major challenge for many countries. In 2019, 14.5% of the Korean population accounted for 41.4% of the total medical expenditure.[5] Healthcare systems face the challenge of

increasing medical expenditure, partly due to the aging population and health insurance coverage expansion. However, the rise is also attributed to inefficient use of healthcare resources, particularly hospital inpatient care by patients in need of long-term care (LTC). For instance, long-term hospitalizations (i.e., social admission or delayed discharge in hospitals) are a critical challenge for many health systems in developed countries, responsible for a substantial share of medical expenditure by older people.[6,7] The literature shows that, insufficient provision and limited affordability of LTC services mainly result in increasing hospital care expenditure by people who do not have medical needs.[8,9] Ideally, older people with medical needs should receive medical services as needed and once those needs are met, integrated care should be provided through long-term care services.

In response to these challenges, the Korean government introduced the national long-term care insurance (LTCI) in 2008 to meet the growing demand for long-term care, and to contain the drastically rising medical expenditures. In principle, LTCI is a universal, long-term care system based on social insurance for all Korean citizens aged 65 and above who are enrolled in the National Health Insurance (NHI). LTCI recipients are evaluated for their care time and intensity and grouped into five care needs levels. They receive LTCI benefits (home or institutional care) depending on the types of eligibility determined by their care needs level. As of 2019, 0.8 million were approved for LTCI. In the last 5 years,

the number of LTCI beneficiaries is growing at annual growth rate of 10.5%. Among beneficiaries, 11.2% and 29.3% were accounted for level 2 and 3, respectively.[10]

As the importance of providing appropriate and affordable services for older people is growing, the long-term sustainability and stability of the two pillars, LTCI and NHI systems, has become increasingly vital. Although the LTC system has steadily strengthened since its introduction,[11-14] there is a need for further improvements.

For instance, regarding the inefficiency of resource utilization, medical spending is expected to decrease due to an increase in access to LTC. However, Although the demand for LTC has been greatly absorbed by home and institutional care, the number of patients admitted to hospitals continues to rise.[15] The studies on the relationship between medical and LTC show mixed results. Most of them argue that these two different service areas have a substitutive relationship, suggesting that LTCI would effectively reduce medical expenditure, length of hospital stays or emergency care.[16-20] For example, regarding impact of LTCI on medical utilization, Cho (2020) found that LTCI introduction in Korea decreases inpatient care use, specifically, admissions with longer stays.[19] Hyun et al. (2014) found that LTCI level 1 benefits had a substantial impact on medical expenditure, while there was no statistically significant change by level 2 in Korea. [21] Feng et al.

(2020) also reported significantly reduced length of stay, inpatient expenditure, and health insurance expenditure in tertiary hospitals in China.[22] Kim (2013) found that an increase in LTC costs is positively associated with acute hospital utilization, but negatively associated with long-term care hospital utilization.[14] Thus, this study attempts to investigate and clarify the effect of LTCI on medical expenditure based on substitutability among different types of medical care.

The LTCI coverage has gradually expanded over the past 10 years. Home care benefit eligibility has been expanded more generously by lowering thresholds and establishing benefits for some people with special needs such as having dementia, living alone, or having a low income. However, the eligibility criteria for institutional care benefits remains unchanged. In this study, we assume that institutional care benefits may have greater effects on medical utilization, particularly hospital admissions. Thus, we focus on institutional care eligibility (LTCI level 2).

Moreover, we examine the effects on home care utilization when recipients become eligible for increased monthly benefit limit. In the existing literature, the findings suggest a negative relationship between home and institutional care. For example, Hyun et al. (2014) demonstrated that LTCI level 2 leads to a reduction in home care use at the intensive margin in Korea. Chen et al. (2017) reported the negative relationship between home care and nursing home care services in Japan.[23]

This study contributes to the existing literature on transitions between different LTC care types, particularly focusing on older people in LTCI level 3 (i.e. not eligible for institutional care benefit). We seek to address whether an expansion in access and affordability of LTC impacts home and institutional care utilization.

2. Study objectives

This study aims to investigate the effects of LTCI on medical and LTC utilization with a focus on institutional care eligibility (LTCI level 2) among older people. This study seeks to clarify the interrelationship across different types of care, and provides some insights for the long-term LTC development. Details of the study objectives are as follows:

(1) To investigate the effect of LTCI level 2 on medical utilization including inpatient and outpatient care in LTC hospital and acute hospital

(2) To investigate the effect of LTCI level 2 on LTC utilization including home and institutional care

(3) To investigate the effect of LTCI level 2 on overall medical and LTC expenditure

II. Literature Review

1. Policy background

1) Long-term care

Owing to demographic and societal changes including aging population, the rise in life expectancy, an increase in female economic activity, reduction in family care, the demand for LTC for older people with limited ability to maintain daily life activities is growing. The global demand for LTC is expected to grow by up to 400 percent in coming decades due to increasing longevity and advances in medical technologies and treatment.[24]

LTC can be defined as a continuum of medical and social services designed to assist people who require extended assistance with activities of daily living as well as instrumental activities of daily living.[25] More recently, WHO published a report on healthy ageing in which described as "Every country needs an integrated continuum of long-term care services that provides to older people who require it the ability to maintain the best possible level of functioning, and offers flexibility to meet the changing and diverse needs that older people may have at home, in their communities and, when needed, in facilities".[26] As implied in this report, strengthening LTC is one of core strategies to promote healthy ageing, and it should

be delivered in a way to best optimize functional ability. LTC includes material supports, home-based care, community-based care and institutional care. LTC care is often provided by formal caregivers such as social workers, nurses, doctors. It also includes informal care for which provided by informal caregivers such as families and friends.

In response to the increasing demand for LTC, many developed countries have introduced publicly-funded, various mixture of LTC programs, in terms of eligibility, financing, coverages, benefits, and services (Table 1).[27] For instance, the Netherlands first introduced a universal mandatory social health insurance scheme for covering LTC services in the 1960. Japan and Korea are the first countries in Asia to implement public LTCI in 2000 and 2008, respectively.

Over the past few decades, we observed many reforms and developments in LTC systems around the world in an effort to better support the aging population and their caregiver as well as to address financial challenges which are emerging as a major issue. For instance, Germany recently implemented LTCI reforms in 2015, of which a major amendment was the introduction of a new definition of LTC needs. It includes improving accessibility by redesigning the assessment instrument to appropriately take account for the care needs of people with dementia, as well as by increasing the existing benefits. To finance the additional benefits, Germany raised the contribution rate of LTCI by 0.5 percent point.[28] As seen from Germany's

experiences and other countries', structural design and financing scheme are important elements contributing the sustainable development of LTCI systems.[29]

Table 1. Public LTC coverage

Country	Eligibility	Coverage programs	Source of financing LTC	Benefits
Germany	Universal coverage within a single system	Social insurance	Tax, premiums, financing from Lander budgets	Cash and in-kind, home and institutional care
Japan	Universal coverage within a single system	Social insurance	50% public contributions by those over 40, 50% governmental divisions	In-kind, home and institutional care
Korea	Universal coverage within a single system	Social insurance	Long-term care insurance fee, central and local government, budgets and out-of-pocket	Cash and in-kind, home and institutional care
Netherlands	Universal coverage within a single system	Social insurance	Contributions and additional tax contributions	Cash and in-kind, home and institutional care
Sweden	Mixed system	Universal, tax-based	84% local municipal taxes, 11-12% national government grants	Cash and in-kind, home and institutional care
United Kingdom	Mixed system: Means-tested system, with universal benefits for disability	Means-tested safety net	Central taxation	Cash and in-kind, home and institutional care
USA (Medicaid)	Means-tested system	Means-tested safety net	Federal and state funds	In-kind, mandatory institutional benefits, optional state community benefits
USA (Medicare)	Social insurance for the elderly	Universal for seniors	Part A: Payroll, income tax, Part B: Medicare premiums and congress funds	Post-acute care in nursing homes

Source: OECD. Public long-term care financing arrangements in OECD countries. 2011

2) Korea's long-term care insurance

(1) Overview of the policy

Korea is one of the first countries in Asia to implement LTCI programs in 2008, a universal program within a single system based on social insurance. It provides a comprehensive coverage to older adults who are aged 65 years and older or younger than 65 with geriatric diseases. LTCI benefits include a monthly coverage (government subsidy) for home or institutional care services that can be covered by insurance. The coverages differ across recipients depending on their care needs levels, where level 1 referring to the highest care needs (Figure 1). The LTCI is financed by monthly premiums from enrollees, government subsidies, and co-payments by LTCI users.

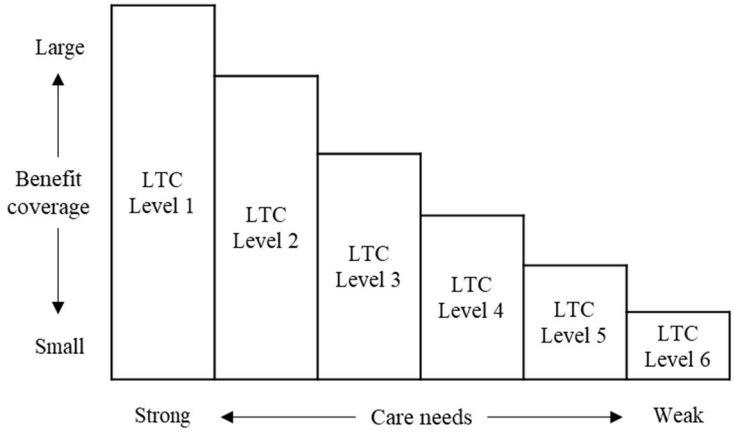


Figure 1. Overview of LTCI in Korea

(Modified from source: United Nations Economic and Social Commission for Asia and Pacific. Long-term care for older persons in the Republic of Korea: Development, challenges and recommendations. 2015)

(2) Eligibility and benefits

The LTCI program, unlike the NHI program, operates the care-need assessment process to determine eligibility for benefits according to their level of needs for LTC. An applicant's mental and functional abilities are evaluated using 52 items covering five categories; physical function, cognitive function, behavioral problems, nursing needs, and rehabilitation needs. The score for each category is summed and converted into 100-point scale. After a review of assessment by the eligibility committee, the final care level is determined based on the LTC score (Figure 2). The eligibility is re-assessed every one to two years.[30]

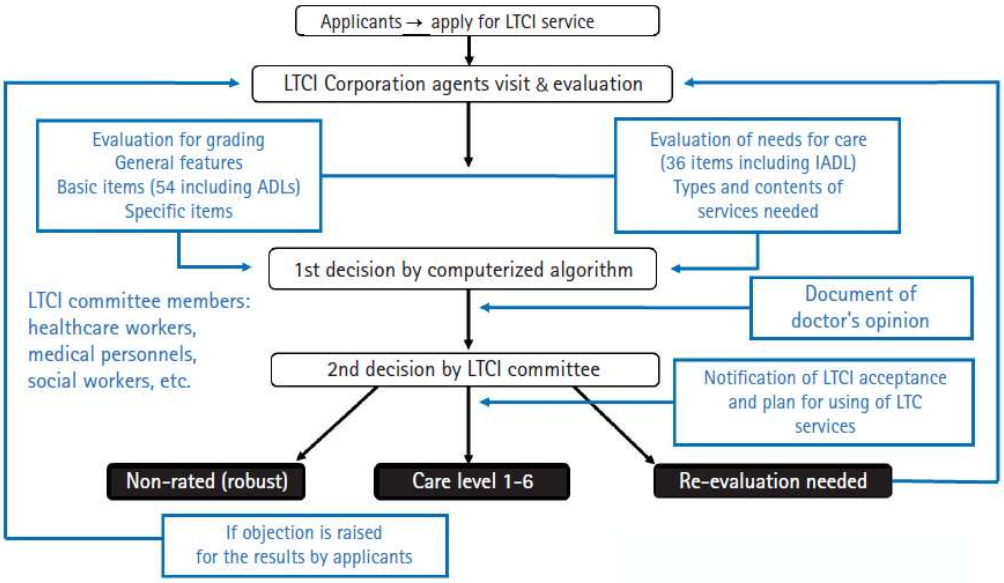


Figure 2. Process of determining the LTCI level

(Source: Ga H. Long-term care system in Korea. Annals of Geriatric Medicine and Research 2020;24(3):181-186)

Each care level provides different LTCI services and benefits. Initially, there were three categories for care needs levels in 2008. Since then, there have been policy reforms in attempt to gradually expand coverage, including addition of a new category, 'special level of dementia (level 5)' in 2014, splitting level 3 into two in 2014, and the recent addition of a 'cognition supporting level (level 6)' in 2018, there are currently six categories (Table 2).[31]

LTCI recipients can choose LTC services from various options with a co-payment according to their LTC level. LTCI services include home-based care, institutional care, and cash benefits. To be eligible for institutional care benefits, the recipients have the LTC score higher than 75 (level 2). Home care services include 1) home-visit care, 2) home-visit nursing, 3) short-term respite care, 4) home-visit bathing, 5) day and night care, 6) provision of welfare equipment.

Table 2. Long-Term Care Insurance care levels and benefits in Korea

Care level	LTC score	Home care		Institutional care		Mental and physical status
		Monthly limit (won)	Copay ment*	Monthly limit (won)	Copay ment*	
Level 1	≥95	1,196	15%	1,768	20%	Requires help in all aspects of daily life
Level 2	75-94	1,054	15%	1,640	20%	Requires help in most parts of daily life
Level 3	55-74	981	15%	1,513	20%	Requires in part of daily life
Level 4	51-54	921	15%	1,513	20%	Requires help in small part of daily life
Level 5	45-50	784	15%	1,513	20%	Dementia patients
Level 6	<45	784	15%	1,513	20%	Dementia with intact physical function

* 50% reduction of the copayment apply in the following cases: 1) medical aid beneficiaries; 2) those with income and wealth below the minimum level determined by the Ministry of Health and Welfare; 3) people whose livelihood is at risk due to such cases as natural disasters, determined by the regulation of the Ministry of Health and Welfare.
Source: Kang et al. Role of healthcare in Korean long-term care insurance. Journal of Korean medical science. 2012:27:S41..

2. Medical and long-term care utilization

1) A relationship between medical and long-term care utilization

Older people are intensive users of medical care, particularly hospital care, but also intensive users of LTC. The nature of relationship between these services can be described as the inter-relationship suggesting that LTC utilization will have an impact on the demand for medical care, and vice versa.[17,32] LTC can facilitate timely discharge from hospital, and reduce rates of admissions through better management of health conditions.

There have been increasing studies to identify the relationship between medical care and LTC services, with objectives of achieving efficiency and equity. Some studies describe the relationship between medical and LTC as substitute effect. For instance, Wildman et al. (2014) demonstrated how individuals may combine health care and social care are in order to maximize their benefit. Based on a framework in which both of two goods, health goods and social goods, provide both attributes but in different quantities, the study suggested health and social care can become substitutes, and further, individuals will over-consume health care and under-consume social care in the present of subsidized health care.[18] Houtven et al. (2004) reported that informal care by children is net substitute not only for long-

term care such as home health care and nursing home care, but also for hospital care and physician visits. Informal care is a complement to outpatient surgery.[33] Forder (2009) studied utilization of long-term care service could substitute medical utilization. The results indicate that for each additional £1 spent on care homes, hospital expenditure falls by £0.35, an extra £1 spent in hospital service corresponds to reduced expenditure on care home service at the same amount.[17] Geraedt (2000) reported financial stability and reduction effect of medical costs by long-term insurance.[34] Costa-Font et al. (2018) find that the public subsidization of LTC services in Spain leads to a reduction in hospital admissions (at both intensive and extensive margin) and utilization.[35] Feng et al. (2020) reported that the introduction of LTCI significantly reduces the length of stay, inpatient expenditures, and health insurance expenditures in tertiary hospitals.[22]

In Korea, Hyun (2015) analyzed the impact of subsidies for formal home and institutional care on medical expenditures. The study found no significant changes in medical expenses at LTCI level 2, but an expanded benefit at level 1 resulted in a reduction in hospital expenses.[21] Cho (2020) analyzed the effect of LTCI implementation on medical and long-term care utilization, and reported a decrease in total medical expenses. Unlike outpatient utilization, which was not significantly affected, inpatient utilization was decreased in terms of both lengths of stay and costs.[19] Choi et al. (2018) reported that LTCI reduces medical utilization

and the burden of medical costs of beneficiaries.[36] The effects of long-term care for the elderly on medical use were examined separately between acute and nursing hospital use. According to the analysis, it affected the probability and cost of using acute cavalry hospitals, but did not have a significant impact, while it had a negative effect on the probability and cost of using nursing hospitals.[14] Shin et al. (2014) found a positive association between LTCI sending and NHI spending among older people. However, it also reports that high-cost and acute medical care is practically substituted by LTC.[37]

Examining the relationship between medical and LTC is critical because inappropriate resource allocation or transfer would result in ineffectiveness and inefficiency of the social security systems including health insurance and LTCI.[38] Underlying that these are issues of costs that governments wish to allocate resources in the most optimal way possible.[18] Considering substitutive effect between these services, well defined roles and functions of these two sectors are essential for achieving a sustainable system.

