

MACROECONOMIC CONSEQUENCES OF PUBLICLY PROVIDED
HEALTH INSURANCE: THE SOUTH KOREAN CONTEXT

by

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Abstract

This dissertation studies the macroeconomic effects of providing public universal health insurance in South Korea. Since its inception in 1989, the South Korean government has increased the public health insurance benefit rate by reducing the co-pay rates and out-of-pocket medical expenditures. Such a policy change has improved the access to health care for the elderly and poor who would have otherwise opted out of medical consumption. I explore this link between medical consumption and health outcomes from the macroeconomic standpoint.

This dissertation is organized in four parts. First, I provide a background on the development of public health insurance, the current population ageing, and the recent decline in aggregate saving in South Korea. Second, I provide an empirical investigation on the link between medical consumption and health outcome using the Korean Welfare Panel Study. The results show that there is a substantial negative effect on health outcomes of opting-out of medical services due to financial difficulty. Third, I examine the effect of the recent expansion in publicly-provided health insurance on aggregate saving. I show that the recent policy change has reduced excessive saving against health uncertainty by reducing out-of-pocket medical expenditures and inducing preventative medical consumption. Finally, I examine the effect on welfare of the current policy proposal to further increase public health insurance benefits. In particular, the welfare analysis compares the benefits on health outcomes and the costs of higher payroll tax rates. Given the rapid population ageing in South Korea, postponing the policy change may result in a large welfare-loss to working-age generations, which would dominate the welfare-gains from improved health outcomes.

List of Abbreviations Used

CES	Constant elasticity of substitution
CT	Computerized tomography
GDP	Gross domestic product
KOSIS	Korean Statistical Information Service
KOWEPS	Korean Welfare Panel Study
MRI	Magnetic resonance imaging
NHIC	National Health Insurance Corporation
OECD	Organisation for Economic Co-operation and Development
OLG	Overlapping generations
PET	Positron emission tomography
QOL	Quality of life
TPI	Time path iteration

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Chapter 1

Introduction

This dissertation examines the consequences of public provision of universal health insurance at the macroeconomic level. Many countries have had extensive discussions regarding expanding or contracting the role of public health insurance in financing health care. Proponents of expansion argue that public health insurance reduces excessive saving for uninsured health risks and foregone consumption, whereas opponents of expansion argue that such an expansion would decrease consumption by increasing the tax rate. This dissertation attempts to redress these competing views by providing a unified analysis of these effects of expanding public health insurance on consumption and saving, and welfare.

Typically, a universal health insurance program pools health risks across all individuals. Absent this safety net, individuals must pay for medical services either themselves directly out-of-pocket or indirectly through private health insurance. However, health insurance markets are prone to market failure as a result of asymmetric information between buyers and sellers of insurance, and consequent adverse selection into insurance markets by high-risk individuals. To mitigate such adverse selection problems, private health insurance companies try to identify high and low risk individuals

and price them accordingly. This can be problematic for high-risk individuals who are often too poor to subscribe to an insurance plan. Without having adequate insurance protection, these underinsured (or uninsured) households often opt out of medical services, especially preventative care and face poor health outcomes. The effect of opting-out of medical services on health outcomes has been extensively studied in the case of the United States where over 47 million individuals were uninsured in 2012 (Institute of Medicine, 2002, 2004; McWilliams, 2009).

Public health insurance addresses this type of market failure by covering all individuals in the pool. But even under a public health insurance, poor households face the risk of opting-out of medical services if co-pay rates are too high. This dissertation offers a life-cycle model that captures the effects of opting-out of medical consumption on health outcomes, and saving and welfare.

Chapter 2 provides a background to the subsequent analysis on the effects of expanding public health insurance on saving and welfare. This chapter is divided into three sections. The first section provides a background on the development of public health insurance in South Korea. I discuss the political and economic circumstances behind the public health insurance expansion. I also discuss the challenges and obstacles that may stall the current expansion effort. The second section focuses on the current population ageing in South Korea in the context of demographic transition discussed by Lee (2003). It shows that the South Korean demographic structure is entering the final stage of demographic transition toward an

economy with a high old-age dependency. The third section discusses the factors that have contributed to the decline in household saving since the Asian Financial Crisis. Among the confounding factors, the recent expansion in social programs (including public health insurance) has contributed to a decline in household saving.