2) A relationship between long-term care and delayed discharge in hospitals

The purpose of LTCI is to contain excessive medical expenditure among older people by reducing length of hospital stays. Hospital delayed discharge (bed-blocking or social admission) occurs when a patient is medically ready for discharge, stay admitted in hospitals because there is no other necessary care or support available, and it is more commonly associated with older people.[7,39,40] Hospital care is often more costly than LTC such as home or institutional care, delayed discharge is a signal of allocative inefficiency.[41,42]

In many developed countries, similar problems have been reported as well.[6,7,39] For instance, Cost et al. (2012) raised concerns that a substantial share of total non-medical days in acute hospitals are attributed by a small number of patient who are waiting for nursing home admission and suggested an increase in nursing home capacity for people who are less likely to have community-based living.[6]

Travers et al. (2008) found that the acute hospital sector becomes a safety net to accommodate some people with high care needs who are unable to be admitted into an appropriate a Residential Aged Care facility in a timely manner, and suggested that issue of access-block occurs due to a mismatch between demand and supply.[43]

Korea is also experiencing unsolved problems in related with delayed discharge or long-stay admission in hospitals, specifically in LTC hospitals. LTC hospitals specialize in treating patients requiring extended hospitalization, usually transferred from acute hospitals. In Korea, LTC hospitals provide subacute to LTC, palliative care, and rehabilitation services and basically all citizens are eligible for government subsidies because it is administered under the NHI.[31] The main cause is due to a lack of coordination between to different care types (Table 3). For instance, with the introduction of LTCI programs in Korea, the number of LTC hospitals have increased along with institutional care facilities, which creates a competitive relationship between two service areas with different purposes. In addition, hospital admission is more accessible than receiving LTCI eligibility for institutional care.[44] To prevent long hospital stays, the government have implemented a policy to apply reduction in payments if a patient stays in LTC hospital for longer than 181 days. Furthermore, redefining the role of LTC hospitals to provide sub-acute medical treatment and rehabilitation to help older people in returning to their community is warranted.

Table 3. Comparison of two types of long-term care facilities in Korea

Facility type	LTC hospital	LTC institution
Related law	Medical law	Long-term care insurance law
National insurance	National health insurance	Long-term care insurance
Services mainly provided	Treatment and prevention of geriatric disease and geriatric syndromes	Assistance with daily living
Indication for admission	Physician decision	Long-term care level 1 or 2
Manpower required	Medical professionals (doctors, nurses), social workers	social workers, nurses or nursing assistant, physiotherapist

Source: Ga H. Long-term care system in Korea. Annals of Geriatric Medicine and Research 2020;24(3):181-186.

3) A relationship between home and institutional care

An implementation of LTCI programs aims to reduce medical spending by providing incentives to substitute with LTC care. Although it may have successfully reduced some of long hospital stays, it also increases concerns about inefficiency and insufficiency of LTC services. Particularly, a large portion of hospital inpatient care utilization transferred to institutional care, resulting in drastically increasing demand and costs. For instance, in Germany, the increase in the number of beneficiaries receiving institutional care is greater than that of home care. In 2005, the proportional of institutionalized beneficiaries reached 31.5%.[45,46] In japan, the demand for nursing home exploded, resulting in long-waiting lists.[47] In Korea, LTCI expenditure for home care increased by 27.2% between 2018 and 2019, whereas institutional care increased by 17.5%.[10] Thus, providing less costly programs such as home care or community-based home care has become increasingly important as more promising alternatives to control increasing LTC expenditures.

For home care, previous studies present the substitution of formal home care services for nursing home or facility care, but a weak relationship.[23] It is noteworthy that informal care is a significant determinant of decision-making

preferences between formal home and institutional care, mainly because formal home care and informal care are complementary each other.

In response to address the challenges, there are growing interests in community-based home care, which provides assistive support and long-term care to people in their own home. Ideally, community-based home care can offer more integrated and comprehensive services than formal home care. Furthermore, community care has been reported to be more cost effective than institutionalization in a nursing home, at all levels of dependency.[48] Yamada et al (2006) reported that nursing home care services has a negative relationship with community-based facilities, also suggested substitution of community-based day and short center services for nursing home care.[49]

Although there is relatively little evidence identifying a direct relationship between formal home and institutional care, it is evident that community-based care would lead to reduction in high-cost institutional care utilization. The Korean government also initiated an introduction of community care project in 2019, aiming to provide more comprehensive care and support to older people.

3. Theoretical model

Although intensity or type of care needs of older people are evaluated by medical providers, there are many other determinants affecting choices that older people and their caregivers make.50-52 The study focuses on an increase in access and affordability to LTC and its effect of utilizations.

This study is related to literatures elucidating individuals' behavioral or determinants associated with decision-making preferences for health-related service utilization. For instance, the Anderson Model is a conceptual model to examine the factors which would lead to healthcare utilization. The model describes individual and contextual determinants of access to medical care, which include predisposing factors, enabling factors, and need.[53,54] The PRECEDE-PROCEED model is a behavioral model providing structural framework for developing and evaluating health behavior change intervention.[55,56] The model encompasses multiple dimension and factors influencing behaviors including enable, predisposing, reinforcing as well as social, epidemiological, and environmental factors.

In this study, eligibility for institutional care which provides individuals with government subsidies to their LTC utilization up to a level of coverage changes their enabling factors such as access to LTC resources, and prices of services,

possibly financial burden and opportunity cost. Thus, the changes in enabling factors would lead to changes in medical and LTC utilization.

III. Methodology

1. Framework of the Study Design

This study aims to analyze the effects of LTCI on medical and LTC utilization. The main intervention of interest is eligibility for LTCI level 2 benefits. At level 2, recipients become eligible for government subsidy to institutional care. Increased access to institutional care benefits will lead to transitioning from medical to institutional care, as well as transitioning from home to institutional care. Figure 3 illustrates the framework of the study.

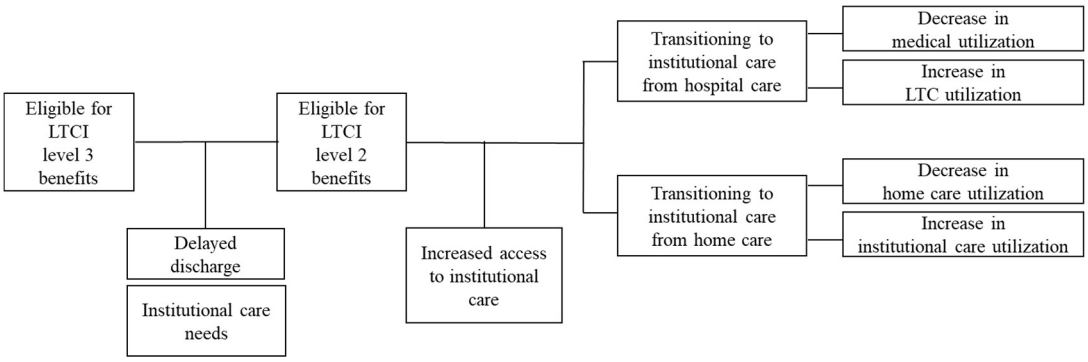


Figure 3. The framework of the study

2. Data and sample

1) Data

We use two sets of population-based cohort data, the LTCI dataset of 2008-2013 linked with the NHI dataset. The LTCI dataset consists of individuals selected by 10% random sampling method from a total of 5.5 million subjects aged 60 years and older in 2002. In total, 588,147 individuals were randomly selected and followed until 2013. Information in reference with LTCI was included in 2008 when LTCI was implemented. The dataset contains LTCI applicants' information including preliminary LTC scores from the first assessment and LTCI levels. The claims data provides information on reimbursed LTC utilization (type of services, insurance payment, OOP, and etc.) and care needs (criteria for the LTC needs assessment which is used for assigning applicants to LTCI level). The NHI dataset contains individuals' socio-demographic and medical utilization information from inpatient and outpatient claims data. We merge the dataset together for the same period of the LTCI dataset.

2) Study sample

The analysis sample consists of 99,841 LTCI applicants during 2009-2013. We excluded 10,734 individuals in 2008, because the LTCI was not implemented until July 2008. The main subjects of interest are those who are eligible for level 2 and 3, thus we excluded if not eligible for these two levels. After excluding 64,730 individuals based on the sample selection criteria, we have 35,111 individuals who are eligible for either level 2 or 3. For the RD model, the final analytic sample within the bandwidth 3.0 includes 5,128 individuals and 2,908 below and above the threshold 75, respectively (Figure 4).

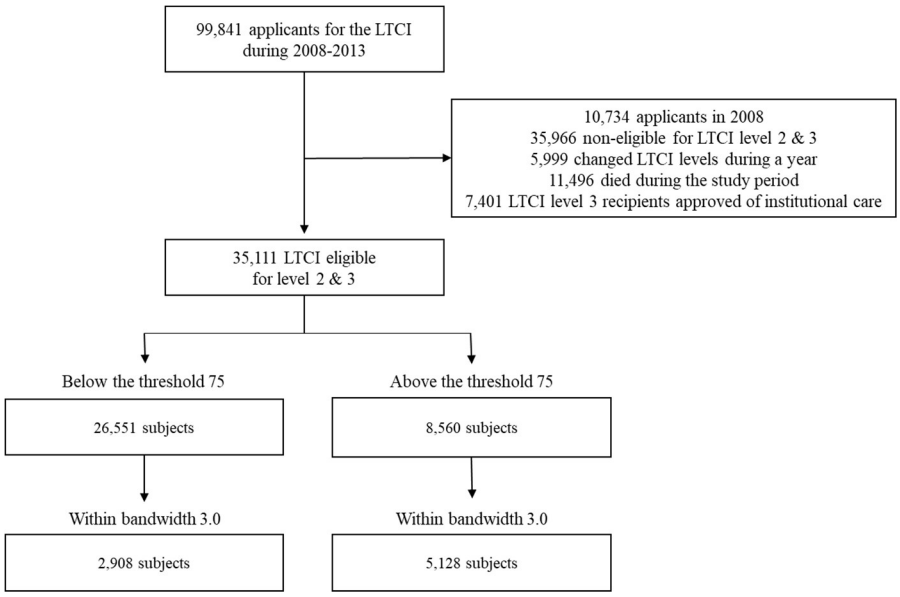


Figure 4. Flowchart of study sample selection

3. Study design

1) Regression discontinuity

(1) Definition

Regression discontinuity (RD) is a research method that attempts to estimate the causal effect of a treatment on outcomes of interest, by examining comparable observations in which the treatment is assigned or not assigned.[57]

Randomized experiments have been considered as the "gold standard" in because it ensures the comparability of units assigned to the treatment and control groups and generate unbiased estimates of treatment effect when carried out properly.[58] However, for various reasons, not all research can effectively be approached with experimental methods in real world. When randomized experiments are not feasible, a method which allows for a rigorous analysis of non-experimental designs, such as RD design, is particularly promising. The RD design, a quasi-experimental design, is a statistical approach which employs threshold based decision making, generating compelling estimates of treatment effects. RD design has been widely used in economics since it was first introduced by Thistlethwaite and Campbell in 1960.[57,59,60] In rather recent years, there are increasing researches in health services using the RD design to address questions in health services research.[61,62]

RD design is characterized by its method of assigning observations. Briefly, a predefined cutoff or threshold on an assignment measure (i.e., running variable) is employed. All observations whose score falls on one side of the cutoff are assigned to a treatment group while those whose score falls on the other side are assigned to a control group. Figure 5 depicts a simple linear RD design that the difference or 'discontinuity' in the two regression lines at the cutoff (c) provides an estimate of the treatment effect.[59,60,63]

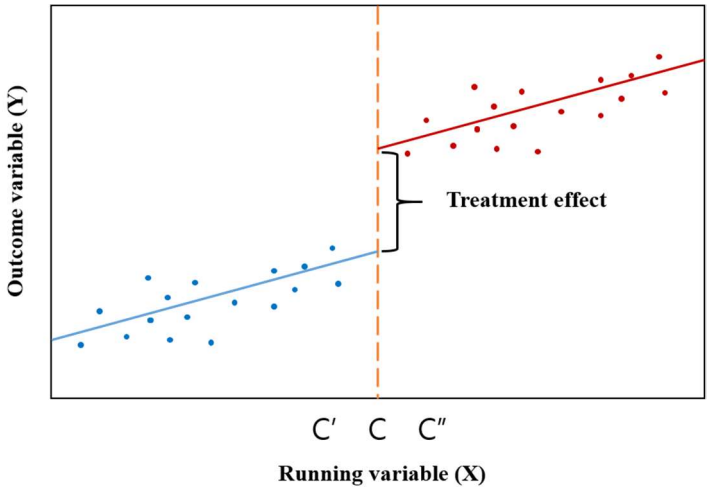


Figure 5. Simple linear RD setup

Modified from source: Lee, David S., and Thomas Lemieux. 2010. "Regression Discontinuity Designs in Economics." Journal of Economic Literature, 48 (2): 281-355.

The main strength of RD design is that it enables to estimate causal effects of treatment or policies, when randomization is not feasible. Second, it takes advantages of policy decision rules which people are differently assigned to a

treatment depending on which side of an arbitrary cutoff people fall.[59,60] On the other hand, limitations include concerns around external validity, particularly because the estimates are local average treatment effect which means they are only interpretable as cause effects for those near the specific cutoff.

(2) Basic structure of RD design

There are three fundamental components; score (i.e., running variable), cutoff, and treatment to define the RD design. For empirical methods for estimation and inference, the simplest and widely used approach would be non-parametric local linear regression which we adopt in this study. It can simply describe as estimating linear regressions of observations lying closed to the cutoff on each side, with different slopes and intercepts. It is equivalent to estimating the average effects of the treatment for two subsets of the sample within a bandwidth to the left and right of the cutoff. [64,65] Thus, the optimal choice of bandwidth is fundamental to improve the validity of RD design, because it can directly affect the estimations and inferences. Among various selection methods to choose the bandwidth, the most popular approach would be a mean-square-error (MSE) optimal method which effectively chooses a bandwidth to optimize a bias-variance trade-off.[66,67]

2) Variables

(1) Three fundamental components: running variable, cutoff, treatment

There are three fundamental components of the RD design (i.e. running variable, cutoff, treatment). In this study, we use a preliminary LTC score as a running variable that denotes the eligibility for institutional care benefits (i.e. treatment) at the cutoff 75 (Figure 6). A preliminary LTC score is based on examination of functional conditions, environmental conditions, and the level of needs for long-term care services. It is important to note that the relation between a preliminary LTC score and the eligibility is not deterministic because LTCI levels might be altered by the Committee.

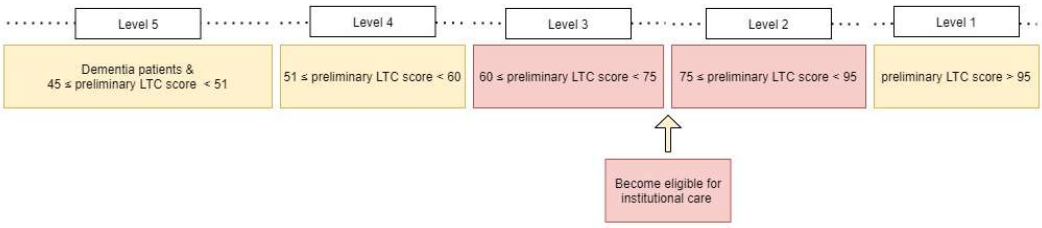


Figure 6. Definition of running variable and cutoff

(2) Dependent variables

The study explores the effects of LTCI level 2 benefits on medical and LTC utilization. Concerning a broad range of outcome variables, we select three main outcomes of interest, which are annual medical expenditure and LTC expenditure, and total expenditure of medical and LTC expenditure. For subgroup analysis, medical utilization includes inpatient and outpatient care measured separately in LTC hospitals and acute hospitals. LTC utilization includes institutional care and home care. Each type of care includes out-of-pocket expenditure, total expenditure, number of care days (length of stay, number of visits), and expenditure per day. In total, we analyze thirty outcome variables, of which three of them are the main outcomes in this study (Table 4).

Table 4. Definition of dependent variables

Type of care	Type of services		Variable	Definition
Panel A. Medical utilization	***Total medical expenditure***			Medical expenditure for all inpatient and outpatient care in LTC and Acute hospitals for a year
	LTC hospital	Inpatient	Inpatient OOP expenditure	Sum of OOP expenditure for inpatient care in LTC hospitals in a year
			Inpatient expenditure	Sum of expenditure for inpatient services in LTC hospitals in a year
			Length of inpatient stay	Sum of length of stay during each admission in LTC hospitals in a year
			Inpatient expenditure/day	Inpatient expenditure per day
		Outpatient	Outpatient OOP expenditure	Sum of OOP expenditure for outpatient care in LTC hospitals in a year
			Outpatient expenditure	Sum of expenditure for outpatient care in LTC hospitals in a year
			No. of outpatient visits	Sum of number of outpatient visits during each admission in acute hospitals in a year
			Outpatient expenditure/day	Outpatient expenditure per day
		Total	Total expenditure	Sum of expenditure for inpatient and outpatient care received in LTC hospitals in a year
	Acute hospital	Inpatient	Inpatient OOP expenditure	Sum of OOP expenditure for inpatient care in acute hospitals in a year
			Inpatient expenditure	Sum of expenditure for inpatient care received in acute hospitals in a year
			Length of inpatient stay	Sum of length of stay during each admission in acute hospitals in a year
			Inpatient expenditure/day	Inpatient expenditure per day
		Outpatient	Outpatient OOP expenditure	Sum of OOP expenditure for outpatient care received in acute hospitals in a year
			Outpatient expenditure	Sum of expenditure for outpatient services care in acute hospitals in a year
			No. of outpatient visits	Sum of number of outpatient visits during each admission in acute hospitals in a year
			Outpatient expenditure/day	Outpatient expenditure per day
		Total	Total expenditure	Sum of expenditure for inpatient and outpatient care in acute hospitals in a year

LTC: Long-term care, OOP: Out-of-pocket

Table 4. Definition of dependent variables *(continued)*

Type of care	Type of services	Variable	Definition
Panel B. LTC utilization	***Total LTC expenditure***		Sum of long-term care expenditure for home and institutional care in a year
	Institutional care	OOP Expenditure	Sum of OOP long-term care expenditure for home care in a year
		Expenditure	Sum of total long-term care expenditure for home care in a year
		# of care days	Sum of home care days received in a year
		Expenditure per day	Home care expenditure per day
	Home care	OOP Expenditure	Sum of OOP long-term care expenditure for institutional care in a year
		Expenditure	Sum of total long-term care expenditure for institutional care in a year
		# of care days	Sum of institutional care days received in a year
		Expenditure per day	Institutional care expenditure per day
Panel C. Medical+ LTC	***Total Medical and LTC expenditure***		Sum of medical and long-term care expenditure in a year

LTC: Long-term care, OOP: Out-of-pocket

(3) Covariates

This study contains eight predetermined covariates that we use to investigate the plausibility of RD design, and also to illustrate covariate-adjusted estimation methods. The covariates included in the analysis are gender, age, residential area of individuals, income level (calculated based on percentiles of insurance contribution), insurance type, Charlson's Comorbidity Index (CCI), disability, and year (Table 5). CCI was calculated monthly using Quan's method.[68]

Table 5. Definitions of covariates

Variable	Definition
Gender	male, female
Age	<74, 75-79, 80-84, 85≤
Region	urban, rural
Income	0 percentile, 1-3 percentile, 4-6 percentile, 7-8 percentile, 9-10 percentile
Insurance type	NHIS, medical aid
Charson's Comorbidity Index	0, 1, 2≤
Disability	Yes, No
Year	2009, 2010, 2011, 2012, 2013

3) Empirical strategy and statistical analysis

The empirical strategy used throughout this study is based on RD design for estimation of treatment effects of the LTC level 2 eligibility on health and long-term care utilization. I implemented an RD design exploiting threshold of preliminary LTC score that generates discontinuous probability of eligibility resulting changes in monthly benefits for long-term care services. We use a local polynomial model adopting the fact that observations just below and above the cutoff (preliminary LTC score 75) are likely to be very similar to each other concerning observed and unobserved characteristics. For the polynomial order, I use a polynomial of order one, as recommended by Gelman and Imbens. High-order polynomials can cause significant approximation errors, such as noisy estimates, results that are sensitivity to polynomial degree, and poor coverage of confidence intervals.[69] The preferred local linear RD estimator to measure the effect of LTCI level 2 on medical and LTC utilization at the cutoff is defined as:

$$\mathbf{Y}_{it} = \beta \times (\mathbf{S}_{it} \geq 75) + f(\mathbf{S}_i) + \gamma \times \mathbf{X}_{ist} + \theta_t + \varepsilon_{ist}$$

where Y_{ist} is the outcome measures for observation i, evaluation year t. $f(S_{it})$ is a smooth function of the running variable, i.e., the preliminary LTC score, X_{ist} is a

set of predetermined covariates, $\boldsymbol{\theta}_t$ is the year-fixed effect, and ε_{ist} is a random error term. Most importantly, $S_{it} \geq 75$ indicates the cutoff generating a dichotomous eligibility between level 2 and 3. Individuals whose score is equal to or above 75 is eligible for level 2. We present our primary interest, RD estimates of the treatment effect, i.e., level 2 near the cutoff using linear specification of the regression function.

As discussed above, we limit the sample to observations close enough to the cutoff 75. Defining the term "close enough" by choosing a bandwidth is an important issue. In general, a goal of bandwidth selection in nonparametric estimations is to balance between precision and bias. In this study, the estimates are based on a bandwidth of 3.0, in order to reduce bias by staying close to the cutoff while still maintaining enough precision. In addition, we also employ MSE-optimal bandwidth selector to examine whether the results with bandwidth 3.0 are robust and similar to other bandwidth choices. We use a triangular kernel function, which assigns zero to all of the observations outside the bandwidth interval and positive linear down-weighting to the observations in the interval.[60,70] For a nonparametric local polynomial inference, we apply robust bias correction for constructing confidence intervals.[60,71,72]

4) Validation and sensitivity analysis

One of the most important RD falsification tests involves examining comparability between those just above and just below the cutoff in terms of observable characteristics. The idea is simply that if observations lack the ability to precisely manipulate the score value they receive, there should be no systematic differences between those with similar values of the score, except the treatment (LTCI level 2). We conduct two validity tests, density of the running variable and predetermined covariates balance test. First, we examine the smoothness of the distribution of the preliminary LTC score around the cutoff (Appendix 1). A noticeable bunching is observed above the cutoff 75, suggesting that there might be manipulation in assigning of recipients to the treatment. A possible reason is that recipients recognize given benefits over the cutoff and try to receive scores high enough to be eligible for level 2. We address the issue in the discussion section. Furthermore, we examine weather predetermined covariates are balanced around the cutoff. We observe discontinuities in the RD plots for a few predetermined covariates (Appendix 2), the estimates are not significant, which indicates that the local randomness assumption is reasonably satisfied.

For sensitivity analysis, we examine 1) the sensitivity to bandwidth choices and alternative polynomial orders, 2) placebo cutoffs.[60]

4. Ethics statement

This study was approved by the Institutional Review Board, Yonsei University Health System (IRB number: 4-2021-0142).

IV. Results

1. Summary statistics

Table 6 provides summary statistics for the characteristics of LTCI recipients eligible for level 2 and 3, both before and after the bandwidth 3.0 was applied in baseline year. In total, the number of recipients in the final analytic sample was 8,036 reduced from 35,111 in the baseline year, including 2,908 recipients (36.2%) in the treatment group (above the cutoff), and 5,128 (63.8%) in the control group (below the cutoff). It is shown that the characteristics of recipients remain almost unchanged after the sample selection. However, recipients below and above the cutoff show statistically different characteristics. Thus, we tested whether predetermined characteristics are balanced around the cutoff. Appendix 2 contains the results for covariate balance test and indicates no evidence that, at the cutoff, recipients below and above differ systematically.

Table 7 provides descriptive statistics for outcome variables. It displays the average expenditure for medical and LTC utilization during the study period. It is clear that both medical and LTC expenditure is higher above the cutoff, however, no statistical difference is seen between medical expenditure below and above the cutoff.

Table 6. Summary statistics: sample characteristics in baseline year

Variables	Level 2 & 3					Bandwidth (3.0)				
	< 75		75 ≤		*P-value*	< 75 (72.08, 74.88)		75 ≤ (75, 77.88)		*P-value*
	N	%	N	%		N	%	N	%	
N	26,551	75.6	8,560	24.4		2,908	36.2	5,128	63.8	
Sex					0.481					0.016
Male	7,337	27.6	2,399	28.0		802	27.6	1,289	25.1	
Female	19,214	72.4	6,161	72.0		2,106	72.4	3,839	74.9	
Age					<.0001					<.0001
<74	5,873	22.1	1,755	20.5		618	21.3	989	19.3	
75-79	6,687	25.2	2,044	23.9		750	25.8	1,204	23.5	
80-84	6,805	25.6	2,048	23.9		741	25.5	1,238	24.1	
85≤	7,186	27.1	2,713	31.7		799	27.5	1,697	33.1	
Region					<.0001					0.003
Urban	15,552	58.6	5,256	61.4		1,875	64.5	3,132	61.1	
Rural	10,999	41.4	3,304	38.6		1,033	35.5	1,996	38.9	
Income					0.005					0.001
Q1	4,064	15.3	1,273	14.9		361	12.4	763	14.9	
Q2	4,968	18.7	1,541	18.0		547	18.8	950	18.5	
Q3	4,148	15.6	1,465	17.1		463	15.9	874	17.0	
Q4	4,091	15.4	1,371	16.0		434	14.9	706	13.8	
Q5	9,280	35.0	2,910	34.0		1,103	37.9	1,735	33.8	
Medical Insurance					0.330					0.022
NHIS	22,487	84.7	7,287	85.1		2,547	87.6	4,365	85.1	
Medical Aid	4,064	15.3	1,273	14.9		361	12.4	763	14.9	

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. All measures are measured at baseline.

Table 6. Summary statistics: sample characteristics in baseline year *(continued)*

Variables	Level 2 & 3					Bandwidth (3.0)				
	< 75		75 ≤		*P-value*	< 75 (72.08, 74.88)		75 ≤ (75, 77.88)		*P-value*
	N	%	N	%		N	%	N	%	
N	26,551	75.6	8,560	24.4		2,908	36.2	5,128	63.8	
CCI					<.0001					0.165
0	20,052	75.5	8,560	100.0		2,070	71.2	3,574	69.7	
1	3,791	14.3	1,232	14.4		419	14.4	736	14.4	
2 ≤	2,708	10.2	1,358	15.9		419	14.4	820	16.0	
Disability					0.008					0.178
No	25,637	96.6	8,213	95.9		2,797	96.2	4,900	95.6	
Yes	914	3.4	347	4.1		111	3.8	228	4.4	
Year					<.0001					0.179
2009	8,883	33.5	3,953	46.2		703	24.2	1,353	26.4	
2010	4,568	17.2	1,598	18.7		646	22.2	1,110	21.6	
2011	3,368	12.7	979	11.4		540	18.6	874	17.0	
2012	3,844	14.5	923	10.8		468	16.1	819	16.0	
2013	5,888	22.2	1,107	12.9		551	18.9	972	19.0	

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. All measures are measured at baseline. CCI: Charlson's comorbidity index

Table 7. Summary statistics: medical and LTC expenditure by year

Variables	Level 2 & 3					Bandwidth (3.0)				
	< 75		75 ≤		*P-value*	< 75 (72.08, 74.88)		75 ≤ (75, 77.88)		*P-value*
	N	%	N	%		N	%	N	%	
N	26,551	75.6	8,560	24.4		2,908	36.2	5,128	63.8	
Medical expenditure										
2009	3,904.1	±6,856.1	5,737.2	±8,871.8	<.0001	5,865.6	±9,220.8	6,044.8	±9,356.1	0.679
2010	4,810.6	±7,697.0	7,836.6	±11,168.9	<.0001	5,426.8	±8,222.9	5,635.3	±9,394.8	0.639
2011	5,882.1	±8,668.7	9,394.4	±10,903.3	<.0001	6,819.1	±10,036.7	6,385.0	±9,380.3	0.411
2012	5,974.8	±8,668.0	10,202.9	±11,454.4	<.0001	7,868.4	±10,789.3	7,200.8	±10,812.4	0.259
2013	5,442.1	±8,287.5	11,093.2	±11,695.5	<.0001	8,356.5	±11,160.4	8,474.3	±11,194.2	0.843
LTC expenditure										
2009	3,885.2	±3,177.4	6,508.3	±5,042.8	<.0001	5,426.8	±8,222.9	5,635.3	±9,394.8	0.639
2010	2,757.8	±2,546.5	5,019.3	±4,779.9	<.0001	4,605.7	±3,695.6	7,173.0	±4,878.0	<.0001
2011	2,336.0	±2,359.3	3,702.2	±3,992.3	<.0001	4,304.6	±3,537.3	6,256.4	±4,658.5	<.0001
2012	2,065.8	±2,176.3	3,528.6	±4,144.4	<.0001	4,058.1	±3,542.4	6,738.6	±5,031.9	<.0001
2013	1,754.3	±1,989.8	2,776.2	±3,485.1	<.0001	3,198.0	±3,272.4	4,896.2	±4,443.3	<.0001
Medical and LTC expenditure										
2009	7,789.3	±6,790.7	12,245.5	±8,086.3	<.0001	10,386.9	±8,757.6	12,448.1	±8,493.5	<.0001
2010	7,568.5	±7,515.4	12,855.9	±10,208.5	<.0001	10,032.5	±7,770.8	12,808.3	±8,203.5	<.0001
2011	8,218.1	±8,410.5	13,096.7	±10,181.7	<.0001	11,123.7	±8,860.2	12,641.4	±8,154.5	0.001
2012	8,040.6	±8,411.5	13,731.5	±10,562.5	<.0001	11,926.4	±9,587.3	13,939.3	±9,147.8	0.001
2013	7,196.5	±8,143.5	13,869.3	±10,818.3	<.0001	11,554.5	±10,218.1	13,370.5	±9,666.0	0.001

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. All measures are measured at baseline. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%.

2. Main results: regression discontinuity estimates

1) Medical utilization

We estimated the effect of the level 2 eligibility on recipients' medical utilization. Table 8 presents the RD estimates of the various outcomes for total medical expenditure (Panel A), LTC hospital care (Panel B), and acute hospital care (Panel C). The results show that level 2 eligibility results in a statistically significant decrease of 1,778,700 won in total medical expenditure per year. Relative to the mean of 6,060,200 won, this represents a 29.5% decrease. Figure 7-(1) presents the average changes in medical expenditure (Panel A) at the cutoff. As seen in the plot, a visible discontinuity is consistent with the RD estimates, indicating a negative effect of level 2 on medical expenditure.

Eligibility for level 2 benefits leads to a larger decrease in acute hospital care, of 1,576,300 won (a 49.2% decrease, p= <.0001) than in LTC hospital care, of 208,300 won (a 7.4% decrease, p=0.568). The estimations for LTC hospital care are not statistically significant, indicating that acute hospital care is more affected by the benefit expansion than LTC hospital care. In acute hospital, the inpatient expenditure significantly declines by the largest amount of 1,061,900 won (a 43.8% decrease, p=0.001) with 8.3 days less length of stay (a 45.8% decrease, p=0.001).

The outpatient expenditure also decreases by 514,300 won (a 65.7% decrease, p=<.0001) with reduced number of outpatient visits (a 7.3 days, 31.2% decrease, p=<.0001).

Table 8. RD estimates for the effect of LTCI on medical utilization

Variables	Medical utilization			
	Coeff.	**SE**	**p-value**	**Mean of dependent variable**
Panel A: Medical expenditure	-1,778.7	(429.5)	<.0001	6,030.2
Panel B: LTC hospital				
Total expenditure	-208.3	(365.1)	0.568	2,820.7
Inpatient OOP expenditure	-67.8	(92.8)	0.465	592.4
Inpatient expenditure	-206.3	(358.8)	0.565	2,777.7
Length of inpatient stay	-3.9	(5.1)	0.449	40.3
Inpatient expenditure/day	-3.6	(1.6)	0.026	15.2
Outpatient OOP	2.5	(4.5)	0.582	9.8
Outpatient expenditure	-2.0	(26.7)	0.939	43.0
Number of outpatient visits	0.8	(0.2)	0.001	1.4
Outpatient expenditure/day	1.0	(0.8)	0.184	2.9
Panel C: Acute hospital				
Total expenditure	-1,576.3	(350.9)	<.0001	3,205.4
Inpatient OOP expenditure	-193.7	(61.3)	0.002	446.8
Inpatient expenditure	-1,061.9	(314.0)	0.001	2,422.5
Length of inpatient stay	-8.3	(2.5)	0.001	18.1
Inpatient expenditure/day	-20.0	(5.2)	<.0001	74.8
Outpatient OOP	-101.0	(20.9)	<.0001	176.4
Outpatient expenditure	-514.3	(120.9)	<.0001	782.9
Number of outpatient visits	-7.3	(1.6)	<.0001	23.4
Outpatient expenditure/day	-1.9	(2.3)	0.409	28.8
Observations	10,809			

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. The dependent variable is a sum of medical and LTC expenditure. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket.

2) Long-term care utilization

We replicate the RD design for the LTC utilization. Table 9 presents the estimates of LTC expenditure (Panel A), institutional care (Panel B), and home care (Panel C). The results show that annual average LTC expenditure significantly increases by 2,467,000 won (p=<.0001) above the preliminary LTC score 75, representing a 39.3% increase compared to the mean value of 6,279,600 won. Figure 7-(2) presents the corresponding results to the estimates. There is a salient change in LTC expenditure around the cutoff.

The results reveal a significant increase in institutional care utilization around the cutoff. A total institutional care expenditure increases 3,178,600 won (a 100.7% increase, p=<.0001) with 93.8 days (a 103.1% increase, p=<.0001). In contrast, eligibility for institutional care benefits reduces home care utilization. In particular, the home care expenditure declines by 711,600 won (a 22.8% decrease, p=<.0001) with 43 days (a 30.5% decrease, p=<.0001).

Table 9. RD estimates for the effect of LTCI on LTC utilization

Variables	Long-term care utilization			
	Coeff.	**SE**	**p-value**	**Mean of dependent variable**
Panel A: LTC expenditure	2,467.0	(256.6)	<.0001	6,279.6
Panel B: Institutional care				
OOP expenditure	632.8	(48.0)	<.0001	547.7
Total expenditure	3,178.6	(245.6)	<.0001	3,158.0
Number of care days	93.8	(7.1)	<.0001	91.0
Expenditure/day	10.9	(0.9)	<.0001	11.6
Panel C: Home care				
OOP expenditure	-89.4	(31.7)	0.005	446.5
Total expenditure	-711.6	(174.5)	<.0001	3,121.6
Number of care days	-43.0	(9.7)	<.0001	141.1
Expenditure/day	-6.2	(2.8)	0.025	24.9
Observations	10,809			

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. The dependent variable is a sum of medical and LTC expenditure. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket.

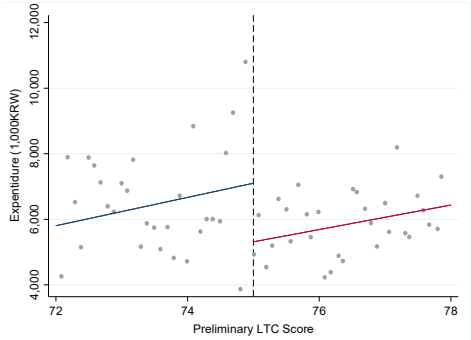
3) Medical and LTC utilization

In sum, we calculate a total expenditure of medical and LTC utilization. Table 10 presents that eligibility for level 2 causes the total expenditure of medical and LTC to increase significantly by 688,300 won (p=0.034) representing a 5.6% compared to the mean of 12,309,800 won. Corresponding to the results, figure 7-(3) displays a discontinuity around the cutoff. The change in total expenditure is a combination of the change in the medical expenditure and the LTC expenditure.