Chapter 3 provides an empirical analysis of the relation between medical consumption and health outcomes. The link between underinsurance and health outcomes has been studied in the context of the uninsured in the United States (Card, Dobkin, and Maestas, 2009; Decker and Rentier, 2004). Despite the universal coverage to all individuals, opting out of medical services do occur in South Korea due to high co-pay rates and limited coverage on various diagnostic medical services. This issue tends to be concentrated among low-income households, who are at a greater risk of opting out of medical services for financial reasons. This chapter estimates the effect of opting-out of medical consumption on self-reported health outcomes. I use the Korean Welfare Panel Study, which includes a unique questionnaire that asks survey respondents whether a household member has missed medical services for financial reasons. I show that the negative effect of opting-out of medical services reduces the likelihood of having good health by 10 percentage points. This estimation is stable across various specifications.

In Chapter 4, I examine the effect of expanding public health insurance on aggregate saving in South Korea. There has been a considerable decline in the household saving rate especially after the Asian Financial

Crisis. Low household saving can hinder private investment, and threatens the households' ability to absorb various income shocks. Several papers document the contributing factors to the decline in household saving in South Korea (Chung, 2009; Shin and Lee, 2010; Karasulu, 2010), but there has been a gap in understanding the effect of expanding public health insurance on household saving. Expansions to public health insurance can increase access to health care, thereby reducing the demand for precautionary saving against health risks. I develop a life-cycle model with endogenous longevity and health outcomes under incomplete markets. I estimate the impact of medical consumption on health outcomes using the Korean Welfare Panel Study (KOWEPS). Estimates from the model imply that the expansion of health insurance accounts for about 0.5 percentage points of the decline in the household saving rate in South Korea.

Recent debates on reforming public health insurance have revolved around the issue of rapid population ageing. Because population ageing implies a larger medically-needy population, there is an upward pressure on the tax rate to finance the outlays for public health insurance. For instance, Lee (2003) argues that both developed and developing countries are in transition to a high old-age dependency, albeit at different stages. Although population ageing is far advanced in developed countries, it is progressing at a faster rate in several emerging economies in Asia such as China, South Korea and Taiwan. It is projected that the population share of elderly (60 or older) in these Asian countries will reach almost 40 percent of the population by 2050. While it is critical for these rapidly ageing emerging

economies to provide affordable health care to the elderly (United Nations, 2012), these countries may also have difficulty in raising the tax rate to expand their public health insurance. In the macroeconomics/health literature, there is a gap in understanding the macroeconomic effects of providing public health insurance in the context of rapidly ageing emerging economies and understanding the benefits of expanding public health insurance relative to costs of higher payroll taxes that are needed to finance these outlays. This dissertation seeks to fill this gap in the case of South Korea.

In particular, in Chapter 5, I examine the effect of expanding the public health insurance benefit rate on welfare in the context of an economy with a high old-age dependency rate. Since the 1990s, there has been a sharp rise in the old-age dependency in South Korea as well as an increase in spending on public health insurance. Despite the increasing tax burden associated with publicly financed health care, the South Korean government intends to increase the public health insurance benefits. Such a policy would create two conflicting implications on average welfare. On the one hand, the policy change improves the welfare of retired generations and working-age generations who are close to retirement by reducing morbidity and mortality from health shocks. Within the older population, including the near-retirement working-age generations, poor individuals would have opted out of medical consumption prior to the policy change. On the other hand, the policy change decreases the welfare of working-age generations by increasing their payroll tax rate. This trade-off makes the

impact of this policy change on average welfare ambiguous. The results suggest that the short-run effect on welfare of increasing the benefit rate in the current old-age dependency would be positive. This is largely due to having a relatively large tax base and thus a smaller increase in tax rate. If the policy change were to be postponed to a later time with a high old-age dependency, then the negative tax effect would dominate the positive effect on health outcomes.

The rest of the dissertation is organized as follows. Chapter 2 provides a background on public health insurance, ageing population, and aggregate saving in South Korea. Chapter 3 describes an empirical model on the relation between medical consumption and health and sets the stage for modeling endogenous health outcomes. Chapter 4 examines the effects of the recent health insurance reform on aggregate saving. Chapter 5 examines the effects of the proposed health insurance reform on welfare over a transition path. Chapter 6 concludes the dissertation. The appendix provides additional details on the computer algorithms and present the health transition matrices.

Chapter 2

Background

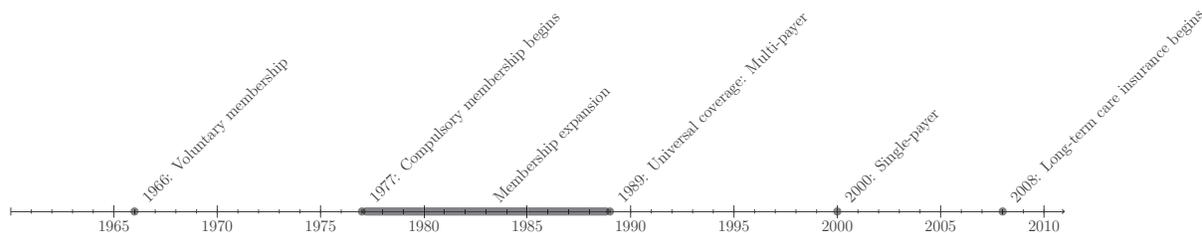
2.1 Public Health Insurance in South Korea