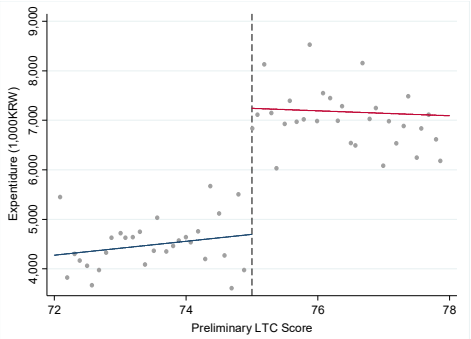
Table 10. RD estimates for the effect of LTCI on medical and LTC expenditure

Variables	Medical and long-term care expenditure			
	Coeff.	**SE**	**p-value**	**Mean of dependent variable**
Medical & LTC expenditure	688.3	(323.7)	0.034	12,309.8
OOP expenditure	184.5	(78.8)	0.019	2,220.6
Observations	10,809			

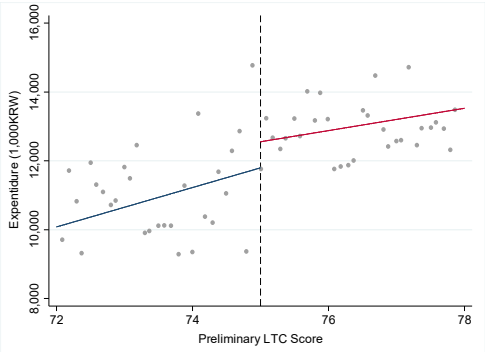
Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. The dependent variable is a sum of medical and LTC expenditure. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket.



(1) Medical expenditure



(2) LTC expenditure



(3) Medical and LTC expenditure

Figure 7. RD plots for medical and long-term care expenditure

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each plot represents a local average of changes in expenditure at preliminary LTC score 75. We use mimicking variance evenly-spaced methods for bin selection. Expenditures are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care.

3. Subgroup analysis by covariates

In this section, we evaluate the heterogeneity of the effect of LTCI level 2 among the levels of covariates, including gender, age, region, income, insurance, CCI, disability, and year. Table 11 presents the results for medical expenditure, LTC expenditure, and medical and LTC expenditure. Each row displays the RD estimates (coefficient of preliminary LTC score 75) for the various subgroups.

Panel A presents the results by gender. The results show that level 2 eligibility at preliminary LTC score significantly reduce the medical expenditure and increase the LTC expenditure for men and women. For medical care, men's expenditure decreases (2,352,300 won decrease, p=0.008) more than that of women's (1,542,100 won decrease, p=0.004). On the contrary, for LTC expenditure, women's expenditure increases (2,678,600 won increase, p=<.0001) higher than that of men's (1,930,100 won increase, p=<.0001). In total, women's total expenditure increases (1,136,500 won increase, p=0.006) whereas men's expenditure decreases although not significant (422,200 won decrease, p=0.593)

Panel C presents the results by region. Eligibility for level 2 causes similar reduction in medical expenditure and increase in LTC expenditure. However, individuals living in rural areas show greater changes in both expenditures (medical: 2,449,700 won decrease, p=0.001 ; LTC: 3,168,000, p=<.0001) than that of

individuals living in urban areas (medical: 1,418,800 won decrease, p=0.016 ; LTC: 2,078,800 won increase, p=<.001).

Panel D and E present the results by income and medical insurance type, respectively. Income level is determined based on insurance contribution that individuals receiving Medical aids belong to the income level Q1. The results show that eligibility for level 2 leads to similar increases of LTC expenditure across the different income levels or medical insurance groups. Thus, changes in LTC expenditure are quiet consistent. However, medical expenditures of individuals in the lowest income level or receiving Medical aids decrease by smaller changes than that of individuals in higher income level or receiving health insurance.

Panel F presents the results based on CCI. The results show that changes of medical expenditure increase in individuals with more comorbidities at preliminary LTC score 75 (CCI 2≤ : 3,497,500 won decrease, p=<.0007). However, increase of LTC expenditure are similar in all subgroups of CCI, resulting significantly higher total expenditure of medical and LTC in individuals with no comorbidity (1,216,500 won increase, p=<.0001)

Panel G presents the results by disability. Individuals without disability show decreased medical expenditure (1,919,000 won decrease, p=<.0001), and increased LTC expenditure (2,517,600 won increase p=<.0001).

Table 11. RD estimates for the effect of LTCI on medical and LTC expenditure at level 2: subgroup analysis by covariates

Variables	Medical expenditure			LTC expenditure			Medical and LTC expenditure		
	Coeff.	SE	p-value	Coeff.	SE	p-value	Coeff.	SE	p-value
A: Gender									
Male	-2,352.3	(889.8)	0.008	1,930.1	(323.4)	<.0001	-422.2	(790.3)	0.593
Female	-1,542.1	(531.9)	0.004	2,678.6	(296.5)	<.0001	1,136.5	(409.6)	0.006
B: Age									
<74	-573.1	(972.1)	0.556	2,218.3	(497.8)	<.0001	1,645.2	(996.9)	0.099
75-79	-4,279.1	(822.1)	<.0001	2,995.7	(380.0)	<.0001	-1,283.5	(803.6)	0.110
80-84	-1,543.0	(1,037.7)	0.137	2,048.1	(576.0)	<.0001	505.1	(747.6)	0.499
85≤	-847.6	(488.9)	0.083	2,608.6	(268.0)	<.0001	1,761.1	(521.5)	0.001
C: Region									
Urban	-1,418.8	(590.0)	0.016	2,078.8	(292.7)	<.0001	659.9	(432.0)	0.127
Rural	-2,449.7	(751.1)	0.001	3,168.0	(465.7)	<.0001	718.3	(537.9)	0.182
D: Income									
Q1	-438.8	(1,061.9)	0.679	2,187.8	(852.2)	0.010	1,749.0	(646.4)	0.007
Q2	-1,873.4	(836.3)	0.025	2,698.8	(504.9)	<.0001	825.4	(755.3)	0.274
Q3	-2,028.8	(769.7)	0.008	2,061.5	(398.8)	<.0001	32.7	(704.3)	0.963
Q4	-678.5	(1,235.4)	0.583	2,481.3	(432.5)	<.0001	1,802.8	(1,163.0)	0.121
Q5	-2,453.1	(810.1)	0.002	2,643.6	(337.0)	<.0001	190.5	(700.7)	0.786
E: Medical Insurance									
NHIS	-1,980.9	(454.0)	<.0001	2,518.3	(285.5)	<.0001	537.4	(336.4)	0.110
Medical Aid	-438.8	(1,061.9)	0.679	2,187.8	(852.2)	0.010	1,749.0	(646.4)	0.007

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, CCI: Charlson's Comorbidity Index.

Table 11. RD estimates for the effect of LTCI on medical and LTC expenditure at level 2: subgroup analysis by covariates *(continued)*

Variables	Medical expenditure			LTC expenditure			Medical and LTC expenditure		
	Coeff.	SE	p-value	Coeff.	SE	p-value	Coeff.	SE	p-value
F: CCI									
0	-1,170.8	(535.5)	0.029	2,387.3	(343.3)	<.0001	1,216.5	(382.6)	0.001
1	-3,026.9	(1,106.0)	0.006	2,896.1	(743.3)	<.0001	-130.9	(1,006.0)	0.896
2≤	-3,497.5	(1,307.4)	0.007	2,525.1	(630.8)	<.0001	-972.4	(1,137.0)	0.392
G: Disability									
No	-1,919.0	(444.4)	<.0001	2,517.6	(255.0)	<.0001	598.6	(313.1)	0.056
Yes	1,778.2	(3,103.6)	0.567	1,413.1	(722.7)	0.051	3,191.3	(3,353.4)	0.341
H: Year									
2009	242.9	(895.4)	0.786	1,655.7	(465.8)	<.0001	1,898.6	(884.9)	0.032
2010	-2,498.3	(944.1)	0.008	2,247.7	(432.9)	<.0001	-250.6	(729.8)	0.731
2011	-2,300.7	(608.1)	<.0001	2,461.7	(444.2)	<.0001	161.1	(769.9)	0.834
2012	-3,579.3	(1,137.1)	0.002	3,554.3	(435.2)	<.0001	-24.9	(855.1)	0.977
2013	-940.3	(1,040.0)	0.366	2,580.2	(498.5)	<.0001	1,639.8	(837.0)	0.050

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditures are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, CCI: Charlson's Comorbidity Index.

4. Subgroup analysis by diagnosis

We examine the heterogeneity in the effects of eligibility for level 2 by patients' diagnoses. We categorize patients by the five major diagnoses defined based on medical expenditures. They are (1) hypertension, (2) dementia and Alzheimer, (3) cerebrovascular disease, (4) diabetes, and (5) Parkinson's disease, extrapyramidal and movement disorders.

As seen in Table 12, medical expenditures for hypertension and dementia decreases by 1,640,500 won (p=0.024) and 1,639,800 (p=0.080), respectively, and LTC expenditures for both diagnoses similarly increase. Diabetes have 2,788,100 won increase of LTC expenditure, leading to the highest increase of total expenditure of medical and LTC (3,398,800 won increase, p=0.015) among all other diagnoses .

Table 12. RD estimates for the effect of LTCI on medical and LTC expenditure at level 2: Subgroup analysis by diagnoses

Variables	Obs.	Medical expenditure			LTC expenditure			Medical and LTC expenditure		
		Coeff.	SE	p-value	Coeff.	SE	p-value	Coeff.	SE	p-value
Top 5 diagnoses										
Hypertension	4,124	-1,640.5	(728.1)	0.024	2,549.6	(342.1)	<.0001	909.1	(549.4)	0.098
Dementia	2,144	-1,639.8	(937.1)	0.080	2,726.8	(488.2)	<.0001	1,087.0	(806.5)	0.178
Cerebrovascular	1,689	-2,031.7	(1,344.0)	0.131	1,979.9	(714.1)	0.006	-51.8	(1,250.3)	0.967
Diabetes	506	610.7	(1,968.2)	0.756	2,788.1	(949.1)	0.003	3,398.8	(1,397.0)	0.015
Parkinson's disease*	297	2,977.6	(2,501.7)	0.234	36.0	(829.5)	0.965	3,013.6	(2,322.0)	0.194
All other diseases	2,049	-1,778.7	(429.5)	<.0001	2,467.0	(256.6)	<.0001	688.3	(323.7)	0.034

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditures are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. We define 5 major diagnoses as a diagnosis list (3-digit ICD 10 code) in the Appendix 17. LTC: long-term care. * Parkinson's disease and extrapyramidal & movement disorders

5. Robustness check for bandwidth choices

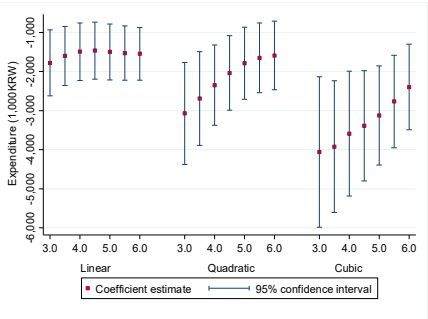
In this section, we examine a series of robustness checks for the main analysis. Table 13 and figure 8 present the sensitivity of the main results to different bandwidths and alternative specifications (i.e. quadratic and cubic polynomial orders) for the RD models for medical expenditure, LTC expenditure, and medical and LTC expenditure. In general, the results report that the estimates in both medical and LTC expenditures remain broadly consistent across the different bandwidth choices under the first order of polynomial. When applying quadratic and cubic polynomial orders, the estimates decline in medical expenditure while remains strong in LTC expenditure.

We conduct estimations and inferences at placebo cutoffs, exploring medical and LTC expenditures (Appendix 15). The results present that p-values in most of placebo cutoff points are not significant, suggesting the outcomes of interest (i.e. medical and LTC expenditures) do not jump discontinuously at the placebo cutoffs.

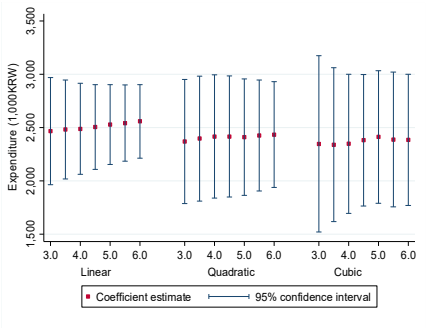
Table 13. RD estimates for the effect of LTCI on medical and LTC expenditure: subgroup analysis by bandwidths and polynomial orders

Bandwidths	Obs.	Polynomial 1(linear)			Polynomial 2(quadratic)			Polynomial 3(cubic)		
		Coeff.	SE	p-value	Coeff.	SE	p-value	Coeff.	SE	p-value
A: Medical expenditure										
3.0	10,809	-1,778.7	(429.5)	<.0001	-3,070.9	(666.4)	<.0001	-4,059.1	(982.2)	<.0001
4.0	13,535	-1,491.9	(376.0)	<.0001	-2,348.2	(523.8)	<.0001	-3,588.9	(813.5)	<.0001
5.0	16,084	-1,500.0	(363.3)	<.0001	-1,790.1	(469.8)	<.0001	-3,125.4	(646.0)	<.0001
6.0	18,384	-1,545.5	(344.1)	<.0001	-1,589.6	(447.3)	<.0001	-2,396.3	(558.2)	<.0001
B: LTC expenditure										
3.0	10,809	2,467.0	(256.6)	<.0001	2,369.9	(296.6)	<.0001	2,348.2	(421.6)	<.0001
4.0	13,535	2,488.9	(217.8)	<.0001	2,417.4	(295.0)	<.0001	2,348.8	(332.5)	<.0001
5.0	16,084	2,528.8	(191.3)	<.0001	2,411.8	(278.5)	<.0001	2,412.8	(317.4)	<.0001
6.0	18,384	2,559.0	(175.5)	<.0001	2,435.3	(253.2)	<.0001	2,385.4	(314.0)	<.0001
C: Medical and LTC expenditure										
3.0	10,809	688.3	(323.7)	0.034	-701.0	(579.2)	0.226	-1,710.9	(861.3)	0.047
4.0	13,535	997.0	(273.9)	<.0001	69.2	(426.8)	0.871	-1,240.1	(719.7)	0.085
5.0	16,084	1,028.8	(256.1)	<.0001	621.7	(373.6)	0.096	-712.6	(545.8)	0.192
6.0	18,384	1,013.6	(239.3)	<.0001	845.7	(340.6)	0.013	-10.9	(463.1)	0.981

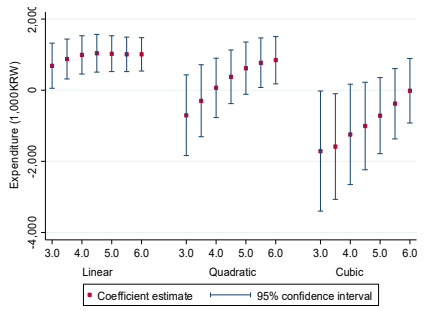
Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. This table reports the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. For sensitivity analysis, we use different bandwidths and polynomial selections. The bandwidths ranges from 3.0 to 6.0 and polynomial selections are linear, quadratic, and cubic. In the main analysis, we use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. Expenditures are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care.



(1) Medical expenditure



(2) LTC expenditure



(3) Medical and LTC expenditure

Figure 8. Robustness check for bandwidth and polynomial order

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each plot represents the coefficient estimate and 95% confidence interval from separate regression discontinuity at preliminary LTC score 75. For sensitivity analysis, we use different bandwidths and polynomial selections. The bandwidths ranges from 3.0 to 6.0 and polynomial selections are linear, quadratic, and cubic. In the main analysis, we use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care.

V. Discussion

1. Discussion of the methods

This study aims to estimate the effects of expanded LTC benefits on medical and LTC utilization focusing on LTCI level 2 institutional care, by implementing a quasi-experiment design with regression discontinuity design.

As stated in the Method section, there are few prerequisites in applying RD designs. First, we use a preliminary LTC score as the running variable. One of the key assumptions for valid RD design is that individuals cannot precisely manipulated the value of the score they receive.[73] We test the density of score at the predefined cutoff 75, and find a jump displaying more observations on the right side of the cutoff. Since the major advantage of RD design is that it mimics random assignment, possible manipulation or sorting around the cutoff should be properly addressed for validity of the study design. Recent literature provides discussions in reference to the rule of sorting. They suggest that knowledge of the assignment rule is sufficient to ensure valid RD design.[59,63] Furthermore, there are two types of manipulation, partial and complete. Partial manipulation occurs when individuals have control over the assignment, but also an endogenous element, in which case it does not lead to identification problems. Complete manipulation occurs when

individuals have complete control over the assignment, it leads to identification problems.[74] For example, Kim (2015) excluded the 75 threshold because of discontinuity in the score density. Instead, they used a threshold of 70 to examine the effects of the LTCI level 2.[21] Nonetheless, we use a cutoff 75 for the analysis even though some degree of potential sorting may have been present. A preliminary LTC score is determined through a complex assessment process based on 52 question, so it is unlikely that either individuals or evaluators had complete control over the score. Therefore, partial manipulation is not a potential threat to the validity of the design.

Second, when assessing the validity of RD design, it is important to test the continuity of baseline covariates by ensuring comparability between the two subsets of observation on each side of the cutoff. We perform a predetermined covariates balance test at bandwidths from 2.0 to 3.0, as well as MSE-optimal bandwidths.[60] The results show no empirical evidence that most of the predetermined covariates are discontinuous around the cutoff at 0.05 significant level.

Lastly, we examine whether the probability of treatment (i.e. LTCI level 2 eligibility) differ across the cutoff. The results show a perfect adherence to treatment above the cutoff, thus indicating that a sharp regression discontinuity design.

2. Discussion of the results

1) Summary of results

This study examines whether eligibility for LTCI level 2 benefits affected medical and LTC utilization. The results indicate that, in summary, LTCI level 2 leads to reduced medical utilization and increased LTC utilization. These findings are consistent with the study hypotheses, suggesting that increased access and affordability to LTC, including home and institutional care, may impact on the transition from medical care to LTC among older people. From a policy perspective, it is important to understand the changes in both medical and LTC utilizations, particularly as LTC benefits expand, because either policy for medical care and LTC can be implemented depending on the policy objective.

(1) Medical utilization

As shown in the main results regarding medical utilization, we observe a decline in overall medical expenditure. We estimate the impact of hospital types, LTC hospital and acute hospital, because each type of hospital has different patient characteristics and treatment, thereby different systems. We compare the estimated decreases in utilizations, observing that LTCI level 2 benefits lead to a larger

decrease in acute hospital utilization than that of LTC hospitals. For inpatient care, we find a reduction in both lengths of stays and expenditure in acute hospital. In acute hospitals, patients with lower medical care needs are encouraged to discharge and transferred to either LTC hospitals or institutions depending on their care needs, because non-medical days contribute to substantial burden on patients, hospitals, and the healthcare systems. Therefore, among patients who no longer require extended hospitalization but still need some form of care, expanded access and affordability of LTC, particularly institutional care, leads to increased LTC utilization. Furthermore, considering that patients are only eligible for institutional care benefits at level 2 and above, the findings suggest that inpatient medical care substitutes for institutional care, and that delayed discharge is decreased and thus inpatient care use reduced when care demands are met by LTC.[41] In comparison with the literature, previous studies provide consistent findings regarding the effect of social care services on hospitalization.[17,19,21,22,36] Alternatively, increased use of LTC may improve health by providing better disease management or social contact and support, thereby reducing the hospital admission rate.[20,75]

Conversely, we find a relatively little change in LTC hospital utilization when LTC benefits are expanded. To examine whether social admissions are decreased or increased by the expanded LTC benefits, we compare the estimates across diagnosis groups for which the majority of medical expenditure occurs

among older people. We find a decrease in LTC inpatient care for hypertension, dementia, and diabetes although not statistically significant. Conversely, LTC utilization is increased among those with cerebrovascular or Parkinson's disease. These results suggest that patients with less severe conditions may have been transferred from LTC hospitals to institutions. Moreover, institutional care may incur lower costs than LTC hospital inpatient care. Per day expenditures did not differ significantly between LTC hospitals and institutions, so there was little incentive for patients to transfer to institutional care. Previous studies also suggested that the current payment system to prevent long length of stay in LTC hospitals in Korea focuses on disincentivizing providers rather than patients, and that the system hence has little impact on patients' responses.[19]

According to the results, medical expenditure decreased by a greater amount among those with higher incomes and NHI than among those with lower income or medical aid beneficiaries, suggesting that people with more financial resources use medical services more. It follows that some of this use may be unnecessary. Thus eligibility for a decreased LTC price would encourage them to transition to LTC. Medical aid and basic livelihood beneficiaries are entitled to government subsidies of 50% and 100%, respectively, as a co-payment for LTC use. Previous studies reported that the Korean public LTCI program promotes

economic and geographic equity regarding access to LTC among underserved people who have higher LTC needs but limited access to care.[76,77]

(2) LTC utilization

For LTC utilization, we find significant changes in both home and institutional care. At LTCI level 2, recipients first become eligible for institutional care benefits, suggesting that these new benefits lead to a decrease in home care and an increase in institutional care as recipients substitute institutional care for home care. Other studies that offer some insights into the substitutive relationship between formal home care and institutional care.[21,23,49] There are several possible explanations for these findings. Older people choose to use institutional care over home care based on their needs including social care and health care needs. In terms of social care needs, informal care by family is very influential, as older people who receive informal home care are less likely to seek institutional care. Furthermore, people sometimes end up in institutional care because they lack social contact or network. Our findings suggest that a lower burden of co-payment may facilitate higher LTC use by the subsidized group than by their counterparts because the subsidized group may have lower family support than is necessary for independent living at home, and therefore they may prefer to be institutionalized, which becomes more affordable when subsidy for co-payment is given.[78,79] For health-related

reasons, they are willing to use institutional care because they need constant care from professionals. As seen in the results, these findings shed some light on the higher need for LTC among older patients with chronic diseases such as hypertension, dementia, and diabetes. Lastly, improved affordability due to government subsidies allows them to use institutional care.

(3) Medical and LTC utilization

Lastly, we assess the changes in total expenditure accounting for both medical and LTC utilization, and find a significant increase. Although the findings offer some plausible results, they do not provide scientific evidence about the cost-effectiveness of expanded LTC benefits for medical care. Some results in the literature that offer insight into the benefits and costs of LTCI. Feng et al (2020) demonstrated a cost-effectiveness analysis of LTCI in China, and found that the benefits of decreased health insurance payments were greater than the cost of implementing LTCI.[22] In addition, many aspects other than money must be considered when measuring the benefits of LTCI, such as health improvements, reduced burden on family caregivers, and labor performance improvement.[80-82]

2) Implications of the study

LTCI seeks to provide movement support to older people who are unable to maintain regular living activities due to old age or geriatric disease, thereby improving old age health and stable living, reducing family burden, and improving quality of life.[30] While under the public social insurance system, a key to the sustainability of LTCI and NHI is management of resource allocation and financial balance of the programs. In light of improving efficiency, our findings offer some insights into policy implications for containing the rapidly growing medical expenditure of older people and LTC services.

As seen in many countries, social admissions or delayed discharge in hospitals contributes to the high medical expenditure among older people, and consequently leads to inefficient use of medical care resources. In the present study, we find that expanded LTC care benefits leads to significant changes in both medical and LTC utilizations, indicating evidence of substitutive relationship, especially between hospital inpatient care and institutional care. This suggests that access to appropriate LTC services for older people would reduce the rapid increase in medical expenditure and mitigate inefficiency.

Additionally, even though problems regarding social admissions often occur in LTC hospitals in Korea, the study findings suggest that these have a

relatively small impact on LTC hospital utilization. The current mechanism to prevent social admission to LTC hospitals is to pay a reduced reimbursement for hospitalizations that last longer than 181 days. However, because the majority of LTC hospitals are private, keeping patients entail more profit than discharging them. In Korea, some LTC private hospitals are operated in franchised networks that rotate patients between hospitals to avoid financial disadvantages. Thus, a policy that employs a greater disincentive for unnecessary admissions is warranted. In addition, these interventions mostly target providers, so patients have little incentive to transfer from medical care to LTC. It follows that, policymakers must gain a better understanding of recipients' needs and preferences, as well as the determinants that influence care choices among older people in their decision-making process.

As briefly mentioned, there are other health, socioeconomic, and behavioral factors affecting demand for medical care and LTC.[49,52,83-85] In particular, many studies provide implied that informal care by family (i.e., children) is strongly influential, and that older people prefer home care provided by informal caregivers to institutional care.[49] However, many older people do not have family caregivers available, partly because family size has decreased. We expect that the role of LTCI will continue to increase in support of healthy living for older people in coming years. From a policy perspective, it is important to design and provide appropriate

LTCI programs that meet the needs of older people. In recent years, major policy themes and practices have emerged, including diversification of the type of formal care provided by LTCI and promoting integration with community resources (i.e., community-based care).[49,79,86] This study finds that expanding LTCI benefits can have a substantial effect on recipients and systems by transferring recipients from home to institutions. Therefore, policymakers should be aware that LTC benefits and services have different effects, and programs must be carefully designed to prevent inefficiency and insufficiency in LTC. For instance, overinstitutionalization among older people can pose a burden to LTC system, thus, provision of alternatives for LTC care is warranted to lessen inadequate institutional care utilization and expenditure for long-term sustainability of the system.[47] Furthermore, it is important to ensure that additional saving in medical expenditure gained through the expanded LTC benefits lead to overall improvements in outcomes.

Another potential policy agenda is to better co-ordinate medical and LTC, particularly among LTC hospital admissions and institutional care.[15,87] In terms of continuity of care and integrated treatment to ensure health and well-being among older people, the quality and medical assistance in institutions must be improved. Older people and their caregiver would prefer hospital stays because they believe that proper medical responses take place there. There is a greater chance that older

people staying in institutions require both medical and LTC. Some argue that LTC is not sufficient to satisfy the needs of beneficiaries. This increases unnecessary hospital care even when the patients have low medical needs. Integrated treatment must be provided to improve the quality and strength of medical response in institutional care services, which have become anxiety inducing factors for older people.

Lastly, NHI and LTCI systems are separated administratively and financially. Policymakers should be aware that challenges to the success of the system development including resource imbalance across the sectors, the fragmented provision of services to older people, and fiscal stability.

3. Limitations and strengths of the study

The present study has several limitations. Firstly, there are issues with the use of claims data provided by the NHIS. The dataset only includes information on publicly reimbursed medical and LTC services; therefore, the study does not account for services that are not covered by public insurance. For instance, the cost of food ingredients, premium room charges, haircut and other beauty care are not covered by LTCI.[30]

Secondly, we use a pooled cross-sectional dataset for analysis. Therefore, our study therefore does not consider the previous status of individuals because it is not a longitudinal design. In Korea, LTCI recipients are to be re-assessed every 2 years to determine the LTCI level. Therefore, changes in levels over the years may greatly affect recipients' health status or other social conditions, influencing their choice of care services. For instance, if recipients are eligible for institutional care in the first year and already reside in institutions, they are more likely to maintain their residence in the second year. Thus, we examine the short-term effects of the policy, but not the long-term effects. In the long-term, the effects of expanded LTCI benefits may differ for both individuals and systems. To estimate the changes in medical and LTC utilization more accurately, further longitudinal studies are needed.

Thirdly, the health consequences of expanded LTCI benefits are not evaluated in the present study. We measure the effects on 1-year changes in health outcomes including ADLs, IADLs, cognitive impairment, and behavioral impairment, and find little impact. However, investigating long-term health outcomes, such as recipient health and well-being improvements, disease improvements, and mortality, would clarify further whether LTCI serves its ultimate purposes.

Despite these limitations, the study demonstrates the effects of expanded LTCI benefits by exploring various medical and LTC utilization. It provides some insights into how the policy affects major services among older people and how individuals transition among those services. Furthermore, a quasi-experimental design using a representative sample improves the internal validity of the study.

VI. Conclusion

This study examines a causal effect of the public LTCI on medical and LTC utilization, focusing on expanded LTCI benefits for institutional care. The study systemically analyzes an array of medical and LTC utilization extensively, and find substitutive relationships between 1) hospital inpatient care and institutional care and 2) home care and institutional care. The findings suggest that increased access and affordability to LTC services may contain a rapid increasing medical expenditure among older people. Considering the fact that further ageing trend will continue in coming years, understanding the aging population will be crucially important for designing and delivering LTC programs to providing necessary support and services they need, and it can lead to improvements of resource allocation efficiency, and ultimately in health and well-being of older people.

Abbreviations

ADL: Activities of Daily Living

CCI: Charlson's Comorbidity Index

IALD: Instrumental Activities of Daily Living

ICD: International Classification of Disease

IRB: Institutional Review Board

LTC: Long-Term Care

LTCI: Long-Term Care Insurance

MSE: Mean Squared Error

NHI: National Health Insurance

OOP: Out-of-Pocket

RD: Regression Discontinuity

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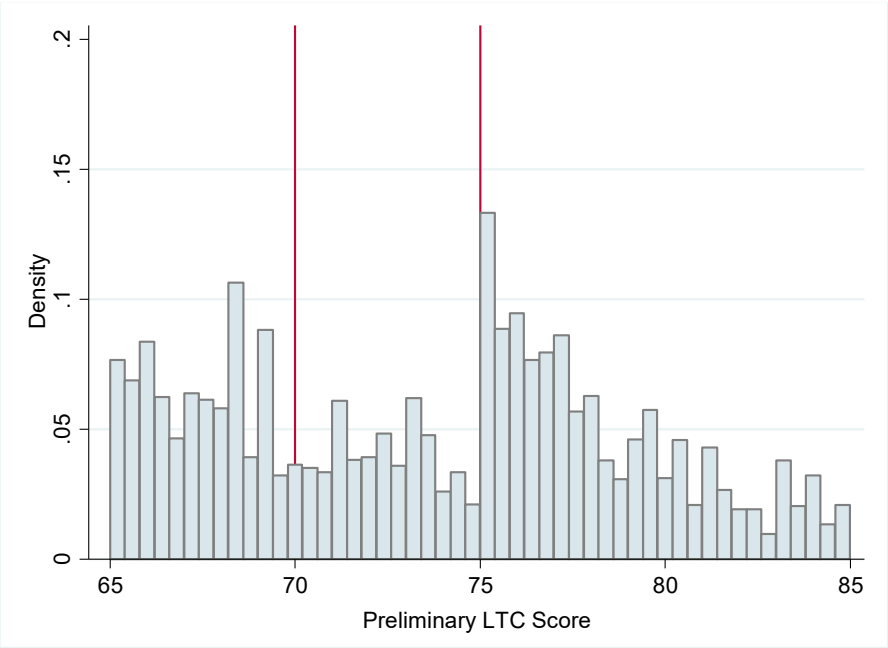
Appendix

Appendix 1. Density of preliminary LTC scores



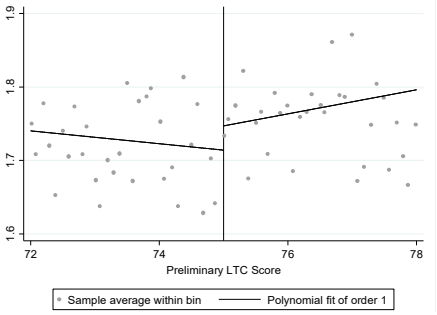
Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. This figure displays the density of preliminary LTC score around the cutoff 75.

Appendix 2. Predetermined covariate balance test

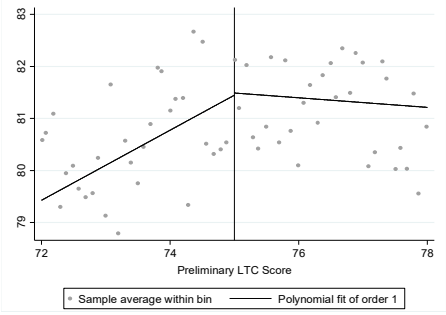
Variables	Bandwidth 3.0				MSE-optimal				
	Coeff.	SE	p-value	Obs	Coeff.	SE	p-value	Obs	Bw
Sex	0.03	(0.03)	0.233	10,809	0.02	(0.02)	0.284	16,335	5.094
Age	-0.02	(0.06)	0.762	10,809	-0.01	(0.06)	0.859	11,716	3.196
Region	0.06	(0.20)	0.759	10,809	0.04	(0.20)	0.842	53,364	16.399
Income	-0.12	(0.13)	0.334	10,809	-0.15	(0.08)	0.060	24,141	8.123
Insurance	0.02	(0.03)	0.513	10,809	0.03	(0.02)	0.070	24,093	8.039
CCI	0.00	(0.05)	0.940	10,809	0.04	(0.04)	0.343	16,335	5.089
Disability	0.01	(0.01)	0.305	10,809	0.01	(0.01)	0.347	19,388	6.216
Year	0.12	(0.08)	0.107	10,809	0.13	(0.08)	0.097	9,860	2.507

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. This table reports the covariate balance test results with bandwidth 3.0 and MSE-optimal bandwidths. Each row presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75.

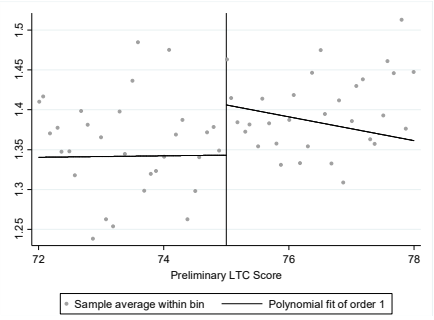
Appendix 3. RD plots for covariates balance test