2.1.1 Historical Background

Public health insurance in South Korea has been shaped by various political pressures and economic circumstances. In the 1960s, the priority in public health policy was to reduce mortality associated with common infectious diseases. For example, the 1963 fatality rate from tuberculosis per 100,000 people in South Korea was 160.0, compared to 84.5 in the Philippines, 32.0 in Japan, 6.1 in in the United States. During this time, the government's role in health care was to build the infrastructure necessary to deliver primary medical services (Park, 2008). The internal government memos from the 1960s reveal that several high-ranking government officials were afraid of an economic slowdown that may be caused by having a compulsory health insurance too soon (Park, 2008).

While South Korea's first public health insurance program was introduced in 1963, the program covered fewer than 0.2 percent of the population until 1976. One reason for this was that most household could not afford the premium, as annual household income per year stood at only \$US 80. In addition, coverage was voluntary rather than mandatory. This

Figure 2.1: Development of public health insurance in South Korea

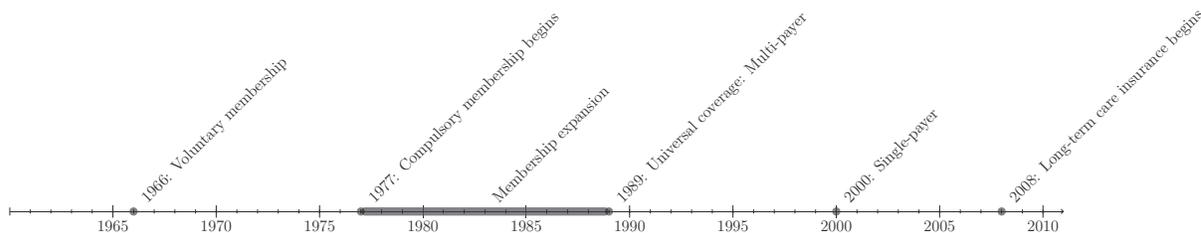


feature of the program was introduced to restrain government spending on health. However, voluntary enrollment attracted relatively high-risk clients to the pool of insured, further inflating the insurance premium (Peabody, Lee, and Bickel, 1995).

In 1977, the compulsory health insurance program began by the military-led government as a means to gain political support (Cho, 2007; Park, 2008; Ringen, Kwon, Yi, Kim, and Lee, 2011). Initially, the insured population was limited to industrial workers in large firms employing 500 or more workers (about 6 percent of the population). The population coverage was expanded incrementally to government employees and private school teachers in 1979, to firms with more than 100 employees in 1981, and to rural residents in 1988. Finally, in 1989, the program achieved universal coverage by extending coverage to the remaining urban population. During this period of time, there were over 350 separate insurance programs and each program oversaw a single pool of individuals by occupation or region. There was no competition among the insurance programs.

Although it took only 12 years to achieve the universal membership, the public health insurance benefit levels in South Korea in the 1990s were extremely low. The majority of health care financing came from out-of-pocket

Figure 2.1: Development of public health insurance in South Korea



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medical expenditures by households. This so-called ‘low benefit, low cost’ system was motivated by the concern among several government officials that a more generous benefit level would entail a steep rise in public health care spending (Park, 2008). However, during the 1987 presidential election, a serious consideration to deepen the benefit rate became necessary to the then ruling conservative party, as they faced a strong opposition from the progressive parties (Park, 2008). Since then, expanding public health insurance benefits has been a policy objective by a wide-spectrum of the political base.

Table 2.1 shows the share of public health expenditure in total health expenditure. The first two columns show the share of social security and general taxation in total health expenditures. I define the sum of these two categories as the public health insurance benefit rate. The table shows that this rate increased from 22 percent in 1980 to 58 percent in 2010. This increase is due to a series of policy changes that reduced the co-pay rates and out-of-pocket medical expenditures. The third column shows that the share of out-of-pocket medical spending (including co-payments) decreased from 74 percent in 1980 to 32 percent in 2010. The final column shows that private health insurance remains small, despite growth in its share of health care financing over the recent decade.

In 2000, over 350 insurance programs were merged under a single-payer, the National Health Insurance Corporation (NHIC). One reason for the merger is that rural insurance programs faced large deficits because many young individuals migrated from rural to urban areas (Kwon, 2009). The

Table 2.1: Sources of health care financing in South Korea (% of the total health expenditure)

Year	Government sources		Private sources	
	Social security	General taxation	Out-of-pocket	Private insurance
1980	12.0	9.6	74.0	0.4
1990	30.0	8.4	57.0	1.2
2000	37.6	11.1	41.5	4.8
2010	45.4	12.9	32.1	5.8

Source: OECD (2013).