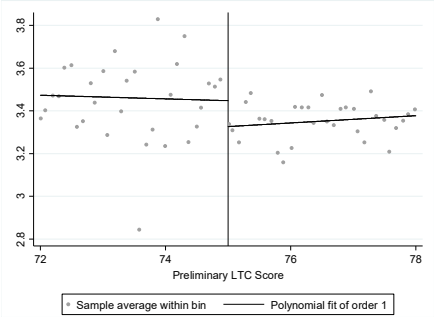
(1) Sex



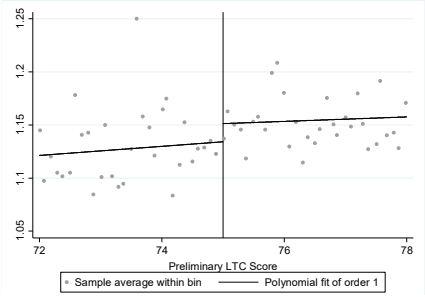
(2) Age



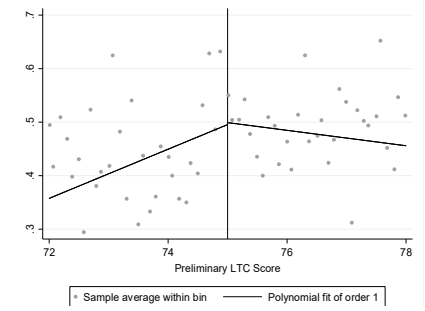
(3) Region



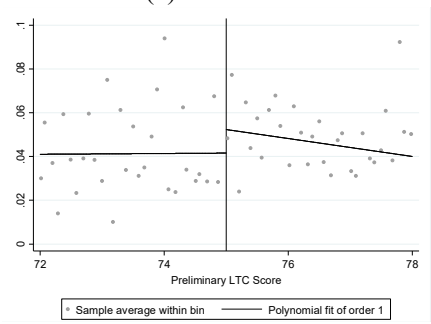
(4) Income



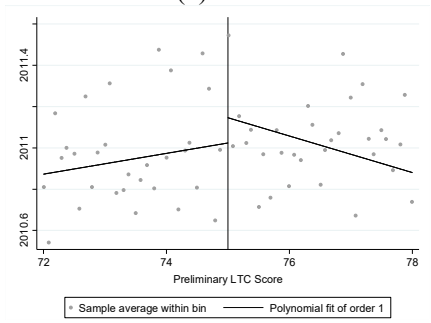
(5) Insurance



(6) CCI

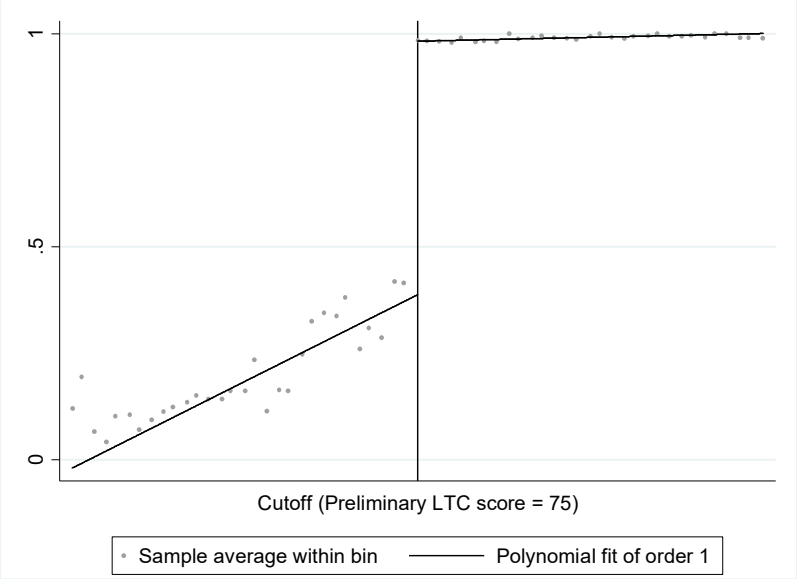


(7) Disability

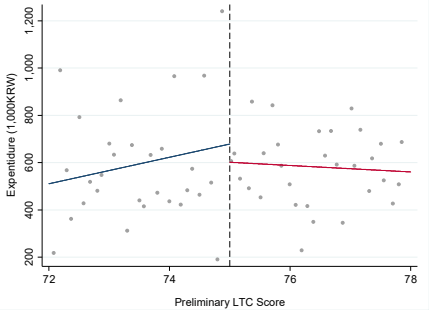


(8) Year

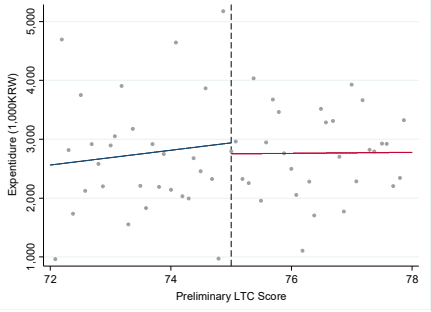
Appendix 4. Probability for LTCI level 2 eligibility



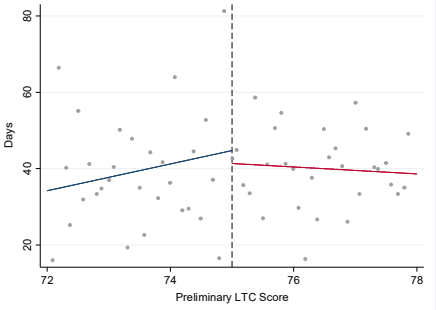
Appendix 5. RD plot for medical utilization: LTC hospital



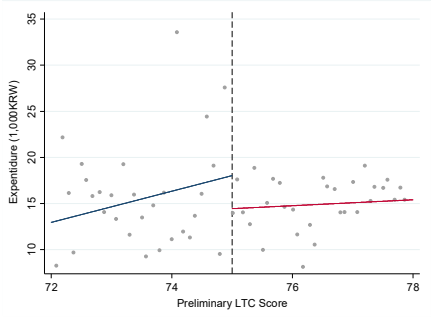
(1) Inpatient OOP expenditure



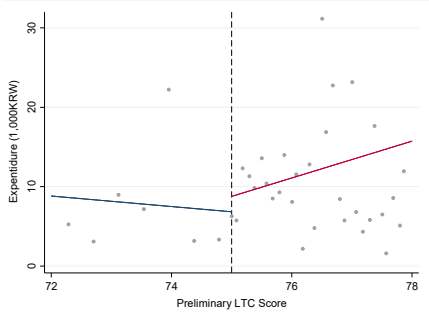
(2) Inpatient expenditure



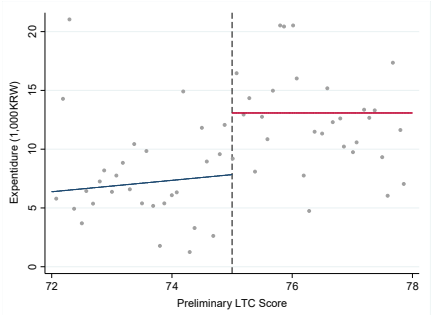
(3) Length of inpatient stay



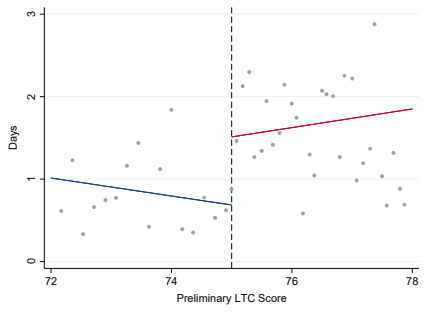
(4) Inpatient expenditure/day



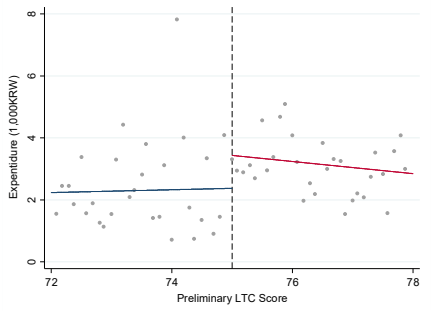
(5) outpatient OOP expenditure



(6) outpatient expenditure

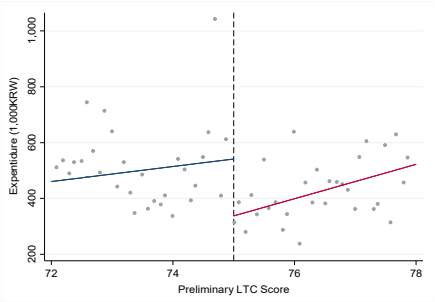


(7) Number of outpatient visits

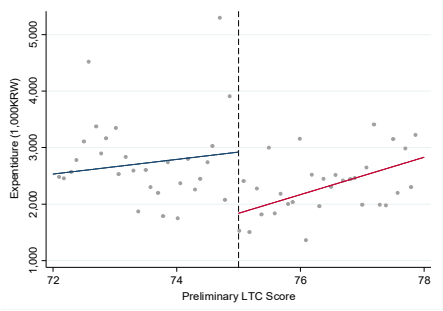


(8) Outpatient expenditure/day

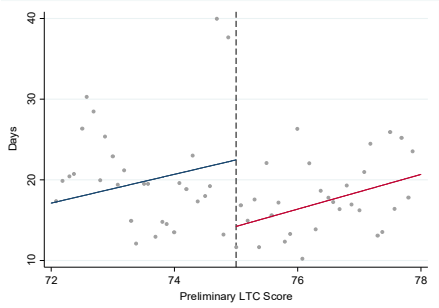
Appendix 6. RD plot for medical utilization: acute hospital



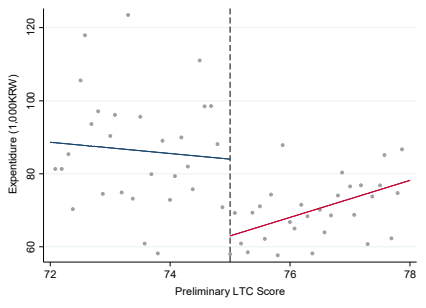
(1) Inpatient OOP expenditure



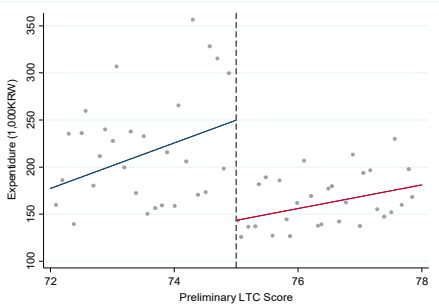
(2) Inpatient expenditure



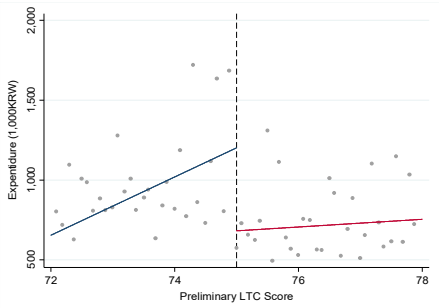
(3) Length of inpatient stay



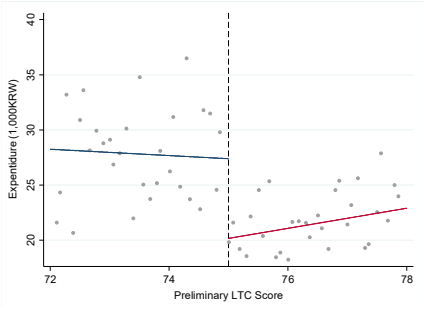
(4) Inpatient expenditure/day



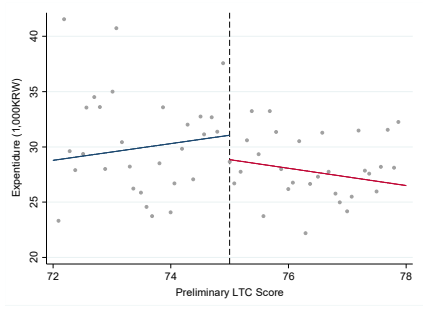
(5) outpatient OOP expenditure



(6) outpatient expenditure

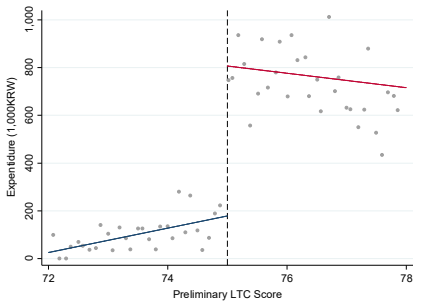


(7) Number of outpatient visits

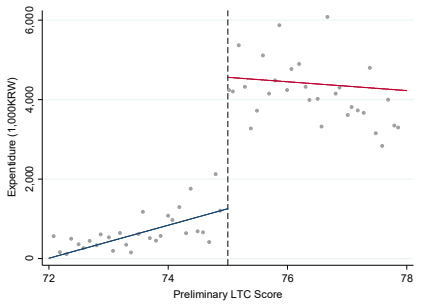


(8) Outpatient expenditure/day

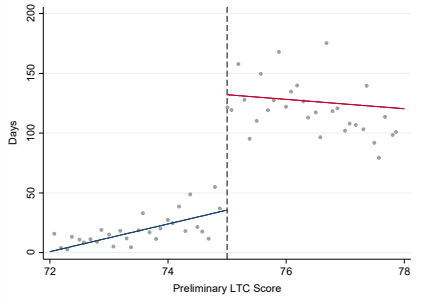
Appendix 7. RD plot for LTC utilization



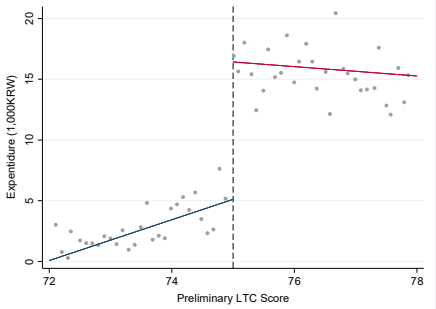
(1) Institutional care: OOP expenditure



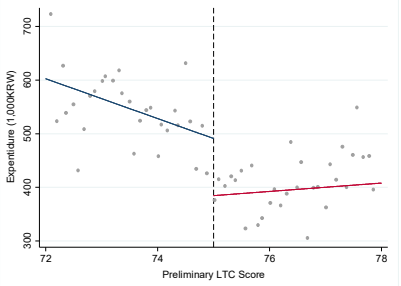
(2) Institutional care: total expenditure



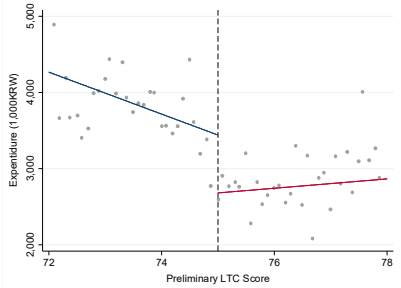
(3) Institutional care: No. of care days



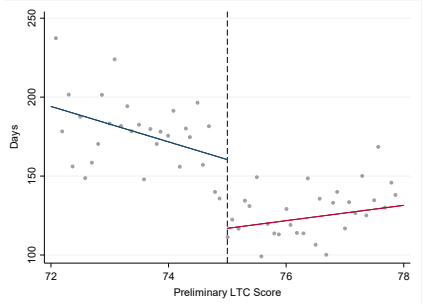
(4) Institutional care: expenditure/day



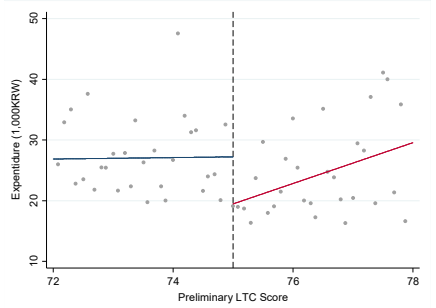
(5) Home care: OOP expenditure



(6) Home care: total expenditure



(7) Home care: number of care days



(8) Home care: expenditure/day

Appendix 8. RD estimates for the effect of LTCI on inpatient care expenditure at level 2

Variables	Inpatient care expenditure			
	Coeff.	SE	p-value	Mean of dependent
Panel A: by provider region				
Total				
Inpatient OOP expenditure	-261.5	(108.8)	0.016	1,039.2
Inpatient expenditure	-1,267.7	(448.2)	0.005	5,193.8
Urban				
Inpatient OOP expenditure	-248.1	(97.7)	0.011	694.1
Inpatient expenditure	-1,035.8	(425.1)	0.015	3,453.6
Rural				
Inpatient OOP expenditure	-13.4	(47.9)	0.780	345.1
Inpatient expenditure	-231.9	(191.4)	0.226	1,740.1
Panel B: by provider type				
Total				
Inpatient OOP expenditure	-261.5	(108.8)	0.016	1,039.2
Inpatient expenditure	-1,267.7	(448.2)	0.005	5,193.8
Public				
Inpatient OOP expenditure	-97.8	(20.8)	<.0001	110.1
Inpatient expenditure	-554.5	(132.3)	<.0001	584.6
Private				
Inpatient OOP expenditure	-163.7	(100.0)	0.102	929.1
Inpatient expenditure	-713.1	(412.6)	0.084	4,609.3
Observations	10,809			

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. The dependent variables are inpatient care expenditure. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket.

Appendix 9. RD estimates for the effect of LTCI on Institutional care expenditure at level 2

Variables	Institutional care expenditure			
	Coeff.	SE	p-value	Mean of dependent
Panel A: by provider region				
Total				
Institutional care OOP expenditure	632.8	(48.0)	<.0001	547.7
Institutional care expenditure	3,178.6	(245.7)	<.0001	3,158.0
Urban				
Institutional care OOP expenditure	381.2	(62.7)	<.0001	316.7
Institutional care expenditure	1,912.3	(314.7)	<.0001	1,741.7
Rural				
Institutional care OOP expenditure	251.6	(56.7)	<.0001	231.0
Institutional care expenditure	1,266.2	(338.3)	<.0001	1,416.3
Panel B: by provider type				
Total				
Institutional care OOP expenditure	632.8	(48.0)	<.0001	547.7
Institutional care expenditure	3,178.6	(245.7)	<.0001	3,158.0
Public				
Institutional care OOP expenditure	49.8	(11.0)	<.0001	29.8
Institutional care expenditure	286.1	(90.4)	0.002	218.2
Private				
Institutional care OOP expenditure	583.0	(49.5)	<.0001	517.9
Institutional care expenditure	2,892.5	(257.3)	<.0001	2,939.9
Observations	10,809			

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. The dependent variables are institutional care expenditure. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket.

Appendix 10. RD estimates for the effect of LTCI on inpatient care expenditure: ACSC

Variables	ACSC expenditure			
	Coeff.	SE	p-value	Mean of dependent
Medical expenditure				
LTC hospital				
Inpatient expenditure	-206.3	(358.8)	0.565	2,777.7
ACSC	-213.9	(234.0)	0.361	259.0
Non-ACSC	7.6	(326.5)	0.981	2,518.8
Acute hospital				
Inpatient expenditure	-1,061.4	(314.0)	0.001	2,416.1
ACSC	-101.4	(54.4)	.062	282.0
Non-ACSC	-960.0	(299.9)	0.001	2,134.1
Observations	10,809			

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. The dependent variables are inpatient care expenditure. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. I defined ACSC admissions using diagnosis list (3-digit ICD-10 code) in the Appendix 18. LTC: Long-term care, ACSC: Ambulatory Care Sensitive Conditions.

Appendix 11. RD estimates for the effect of LTCI on health outcomes

Variables	Health outcomes			
	Coeff.	SE	p-value	Mean of dependent
Activity of daily living	0.6	(0.1)	<.0001	-1.1
Instrumental activity of living	0.5	(0.1)	<.0001	-0.7
Cognitive	0.1	(0.0)	0.002	-0.2
Behavioral	0.1	(0.1)	0.017	0.1
Observations	10,809			

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. The dependent variables are one-year changes of each indicator for health outcome. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year.

Appendix 12. RD estimates for the effect of LTCI on LTC hospital utilization at level 2: subgroup analysis by covariates

Variables	Medical utilization: LTC hospital								
	Total expenditure	**Inpatient OOP expenditure**	**Inpatient expenditure**	**Length of inpatient stay**	**Inpatient expenditure/ day**	**Outpatient OOP expenditure**	**Outpatient expenditure**	**No. of outpatient visits**	**Outpatient expenditure per day**
	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)
Sex									
Male	-195.4	-35.4	-166.6	-2.7	-4.5	-2.2	-28.8	0.2	-1.0
	(787.3)	(213.5)	(761.5)	(11.2)	(3.1)	(10.0)	(61.0)	(0.5)	(1.7)
Female	-223.4	-83.9	-229.7	-4.7	-3.2*	4.3	6.3	1.0***	1.8***
	(326.3)	(74.9)	(326.7)	(5.0)	(1.7)	(2.7)	(15.7)	(0.3)	(0.6)
Age									
<74	519.9	150.4	568.4	9.8	-5.9*	-3.0	-48.5	0.8	1.5
	(753.2)	(185.7)	(770.5)	(9.2)	(3.6)	(17.1)	(109.8)	(0.8)	(1.4)
75-79	-825.3	-260.5*	-833.7	-12.5	-4.3	7.3*	8.4	1.4***	1.4
	(588.2)	(153.6)	(593.5)	(8.2)	(3.1)	(3.7)	(22.0)	(0.3)	(1.4)
80-84	121.0	62.0	128.4	0.6	-0.6	-1.5	-7.4	0.2	0.7
	(816.9)	(210.4)	(818.4)	(12.3)	(2.7)	(5.4)	(28.6)	(0.4)	(1.8)
85≤	-568.9	-189.6*	-589.3	-10.4	-4.2*	5.5***	20.4***	0.9***	1.0*
	(421.7)	(112.2)	(422.3)	(6.3)	(2.2)	(1.8)	(5.7)	(0.2)	(0.5)
Region									
Urban	-141.7	-83.7	-110.9	-1.6	-3.4*	-2.2	-30.8	0.5**	0.0
	(488.2)	(129.4)	(475.5)	(6.6)	(1.9)	(6.7)	(41.2)	(0.2)	(0.8)
Rural	-343.5	-43.1	-390.3	-7.8	-4.0	9.7***	46.7***	1.5***	2.9**
	(610.7)	(126.7)	(609.8)	(9.0)	(3.6)	(2.9)	(9.9)	(0.5)	(1.1)

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket. CCI: Charlson's comorbidity index. *** p<0.01, ** p<0.05, * p<0.10.

Appendix 12. RD estimates for the effect of LTCI on LTC hospital utilization at level 2: subgroup analysis by covariates *(continued)*

Variables	Medical utilization: LTC hospital								
	Total expenditure	**Inpatient OOP expenditure**	**Inpatient expenditure**	**Length of inpatient stay**	**Inpatient expenditure/ day**	**Outpatient OOP expenditure**	**Outpatient expenditure**	**No. of outpatient visits**	**Outpatient expenditure per day**
	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)
Income									
Q1	-1.8	-24.5	-66.3	0.0	-1.7	3.9***	64.6***	1.7***	3.8***
	(705.0)	(37.1)	(707.9)	(10.9)	(4.0)	(0.9)	(18.7)	(0.5)	(1.2)
Q2	-894.5	-185.9	-903.8	-13.8	-6.9	3.9	9.3	1.1***	0.8
	(839.4)	(205.9)	(838.2)	(11.7)	(3.6)	(2.3)	(7.2)	(0.4)	(0.9)
Q3	-881.6	-251.7	-891.0	-9.6	-4.3	3.8	9.4	0.5	0.8
	(822.0)	(206.3)	(819.4)	(10.0)	(3.6)	(2.6)	(9.1)	(0.6)	(1.6)
Q4	270.1	31.6	361.0	3.4	-1.2	-9.3	-90.8	0.2	0.6
	(1,061.4)	(271.1)	(1,075.0)	(15.4)	(5.0)	(19.0)	(126.1)	(0.8)	(1.5)
Q5	204.5	13.4	212.6	-0.2	-3.2	4.1	-8.0	0.7**	0.4
	(500.7)	(120.4)	(504.5)	(7.1)	(2.1)	(4.2)	(22.6)	(0.3)	(1.6)
Medical Insurance									
NHIS	-234.4	-79.8	-221.8	-4.3	-3.9**	2.1	-12.6	0.7**	0.6
	(419.7)	(100.0)	(411.5)	(5.7)	(1.5)	(5.2)	(30.4)	(0.3)	(0.8)
Medical Aid	-1.8	-24.5	-66.3	0.0	-1.7	3.9***	64.6***	1.7***	3.8***
	(705.0)	(37.1)	(707.9)	(10.9)	(4.0)	(0.9)	(18.7)	(0.5)	(1.2)
CCI									
0	-52.9	-22.6	-61.7	-1.6	-2.4	3.9	8.8	1.0***	1.1
	(390.1)	(102.8)	(385.9)	(5.9)	(1.7)	(4.5)	(25.5)	(0.3)	(0.7)
1	-1,164.9	-348.8	-1,137.4	-12.8	-9.4*	-1.3	-27.6	0.1	-0.5
	(1,212.8)	(288.8)	(1,217.1)	(17.1)	(5.4)	(3.4)	(34.9)	(0.5)	(2.3)
2 ≤	-223.8	-61.3	-199.0	-8.4	-3.9	-0.4	-24.8	0.9	2.3*
	(966.3)	(213.8)	(982.3)	(14.4)	(4.2)	(10.6)	(63.6)	(0.6)	(1.3)

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket. CCI: Charlson's comorbidity index. *** p<0.01, ** p<0.05, * p<0.10.

Appendix 12. RD estimates for the effect of LTCI on LTC hospital utilization at level 2: subgroup analysis by covariates *(continued)*

Variables	Medical utilization: LTC hospital								
	Total expenditure	**Inpatient OOP expenditure**	**Inpatient expenditure**	**Length of inpatient stay**	**Inpatient expenditure/ day**	**Outpatient OOP expenditure**	**Outpatient expenditure**	**No. of outpatient visits**	**Outpatient expenditure per day**
	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)
Disability									
No	-337.2	-101.0	-334.1	-5.2	-4.0**	2.3	-3.1	0.8***	1.0
	(371.3)	(91.2)	(363.5)	(5.3)	(1.7)	(4.7)	(27.9)	(0.3)	(0.8)
Yes	2,537.5*	621.8**	2,516.8*	23.3	3.7	5.0	20.7	0.3	1.1
	(1,322.1)	(308.9)	(1,320.7)	(16.6)	(6.8)	(3.8)	(15.0)	(0.5)	(1.7)
Year									
2009	563.6	142.7	644.9	8.1	-0.4	-10.2	-81.3	0.2	-0.7
	(526.0)	(134.9)	(546.8)	(8.3)	(2.6)	(13.9)	(89.5)	(0.6)	(1.8)
2010	-10.2	6.1	-30.2	-2.9	-4.6*	4.5	20.0	1.0*	3.1***
	(531.2)	(127.0)	(535.8)	(8.0)	(2.6)	(6.9)	(37.2)	(0.6)	(1.1)
2011	-938.8*	-189.9	-944.7*	-11.8	-3.3	3.9	6.0	0.9***	1.9*
	(555.1)	(166.1)	(552.4)	(8.5)	(2.3)	(2.5)	(14.7)	(0.3)	(0.3)
2012	-1,832.9*	-457.8*	-1,892.2*	-28.0*	-7.9**	12.3***	59.3***	1.5***	1.2
	(1,054.6)	(256.9)	(1,049.4)	(14.6)	(3.5)	(4.5)	(23.0)	(0.4)	(1.2)
2013	873.1	128.5	886.6	10.2	-2.0	0.8	-13.5	0.5	-0.1
	(829.5)	(168.8)	(829.8)	(12.0)	(3.9)	(2.4)	(24.4)	(0.3)	(1.7)

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket. CCI: Charlson's comorbidity index. *** p<0.01, ** p<0.05, * p<0.10.

Appendix 13. RD estimates for the effect of LTCI on acute hospital utilization at level 2: subgroup analysis by covariates

Variables	Medical utilization: acute hospital								
	Total expenditure	**Inpatient OOP expenditure**	**Inpatient expenditure**	**Length of inpatient stay**	**Inpatient expenditure/ day**	**Outpatient OOP expenditure**	**Outpatient expenditure**	**No. of outpatient visits**	**Outpatient expenditure per day**
	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)
Sex									
Male	-2,171.5***	-139.0	-1,219.3*	-7.7	-32.4***	-166.4***	-952.2***	-12.9***	-8.9**
	(695.0)	(144.6)	(719.6)	(5.4)	(9.0)	(42.5)	(297.6)	(3.8)	(4.3)
Female	-1,321.0***	-212.4***	-983.8**	-8.5**	-14.7**	-75.4***	-337.1***	-4.9***	0.9
	(411.5)	(72.6)	(387.3)	(3.6)	(6.5)	(23.8)	(123.8)	(1.5)	(2.1)
Age									
<74	-1,108.1	-42.5	-872.5	-8.5	-26.6	-152.2*	-235.5	-8.3	-0.5
	(997.8)	(174.6)	(904.4)	(5.2)	(22.2)	(79.8)	(392.8)	(5.7)	(6.4)
75-79	-3,453.8***	-480.4***	-2,372.2***	-13.9***	3.8	-154.0***	-1,081.6**	-12.4***	-5.1
	(803.5)	(133.3)	(631.7)	(5.4)	(13.8)	(47.3)	(443.9)	(3.6)	(5.0)
80-84	-1,672.3**	-198.8	-1,197.2**	-12.4**	-21.7**	-84.1***	-475.1**	-7.1**	-4.3*
	(664.9)	(138.9)	(577.5)	(5.5)	(10.4)	(29.1)	(203.2)	(3.2)	(2.6)
85≤	-279.4	-42.2	-34.7	0.1	-30.9**	-39.3*	-244.7	-2.6*	2.4
	(329.0)	(52.7)	(274.4)	(2.7)	(12.7)	(23.8)	(155.9)	(1.5)	(2.0)
Region									
Urban	-1,286.1***	-160.3**	-833.5**	-6.2**	-17.4**	-104.4***	-452.6***	-6.7***	-2.2
	(495.3)	(76.2)	(398.9)	(2.4)	(6.8)	(27.6)	(128.3)	(2.1)	(3.5)
Rural	-2,106.2***	-255.3***	-1,478.6***	-12.0**	-23.8***	-95.4***	-627.6**	-8.6***	-1.9
	(488.2)	(127.5)	(560.8)	(5.6)	(9.0)	(36.7)	(272.7)	(1.8)	(2.8)

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket. CCI: Charlson's comorbidity index. *** p<0.01, ** p<0.05, * p<0.10.

Appendix 13. RD estimates for the effect of LTCI on acute hospital utilization at level 2: subgroup analysis by covariates *(continued)*

Variables	Medical utilization: acute hospital								
	Total expenditure	**Inpatient OOP expenditure**	**Inpatient expenditure**	**Length of inpatient stay**	**Inpatient expenditure/ day**	**Outpatient OOP expenditure**	**Outpatient expenditure**	**No. of outpatient visits**	**Outpatient expenditure per day**
	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)
Income									
Q1	-437.0	-0.1	-536.4	-11.0	3.7	-32.9	99.3	-6.6	9.1*
	(643.0)	(13.8)	(599.0)	(6.7)	(11.9)	(17.5)	(195.8)	(3.8)	(5.5)
Q2	-987.4**	-140.5	-904.4*	-9.5	-22.4*	-54.9	-83.0	-6.7	-3.9
	(449.5)	(119.3)	(468.3)	(6.5)	(11.5)	(52.4)	(171.1)	(4.3)	(2.6)
Q3	-1,141.9**	-238.0*	-782.7	-8.5	2.7	-34.1	-359.2	-2.2	-1.0
	(565.7)	(129.8)	(598.8)	(5.6)	(12.0)	(47.7)	(330.6)	(3.1)	(3.5)
Q4	-978.1	-51.8	-586.7	1.4	-61.3***	-84.2*	-391.4	-5.3	9.9**
	(865.9)	(120.3)	(711.3)	(5.4)	(18.6)	(50.2)	(307.1)	(4.3)	(4.7)
Q5	-2,659.9***	-327.8***	-1,614.7***	-10.2***	-23.3***	-179.3***	-1,045.2***	-10.4***	-9.7**
	(581.3)	(93.1)	(486.6)	(3.4)	(8.8)	(36.7)	(259.6)	(2.4)	(4.7)
Medical Insurance									
NHIS	-1,753.6	-226.0***	-1,137.0***	-7.8***	-23.8***	-112.3***	-616.6***	-7.5***	-3.8
	(383.2)***	(70.1)	(346.1)	(2.5)	(6.1)	(24.6)	(140.0)	(1.7)	(2.7)
Medical Aid	-437.0	-0.1	-536.4	-11.0	3.7	-32.9*	99.3	-6.6*	9.1*
	(643.0)	(13.8)	(599.0)	(6.7)	(11.9)	(17.5)	(195.8)	(3.8)	(5.5)
CCI									
0	-1,124.7***	-177.5**	-741.9*	-5.3*	-15.9**	-106.4***	-382.8**	-6.9***	-0.8
	(430.0)	(75.8)	(386.5)	(2.8)	(6.2)	(31.8)	(191.6)	(2.3)	(2.5)
1	-1,869.0***	-171.5	-1,494.8*	-10.9	-29.5*	-51.7	-374.3	-6.1**	2.4
	(681.2)	(197.4)	(875.1)	(7.9)	(17.7)	(49.2)	(503.3)	(2.9)	(7.0)
2 ≤	-3,273.9***	-302.3**	-2,088.5***	-19.2***	-25.9	-126.9***	-1,185.4***	-9.6***	-10.9**
	(876.4)	(149.4)	(736.5)	(7.1)	(16.3)	(45.6)	(386.2)	(3.0)	(5.0)

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket. CCI: Charlson's comorbidity index. *** p<0.01, ** p<0.05, * p<0.10.

Appendix 13. RD estimates for the effect of LTCI on acute hospital utilization at level 2: subgroup analysis by covariates *(continued)*

Variables	Medical utilization: acute hospital								
	Total expenditure	**Inpatient OOP expenditure**	**Inpatient expenditure**	**Length of inpatient stay**	**Inpatient expenditure/ day**	**Outpatient OOP expenditure**	**Outpatient expenditure**	**No. of outpatient visits**	**Outpatient expenditure per day**
	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)
Disability									
No	-1,587.9***	-209.2***	-1,141.1***	-9.1***	-20.0***	-96.8***	-446.7***	-7.1***	-1.2
	(319.5)	(62.8)	(313.8)	(2.6)	(5.3)	(19.2)	(141.7)	(1.7)	(2.1)
Yes	-759.3	212.0	1,062.3	12.6**	-16.8	-169.5	-1,821.6	-8.6	-16.9
	(3,365.5)	(169.0)	(980.0)	(4.9)	(29.2)	(252.6)	(2,492.6)	(14.9)	(13.8)
Year									
2009	-320.6	-78.8	-382.5	-2.1	-5.4	-31.5	61.8	-4.4	7.4
	(626.2)	(119.9)	(609.2)	(5.2)	(11.7)	(40.5)	(184.0)	(3.7)	(4.6)
2010	-2,480.3***	-426.5**	-1,936.1**	-14.2**	-24.2	-110.0***	-544.1	-2.3	-4.5
	(865.7)	(173.9)	(833.7)	(6.6)	(16.3)	(40.6)	(348.2)	(2.8)	(4.7)
2011	-1,385.0*	-64.3	-460.6	-4.9	-21.5	-160.6*	-924.4**	-10.1**	-2.2
	(743.7)	(97.8)	(564.4)	(5.5)	(13.7)	(86.2)	(456.7)	(4.5)	(3.2)
2012	-1,757.7**	-278.1*	-1,606.6**	-16.8**	-26.7*	-49.3	-151.0	-6.6**	-0.5
	(687.4)	(159.0)	(646.3)	(6.9)	(15.3)	(33.2)	(178.6)	(2.9)	(4.6)
2013	-1,818.2***	-113.7	-875.1*	-4.0	-22.1	-153.3**	-943.1*	-13.2***	-8.0**
	(605.7)	(96.2)	(509.0)	(4.6)	(14.3)	(74.1)	(553.5)	(4.7)	(3.9)

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket. CCI: Charlson's comorbidity index. *** p<0.01, ** p<0.05, * p<0.10.

Appendix 14. RD estimates for the effect of LTCI on LTC utilization at level 2: subgroup analysis by covariates

Variables	Institutional care				Home care			
	OOP expenditure	**Total expenditure**	**No. of care days**	**Expenditure/day**	**OOP expenditure**	**Total expenditure**	**No. of care days**	**Expenditure /day**
	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)
Sex								
Male	459.6***	2,118.4***	64.8***	7.3***	-54.2	-188.3	-30.3**	-7.6
	(52.4)	(260.9)	(7.4)	(1.1)	(50.1)	(322.2)	(13.9)	(7.1)
Female	698.2***	3,582.4***	104.7***	12.3***	-101.9***	-903.8***	-47.6***	-5.7*
	(63.2)	(307.2)	(9.1)	(1.0)	(34.2)	(171.7)	(11.4)	(3.0)
Age								
<74	515.5***	2,629.3***	78.9***	8.6***	-58.8	-411.0	-33.5	-10.7
	(80.9)	(366.7)	(10.8)	(1.2)	(62.3)	(372.2)	(23.6)	(6.8)
75-79	705.5***	3,669.6***	106.2***	13.4***	-87.6**	-673.9**	-37.8**	-2.1
	(52.2)	(311.4)	(8.7)	(1.1)	(41.1)	(286.3)	(16.7)	(4.0)
80-84	592.2***	2,852.1***	85.5***	9.8***	-105.1	-804.0**	-36.3**	-13.8
	(87.1)	(595.7)	(16.5)	(2.0)	(70.2)	(355.8)	(17.2)	(8.6)
85≤	678.8***	3,464.1***	101.3***	11.4***	-90.8**	-855.4***	-60.1**	-1.6
	(71.6)	(315.1)	(9.3)	(1.3)	(43.3)	(243.4)	(10.7)	(4.6)
Region								
Urban	611.5***	2,976.2***	88.3***	10.2***	-115.1**	-897.5***	-54.8***	-9.1**
	(65.3)	(320.6)	(9.4)	(1.1)	(51.3)	(279.2)	(13.7)	(3.7)
Rural	655.8***	3,541.2***	103.6***	12.2***	-36.1	-373.2**	-20.3***	-1.7
	(87.1)	(442.3)	(13.0)	(1.5)	(28.9)	(155.4)	(7.2)	(2.8)

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket. CCI: Charlson's comorbidity index. *** p<0.01, ** p<0.05, * p<0.10.