Notes: Out-of-pocket medical spending includes the co-payments for the covered services. The health expenditures from corporations and non-profit organizations are omitted.

merger also decreased the administrative costs by achieving the economies of scale in a single large pool. The administrative costs in 2000 prior to the merger was as high as 9.5% of the insurance program's total expenditure, and in 2006 the administrative costs decreased to less than 4% of the total expenditure (Kwon, 2009).

2.1.2 Institutional Background

Generally public health insurance is financed through either general taxation or social contributions specific to health insurance. Similar to the systems in Germany and Belgium, the public health insurance in South Korea is a type of social health insurance, which collects social contributions.¹ To balance the budget, the NHIC sets the social contribution rate, and collects them as proportional payroll taxation. The contribution is split equally between employers and employees. For self-employed, the government subsidizes the half of their contribution payments. The NHIC

¹In contrast, Canada and Britain draws from general taxation to finance their public health insurance.

also receives assistance from the general tax revenue to partially fund the social insurance program (e.g. such as subsidizing the self-employed) and fully fund the Medical Aid Programme for the poor. The contribution rate had been historically set at around 5 percent of gross income, and recently rose to 6 percent. The increase in the contribution rate reflects the increase in the benefit rate.

In parallel to compulsory health insurance, the government also enacted the Medical Aid Programme for the poor in 1977. Eligibility for program benefits depends on income and wealth thresholds. In 2012, single/unattached individuals with monthly incomes below 320,000 Korean won (approximately \$US 300) and net wealth below 29 million Korean won (approximately \$US 27,000) would be eligible for benefits. Overall, 3.6 percent of the population (1.8 million people) received benefits in 2006. There are two types of recipients for Medical Aid Programme. The first group consists of the elderly or disabled who receive fully-paid inpatient and outpatient care. The second group consists of working-age who receive only fully-paid inpatient care.

The provision of health care services in South Korea is dominated by private sector (90 percent of provision), whereas the public sector specializes in psychiatric care, and as well as primary care in rural areas. The number of hospital beds in South Korea was 8.8 beds per 1000 people in 2010, which was higher than the OECD average of 4.9. And the average length of stay in hospital in 2010 was 14.2 days, much higher than the OECD average of 7.1 days. Such lengthy hospital stays can be explained

by the lack of long-term care facilities in South Korea. It has been common that elderly patients even with a minor ailment rely on acute care beds at general hospitals. Another reason for lengthy hospital stays is that physicians in South Korea have been reported to over-supply medical services to their patients to raise their income (Jones, 2010; Chun, Kim, Lee, and Lee, 2009). This has led to an oversupply of expensive medical equipment such as CT scanners and MRI machines. The number of CT scanners per million people in 2010 was 19.9, higher than the OECD average of 12.5, and the number of MRI machines per million people in 2010 was 35.3, again higher than the OECD average of 22.6. Because these imaging services have not been covered by the public health insurance, there exists monetary incentives for physicians to provide these uninsured services at a higher price (Jones, 2010)².

Comparing to other OECD countries, there has been a shortage of health care professionals in South Korea. The number of physicians per 1000 people in 2010 was 2, less than the OECD average of 3. The number of nurses per 1000 people in 2010 was 4.6, much lower than the OECD average of 8.6. The shortage is more pronounced in rural areas, as the distribution of physicians is concentrated in the major urban areas. For example, in 2005, about 73 percent of medical specialists were located in the major cities, which accounted for about 47 percent of the population.

When physicians provide covered services, they are reimbursed by the

²CT scanners are now covered by public health insurance. This had led to a sudden increase in installing of new MRI machines in South Korea.

NHIC on a fee-for-service basis. The co-pay rate for inpatient care is 20 percent. The co-pay rates for covered services range from 20 to 60 percent. For example, the co-pay rate for outpatient care at a tertiary (most advanced) hospital is 60 percent, whereas the co-pay rate for outpatient care at a public health center is 30 percent. The purpose of this price discrimination is to encourage patients to substitute primary clinics for specialized medical institutions, as family physicians in South Korea do not function as gatekeepers.

For non-covered services, the patients pay either directly out-of-pocket or indirectly through private health insurance. Non-covered services include screening services such as sonograms and PET scans. Some of these services are considered either preventative or essential diagnostic services. The combination of low benefits and high co-payments have created a barrier in access to health care. Several studies show that such large co-payments and exclusion of certain ‘essential’ medical services leave many South Koreans vulnerable to medical bankruptcy (Wagstaff, 2006; Ruger and Kim, 2007; Van Doorslaer, O’Donnell, Rannan-Eliya, Somanathan, Adhikari, Garg, Harbianto, Herrin, Huq, Ibragimova et al., 2007) and the risk of opting-out of medical treatment (Kim, Ko, and Yang, 2005; Kim, 2008; Son, Shin, and Kim, 2010). The risk of opting out-of medical consumption is especially prevalent for the poor. For example, Kim, Oh, and Jha (2014) find that those of low socioeconomic status suffer a higher within-hospital mortality due to disadvantaged access to health care.

In this vein, there has been a series of reforms to reduce the co-pay

Table 2.2: Out-of-pocket health care spending in OECD countries (% of total health expenditure)

Year	Canada	France	Germany	S. Korea	U.K.
2000	15.9	7.1	11.4	41.5	11.4
2005	14.6	6.6	13.5	37.9	9.8
2010	14.2	7.3	13.2	32.1	8.9

Source: OECD (2012).

rate and extend the list of covered services. For example, the NHIC began covering the bone marrow transplant service in 1992, intraocular lens for cataract surgery in 1993, and CT scans in 1996. The public health insurance also increased the annual limit of days in hospital stays from 180 days in 1984, to 210 days in 1995, to 270 days in 1997, to without limit in 2000. This particular reform alleviated the financial burden of those patients with a chronic illness (Huh, Shin, Kang, Kim, and Kim, 2007). Moreover, the co-pay rate for treatments for cancer and catastrophic diseases decreased from 20 percent to 10 percent in 2005, and from 10 percent to 5 percent in 2009.

To provide a comparative perspective on the private financing of health care with other countries, Table 2.2 compares the share of out-of-pocket medical spending in total health expenditure among several OECD countries between 2000 and 2010. It shows that the recent policy changes have decreased the share of out-of-pocket medical expenditure from 42 percent in 2000 to 32 percent in 2010. However, this figure is still substantially higher in comparison to that of other OECD countries. The share of out-of-pocket medical spending in total health expenditure in 2010 was 20 percent on average among the OECD countries. Wagstaff (2006) compares South Korea

with Taiwan, a country with a similar public health insurance system and a comparable level of per capita income. He finds that catastrophic medical expenditure shocks are more frequent in South Korea because of its high co-pay rates. Wagstaff (2006) also shows that large out-of-pocket medical expenditures in South Korea is largely concentrated among the high-income households. Given the lack of protection for the low-income households in South Korea, it can be said that low-income households simply opt-out of expensive non-covered services (Kim et al., 2014) because the list of covered services is relatively narrow in South Korea.

2.1.3 The Future of Public Health Insurance in South Korea

Benefit rates under South Korea's public health insurance program are expected to increase. While many agree on the notion that the current health care financing in South Korea relies too heavily on out-of-pocket medical expenditure, the extent to which public health insurance should replace out-of-pocket medical expenditures is still under discussion. Since the integration reform in 2000, both conservative and progressive parties have introduced various plans to increase the benefit rate to between 70 and 80 percent. However, there is no consensus in how fast it will reach the target.

Recently, balancing the NHIC budget has become a focal point for setting the pace of benefit expansion. And in the face of NHIC's budget deficit, the government stalled the plan on increasing the benefit rate. For

example, when the NHIC budget deficit in 2001 was estimated to be 4 trillion Korean won (approximately \$US 4 billion), the government rolled back on benefits for certain medical services. For example, in 2001 non-surgical dental scaling was delisted. Another example of postponing the promised expansion is during the presidential election in 2002, when the center-left party candidate Rho who later became president ran on the promise to increase the public health insurance benefit rate to 80 percent by 2008. This target was revised in 2005 downward to achieving 71.5 percent by 2008, and revised again in 2006 to achieving 72 percent by 2017, and 85 percent by 2030. Although the Rho administration provided a detailed plan to expand public health insurance, since then the pace of expansion has not met its policy goal – the benefit rate was 56 percent in 2001 and 54 percent in 2010.

The current conservative government intends to increase the benefit rate. In 2013, the Park administration proposed a policy change that would reduce catastrophic health expenditure borne out of four major illnesses (cancer, heart disease, stroke, rare (orphan) diseases). This proposal also includes coverage for associated imaging services (CT scan, MRI, PET scan), chemotherapy, and other related services, which had not been covered. These reforms are part of a broader policy objective to increase the benefit rate to around 80 percent by 2016. However, the government may again slow the pace of expansion in the future given the expected increase in tax rate, which is unpopular among the public (Kwon, 2009). In Chapter 5, I examine the consequences of postponing the expansion for welfare

in the face of rapidly ageing population in South Korea.