Appendix 14. RD estimates for the effect of LTCI on LTC utilization at level 2: subgroup analysis by covariates *(continued)*

Variables	Institutional care				Home care			
	OOP expenditure	**Total expenditure**	**No. of care days**	**Expenditure/day**	**OOP expenditure**	**Total expenditure**	**No. of care days**	**Expenditure /day**
	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)
Income								
Q1	46.3***	3,471.6***	91.8***	12.4***	-3.0	-1,283.8**	-49.5**	0.9
	(9.8)	(690.7)	(18.7)	(2.0)	(21.8)	(505.6)	(25.2)	(4.1)
Q2	651.8***	3,396.7***	98.4***	11.3***	-95.6*	-698.0*	-39.5**	-15.7***
	(92.0)	(501.1)	(14.9)	(1.9)	(55.1)	(380.0)	(19.5)	(4.9)
Q3	724.2***	3,067.8***	90.9***	11.5***	-163.7**	-1,006.3***	-48.7***	-7.0
	(83.2)	(83.2)	(10.0)	(0.9)	(67.8)	(391.9)	(17.6)	(5.9)
Q4	684.5***	2,835.6***	85.9***	10.5***	-73.8	-354.3	-39.7**	-4.9
	(90.5)	(360.5)	(12.1)	(1.6)	(72.2)	(413.1)	(17.9)	(7.9)
Q5	762.4***	3,136.1***	96.1***	10.0***	-88.6**	-492.5**	-40.5***	-5.1
	(65.4)	(259.9)	(7.7)	(0.8)	(36.1)	(205.5)	(12.8)	(5.8)
Medical Insurance								
NHIS	722.8***	3,144.9***	94.4***	10.7***	-103.5***	-626.6***	-42.0***	-7.8**
	(53.3)	(231.6)	(6.8)	(0.8)	(35.6)	(210.2)	(10.6)	(3.4)
Medical Aid	46.3***	3,471.6***	91.8***	12.4***	-3.0	-1,283.8**	-49.5**	0.9
	(9.8)	(690.7)	(18.7)	(2.0)	(21.8)	(505.6)	(25.2)	(4.1)
CCI								
0	654.3***	3,135.8***	93.3***	10.8***	-95.9**	-748.6***	-47.6***	-7.6*
	(69.3)	(317.9)	(9.3)	(1.1)	(46.7)	(263.5)	(11.1)	(4.4)
1	745.3***	3,645.9***	107.5***	12.1***	-95.8*	-749.8**	-45.2***	-18.2***
	(93.0)	(583.1)	(15.7)	(1.8)	(53.3)	(309.5)	(16.0)	(6.0)
2 ≤	463.8***	3,026.0***	86.9***	10.4***	-49.4	-500.9	-23.1	8.6
	(81.7)	(495.6)	(13.4)	(1.9)	(62.7)	(429.2)	(33.8)	(8.6)

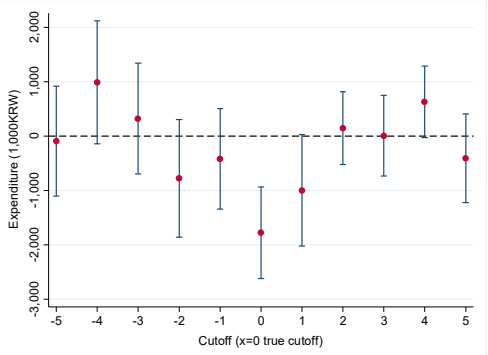
Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket. CCI: Charlson's comorbidity index. *** p<0.01, ** p<0.05, * p<0.10.

Appendix 14. RD estimates for the effect of LTCI on LTC utilization at level 2: subgroup analysis by covariates *(continued)*

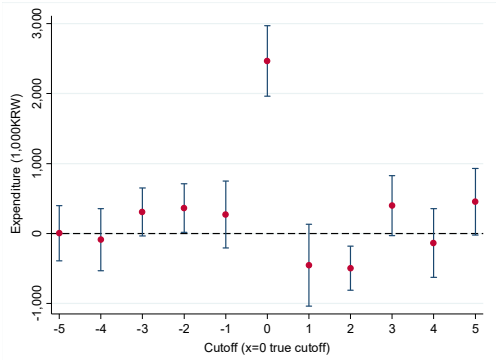
Variables	Institutional care				Home care			
	OOP expenditure	**Total expenditure**	**No. of care days**	**Expenditure /day**	**OOP expenditure**	**Total expenditure**	**No. of care days**	**Expenditure /day**
	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)
Disability								
No	638.4***	3,214.0***	94.6***	11.0***	-84.8***	-696.4***	-43.0***	-6.3**
	(51.4)	(256.9)	(7.4)	(0.9)	(28.8)	(158.5)	(8.9)	(3.1)
Yes	562.5**	2,727.4***	86.8***	9.1***	-228.0*	-1,314.3*	-57.2*	-0.3
	(255.9)	(894.3)	(26.0)	(2.9)	(137.1)	(787.2)	(30.7)	(12.2)
Year								
2009	341.2***	1,913.0***	63.0***	5.3***	9.5	-257.4	-7.3	-8.0
	(89.6)	(418.5)	(14.0)	(1.1)	(77.7)	(462.9)	(16.3)	(12.7)
2010	635.4***	2,892.9***	86.1***	9.6***	-84.4*	-645.1**	-26.1**	-9.4*
	(82.6)	(445.9)	(13.1)	(1.5)	(50.3)	(307.5)	(11.8)	(5.3)
2011	673.2***	3,312.8***	98.9***	11.4***	-114.8**	-851.0**	-61.5**	-4.1
	(113.3)	(362.2)	(10.9)	(1.2)	(53.8)	(341.8)	(19.1)	(3.7)
2012	820.7***	4,446.1***	128.0***	15.4***	-127.1*	-891.8**	-49.0*	-11.3*
	(75.5)	(357.4)	(9.7)	(1.5)	(69.4)	(426.7)	(26.4)	(6.5)
2013	661.8***	3,410.1***	96.6***	12.8***	-115.0**	-829.9***	-62.2**	-1.4
	(77.6)	(405.5)	(11.3)	(1.4)	(54.0)	(313.9)	(26.3)	(2.7)

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 75. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket. CCI: Charlson's comorbidity index. *** p<0.01, ** p<0.05, * p<0.10.

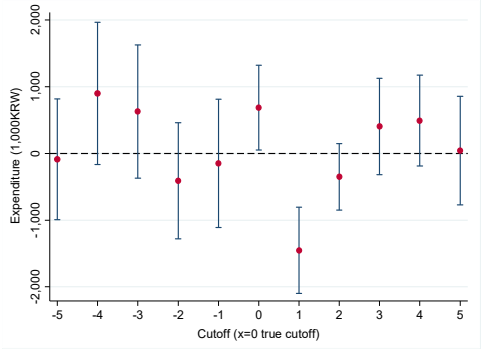
Appendix 15. Sensitivity analysis for medical and LTC utilization (placebo cutoffs)



(1) Medical expenditure



(2) LTC expenditure



(3) Medical and LTC expenditure

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each plot represents the coefficient estimate and 95% confidence interval from seperate regression discontinuity at preliminary LTC score 75. For sensitivity analysis, We use placebo cutoffs ranging from -5 to +5. The true cutoff is 0. Expenditures are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditure are discounted at annual rate of 3%. LTC: long-term care.

Appendix 16. RD estimates for the effect of LTCI on medical and LTC utilization at preliminary LTC score 70

Variables	Medical and LTC utilization			
	Coeff.	SE	p-value	Mean of dependent variable
Panel A: Medical				
Medical expenditure	-89.8	(515.7)	0.862	5,696.8
LTC hospital				
Total expenditure	-22.4	(406.2)	0.956	2,253.8
Inpatient OOP expenditure	28.6	(86.3)	0.740	463.6
Inpatient expenditure	-15.3	(403.2)	0.970	2,220.8
Length of inpatient stay	0.1	(6.4)	0.984	32.8
Inpatient expenditure/day	-0.5	(1.8)	0.774	12.7
Outpatient OOP expenditure	-1.0	(4.3)	0.823	6.5
Outpatient expenditure	-7.1	(26.1)	0.784	32.9
No. of outpatient visits	-0.2	(0.4)	0.545	0.7
Outpatient expenditure/day	-0.8	(1.0)	0.382	2.0
Acute hospital				
Total expenditure	-67.8	(299.6)	0.821	3,440.5
Inpatient OOP expenditure	-45.0	(48.3)	0.351	424.2
Inpatient expenditure	-245.5	(257.9)	0.341	2,387.4
Length of inpatient stay	-0.6	(2.3)	0.802	17.4
Inpatient expenditure/day	-12.4	(5.4)	0.021	83.6
Outpatient OOP expenditure	-1.7	(22.4)	0.939	218.6
Outpatient expenditure	177.7	(98.1)	0.070	1,053.1
No. of outpatient visits	-2.4	(2.0)	0.238	29.7
Outpatient expenditure/day	-1.6	(2.3)	0.477	29.7

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 70. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket.

Appendix 16. RD estimates for the effect of LTCI on medical and LTC utilization at preliminary LTC score 70 *(continued)*

Variables	Medical and LTC utilization			
	Coeff.	SE	p-value	Mean of dependent variable
Panel B: Long-term care				
LTC expenditure	3.1	(201.1)	0.988	4,179.3
Institutional care				
OOP expenditure	10.9	(9.1)	0.233	15.9
Total expenditure	62.6	(43.3)	0.148	97.4
No. of care days	1.7	(1.2)	0.148	2.8
Expenditure/day	0.2	(0.2)	0.186	0.4
Home care				
OOP expenditure	-33.4	(30.6)	0.275	572.1
Total expenditure	-59.5	(196.0)	0.762	4,081.9
No. of care days	7.0	(8.9)	0.430	182.5
Expenditure/day	-1.5	(3.1)	0.612	29.4
Panel C: health and Long-term care				
Medical and LTC expenditure	-86.7	(462.2)	0.851	9,876.1
OOP expenditure	-41.6	(102.0)	0.683	1,701.4
Observations	8,890			

Notes: We use a pooled dataset from 2009-2013 NHI and LTCI claim data. Each cell presents the coefficient estimate from separate regression discontinuity at preliminary LTC score 70. We use non-parametric local linear regression estimates with triangular kernel weight and bandwidth 3.0. We adjust for covariates including sex, age, region, income, insurance, cci, disability, and year. Expenditure are reported in 1,000 Korean Won (KRW). 1 US$ is approximately 1,165 KRW in 2009. All expenditures are discounted at annual rate of 3%. LTC: long-term care, OOP: out-of-pocket.

Appendix 17. A list of Top 5 diagnoses

Top 5 diagnosis	ICD10
(1) Hypertension	I10, I11, I12, I13, I14, I15
(2) Dementia	F00, F03, F01, F02
(3) Cerebrovascular diseases	I60, I61, I62, I63, I64, I65, I66, I67, I68, I69
(4) Diabetes	E10, E11, E12, E13, E14
(5) Parkinson's, extrapyramidal and movement disorders	G20, G21, G22, G23, G24, G25, G26

Appendix 18. Definition of Ambulatory Care Sensitive Conditions

Type	Condition	ICD10 code
Acute	Cellulitis	L03–04, L08, L88, L98.0, L98.3
	Dehydration and gastroenteritis	E86, K52.2, K52.8, K52.9
	Dental conditions	A69.0, K02–06, K08, K09.8, K09.9, K12–13
	Ear, nose and throat infections	H66–67, J02–03, J06, J31.2
	Gangrene	R02
	Nutritional deficiencies	E40–43, E55, E64.3
	Pelvic inflammatory disease	N70, N73–74
	Perforated/bleeding ulcers	K25.0–25.2, K25.4–25.6, K26.0–26.2, K26.4–26.6, K27.0–27.2, K27.4–27.6, K28.0–28.2, K28.4–28.6
	UTI/pyelonephritis	N10–12, N13.6, N39.0
	Constipation	K59.0
	Gastro-oesophageal reflux disease	K21
Chronic	Angina	I20, I24.0, I24.8–24.9
	Asthma	J45–46
	COPD	J41–44, J47
	Congestive heart failure	I11.0, I50, J81
	Convulsions/epilepsy	G40–41, R56, O15
	Diabetes complications	E10.0–10.8, E11.0–11.8, E12.0–12.8, E13.0–13.8, E14.0–14.8
	Hypertension	I10, I11.9
	Iron deficiency anaemia	D50.1, D50.8–50.9
Vaccine-preventable	Influenza	J10–11
	Pneumonia and other acute LRTI	J13–14, J15.3–15.4, J15.7, J15.9, J16.8, J18.1, J18.8, J20–20.2, J20.8, J20.9, J22
	Aspiration	J69.0, J69.8
	Tuberculosis and other vaccine preventable	A15–16, A19, A35–37, A80, B05–06, B16.1, B16.9, B18.0–18.1, B26, G00.0, M01.4

국문초록

노인장기요양보험이 의료와 장기요양 서비스 이용에 미치는 영향
– 요양시설급여혜택을 중심으로 –

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서론: 인구 고령화와 함께 노인과 가족들을 위한 사회적 돌봄의 필요성이 중요한 정책과제가 되었다. 한국은 노인들이 건강하게 노후를 보내고 가족의 부양부담감을 줄여주기 위해 2008년 노인장기요양보험 제도를 도입하였다. 장기요양서비스에 대한 수요와 노인 진료비 증가가 계속될 것으로 예측되므로, 노인장기요양보험과 국민건강보험의 효율성 제고 및 지속가능성 확보는 우리나라 사회보장 안정성을 위한 중요한 과제이다. 이 연구에서는 두 보험제도 간의 재정적 균형을 중요한 정책 방향으로서 초점을 두고, 노인장기요양보험이 의료와 장기요양서비스 이용에 미치는 영향을 분석하였다. 그중 의료와 장기요양 관련 비용 지출 규모를 크게 증가시킬 수 있는 요양시설급여혜택에 따른 이용 변화를 살펴보았다.

연구방법: 이 연구는 국민건강보험공단 노인코호트 데이터 2009-2013 자료를 활용하였다. 장기요양점수를 기준으로 장기요양 3등급과 2등급 간의 구분이 가능한 준실험적 상황을 이용하여 회귀 불연속 모형을 적용하여 요양시설급여혜택이 의료와 장기요양서비스 이용에 어떠한 영향을 미쳤는지 인과효과를 추정하였다. 국지적 선형회귀를 활용한 비모수적 접근을 채택하였고, 커널 가중 회귀 모형을 이용하였다. 기준점 75점을 기준으로 bandwidth는 3.0으로 설정하였고, 모형의 타당성 검토를 위해 가정 검정과 민감도 분석을 실시하였다. 종속변수로는 의료와 장기요양서비스를 유형별로 세분화하여 연간 이용량과 비용을 함께 분석하였다.

연구결과: 2009 년부터 2013 년까지 노인장기요양보험 2-3 등급 수급자는 35,111명이었다. 그 중 기준점 75점에서 bandwidth 3.0 범위 내 연구 대상자 수는 총 8,036명으로 2등급 2,908명 (36.2%)과 3등급 5,128명 (63.8%)이었다. 회귀 불연속 분석 결과, 전체 의료비용은 약 178만원, 종속변수 평균치의 29.5% 감소하였다 (p=<.001). 장기요양 비용은 247만원 (39.3%, p=<.001) 증가하여, 의료와 장기요양 비용은 합친 총액은 64 만원(5.6%, p=<0.034) 증가하였다. 의료이용 중 특히 입원 비용의 감소가 컸고, 비용 규모를 비교해보면 장기요양병원 입원 비용의 감소 규모(28만원, 7.4%, p=<.568)보다 급성기병원 (158 만원, 49.2%, p=<.001) 비용의 감소 규모가 더 컸다. 장기요양 중 요양시설 비용은 320 만원 (100.7%, p=<.001) 증가한 반면 재가서비스 이용은 71만원 (22.8%, p=<.001) 감소하였다.

결론: 이 연구는 노인장기요양보험 수급자를 대상으로 요양시설급여혜택이 의료와 장기요양서비스 이용 변화에 미치는 영향을 준실험적 연구 방법론인 회귀 불연속 모형을 통하여 추정하였다. 연구 결과에서 의료이용량과 비용이 모두 감소하였고 특히 급성기 병원 입원에서 큰 효과를 확인하였고, 특히 급성기 치료 이후 회복과 재활을 위해 장기요양시설로 이동으로 인한 결과로 볼 수 있다. 또한 요양시설급여혜택으로 인해 시설서비스에서 시설로 큰 이용 변화를 통해 시설에 대한 수요가 큰 것을 확인할 수 있었다. 지난 10년간 요양욕구 해소와 돌봄 부담 감소 등 많은 성과를 이루었지만, 여전히 의료와 장기요양 간의 역할 정립 미비, 제한적 접근성 등으로 인한 사회적 문제점을 안고 있다. 이 연구를 통해 두 서비스 간의 관계를 이해하고, 장기요양보험과 국민건강보험의 지속 가능한 발전을 위한 정책적 근거를 제시할 수 있기를 기대한다.