2.2 Population Ageing in South Korea

This section provides a background on population ageing in South Korea and its macroeconomic consequences. South Korea has the fastest ageing population in the OECD. Table 2.3 compares how many years it takes for the selected countries to reach a certain threshold of elderly's population share. Elderly is defined as those 65 years or older. These thresholds are provided by the United Nations to categorize the severity of population ageing by measuring the elderly's population share. The categories include "ageing society" (7-14% of the population), "aged-society" (14-20%), and "hyper-aged society" (20% or more). The table shows that South Korea has not reached the 'aged-society' yet but it is progressing at a much faster rate than other advanced economies. It predicts that South Korea will enter the hyper-aged society by 2026.

Lee (2003) uses three dependency ratios to measure demographic transitions in the population. These include the total, youth, and old-age dependency ratios.³ Based on this, he defines three demographic transitions that are characterized by changes in these ratios. The first stage is characterized by high fertility, high mortality, high youth dependency, and low old-age dependency. This is because improved access to basic health

³The total dependency ratio is measured by the number of elderly and youth divided by the number of working-age population. Similarly, the youth dependency ratio is measured by the number of youth divided by the number of working-age population, and the old-age dependency ratio as the number of elderly divided by the number of working-age population.

Table 2.3: Share of elderly in total population over time in selected countries

Country	Share of elderly and year			Elapsed number of years	
	7%	14%	20%	7 → 14%	14 → 20%
South Korea	2000	2018	2026	18	8
Japan	1970	1994	2006	24	12
Italy	1927	1988	2006	61	18
Germany	1932	1972	2009	40	37
United States	1942	2015	2036	73	21
France	1864	1979	2018	115	39

Source: KOSIS (2011).

Elderly is defined as 65 years or older. The United Nations categorizes the pace of ageing by population share of elderly. The category includes the elderly's population shares 7-14% as "aging society", 14-20% as "aged society" (14-20%), and 20% or more as "Hyper-aged society".

care and nutrition greatly reduces the infant mortality rate. Because many infants survive to childhood, the total dependency ratio increases. The second stage is characterized by a decline in fertility and sustained decreases in mortality. Generally, the decrease in fertility dominates the decrease in mortality such that the total dependency ratio falls. The second stage usually takes about 40-50 years. In the third and final stage, while the past decline in fertility shrinks the relative size of labour force, the life expectancy of the elderly keeps increasing. As a result, the total dependency ratio begins to climb with higher old-age dependency ratio.

Figure 2.2 shows the total, youth, and old-age dependency ratios in South Korea between 1960 and 2010. The population structure in the 1960s corresponds to the first stage of demographic transition where the total dependency ratio is driven by a large reduction in the mortality rate at younger ages. There was a remarkable decrease in the infant mortality rate in South Korea from 114 deaths per 1000 live births in the early 1960s

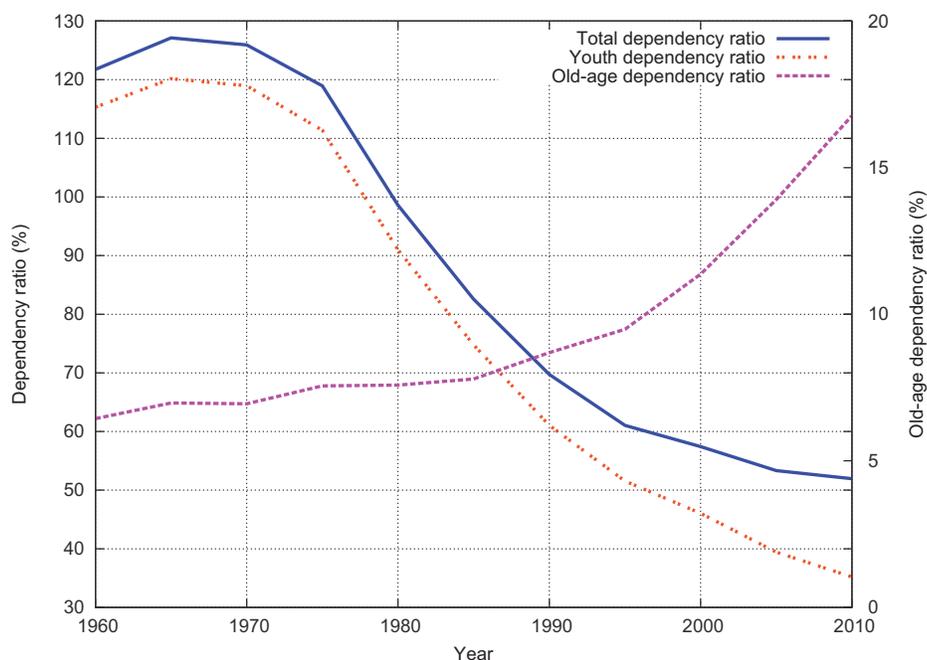


Figure 2.2: Dependency ratios

Source: OECD (2014).

Notes: Total dependency ratio: the number of youth (-20) and elderly (65+) divided by the number of working-age (20-64); Youth dependency ratio: the number of youth divided by the number of working-age; old-age dependency ratio: the number of elderly divided by the number of working-age.

to 33 deaths per 1000 live births in the late 1970s. This coincides with the government's effort to combat infectious disease (e.g. typhoid, diphtheria, cholera, and tuberculosis) through mass immunization and public sanitation projects (Cho, 2007; Park, 2008).

Between 1970 and 2000, the youth dependency ratio decreased in South Korea due to a rapid decline in the fertility rate. Table 2.4 shows in the first row that the fertility rate for women aged 15 to 49 decreased from about 5 children in 1970 to 2 children in 1990. The South Korean government advocated for low fertility under the National Family Planning Program and with slogans such as 'have fewer babies, bring them up well' (Chun et al., 2009). The program successfully reduced the fertility rate

Table 2.4: Demographic indicators between 1970 and 2010

Year	1970	1980	1990	2000	2005	2010
Fertility rate	4.53	2.82	1.57	1.47	1.08	1.23
Life expectancy at birth	62.1	65.9	71.4	75.9	78.5	80.6
Life expectancy at 65	10.2	10.5	12.4	14.3	15.8	17.2
Infant mortality	45.0	17.0	10.0	6.2	4.7	3.2

Source: OECD (2013).

Notes: Fertility rate represents the average number of children born to women aged 15 to 49. Life expectancy at 65 represents the life expectancy at 65 for male only. Infant mortality represents the number of deaths per 1000 live births. Due to unavailable data, the infant mortality for 1980 corresponds to 1981 value, 1990 to 1991 value, and 2000 to 1999 value.

by providing various contraceptive methods and by promoting the ideal number of children to two (Choe and Park, 2006). Although in the 1990s the program changed its goal from decreasing fertility to improving reproductive health, the fertility rate continued to fall throughout the 2000s to below the replacement level of 2.1 children. Such a low fertility rate in developed countries is a common phenomenon due to the rising cost of investing in human capital (Lee, 2003). And it seems unlikely that the fertility rate in South Korea will return to the replacement level in the near future. The resulting effect of three decades of low fertility on the relative size of labour force is imminent as South Korea enters the third stage of demographic transition.

The old-age dependency ratio in South Korea began rising rapidly in the 1990s. At the same time, the life expectancy for elderly men at age 65 rose rapidly in the 1990s and 2000s. This also coincides with improved access to health care by providing universal public health insurance. The leading causes of old-age mortality in South Korea are cancer, strokes, and cardiovascular illnesses. The mortality rates for these illnesses have been

decreasing and are projected to continue to decrease in the future. Olshansky, Goldman, Zheng, and Rowe (2009) show that medical innovation will significantly slow down human ageing process. They predict that the life expectancy at age 65 in the United States would increase from 17.4 in 2000 to 23.7 in 2030 and to 29.8 in 2050, even after accounting for increment dissemination of anti-ageing technology to a vast portion of population. Given the anti-ageing medical technology would be also available in South Korea, one can expect that the old-age dependency in South Korea may increase even at a faster rate in the future.

Such a rapid population ageing process in South Korea is a threat to providing public health insurance for two reasons. First, the current demographic transition implies a shrinking relative size of labour force, which is also the tax base for public health insurance. Even without increasing the benefit rate, maintaining the current benefit rate inevitably shrinks the tax base and increases the tax rate to meet the increased outlays for public health insurance (Lee, 2003). Second, the demographic trend puts an upward pressure on the demand for medical services by the growing elderly population. Lee (2011) reports that the share of medical spending on elderly care in total medical expenditure in South Korea increased from 24 percent in 2005 to 32 percent in 2010, rising faster than total medical expenditure. The rise in old-age medical expenditure is driven largely by the increase in chronic illnesses such as high blood pressure, diabetes, dementia, cataract, and arthritis. Shortages of long-term care beds have

increased placement of seniors into alternate level of care beds within hospitals, which is considered to be an inefficient use of medical resources (Chun et al., 2009; Jones, 2010).

To address the rising cost of treating chronically-ill elderly patients, there have been several policy initiatives in South Korea. In 2008, the government implemented the long-term care program, which provides various home care and residential care for disabled elderly. The long-term care program quadrupled the number of residential care facilities between 2005 and 2009 (534 to 2455). Nevertheless, long-term care infrastructure is relatively underdeveloped in South Korea. For instance, the share of elderly receiving home care was about 2.9 percent in 2009, far less than the OECD average of 8.6 percent.

The long-term care program in South Korea is run by the NHIC, and financed by the long-term care contribution, which is shared between government subsidies and social contributions. The government finances 20 percent of annual long-term care expenditures. The individual contribution rate for long-term care in 2009 was about 5 percent of the individual's public health insurance contribution. And the co-pay rate for long-term care services ranges from 15 to 20 percent. The government provides co-payment subsidies to those eligible for the Medical Aid Programme. Although the main analysis in this dissertation abstracts from modeling the long-term care, long-term care expenses are expected to become an important factor in explaining medical consumption in South Korea.⁴

⁴For instance, in the macroeconomics/health literature, Kopecky and Koreshkova (2013) find that

2.3 Household Saving in South Korea

This section provides a background on the decline in the household saving rate in South Korea since the inception of universal public health insurance in 1989. This section is closely related to Chapter 4, which examines the effect of providing public health insurance on aggregate saving. Figure 2.3 shows gross saving rates by sector between 1989 and 2012. While the public saving rate did not show a noticeable change, the private saving rate fell by 7 percentage points. The decline in private saving rate is due to the coinciding decline in household saving rate. The gross household saving rate decreased from 18 percent in 1989 to 5 percent in 2010. There was a brief spike in the household saving rate in 1998 due to the Asian Financial Crisis, which caused many households in South Korea to withhold consumption against uncertainty. This brief increase in the household saving rate was followed by a steep decline to around 5 percent which was maintained throughout the 2000s. Such a low household saving rate made corporate borrowing more difficult so that they raised their own capital (Karasulu, 2010). This has put an upward pressure on the corporate saving rate to increase by 10 percentage points between 1998 and 2010.

In addition to expanding public health insurance benefits, several confounding factors contributed to the decline in household saving rate between 1989 and 2010 in South Korea. The literature offers four factors that contributed to the decline in household saving. The first factor is a

elderly in the United States save a significant portion of their retirement savings to pay for nursing home expenses.

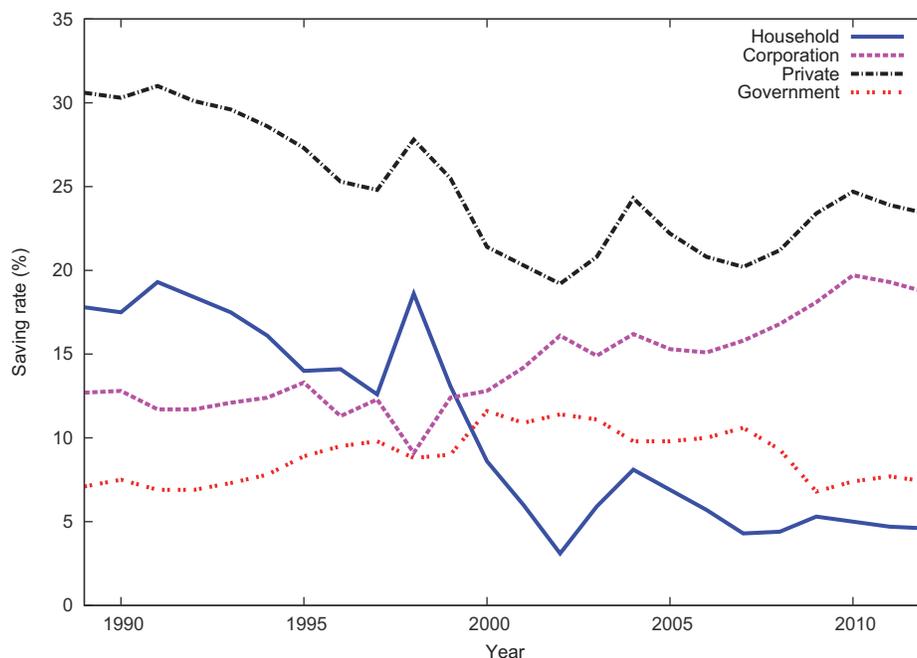


Figure 2.3: Gross saving rates in South Korea by sector

Source: Bank of Korea(2013).

Notes: The gross saving rates are calculated by taking the share of total savings in disposable income in the respective sectors.

slow growth rate of household income beginning in the 1990s. The slow-down of household income continued throughout the 2000s, as large firms in South Korea outsourced labour-intensive jobs to overseas (Shin and Lee, 2010). The amount of foreign direct investment increased from \$US 19 billion in the 1990s to \$US 214 billion in 2007. During the same time, the rise in large-scale retail shops in South Korea decreased the market share for small businesses, which constitute a substantial share of household income.

Second, the Bank of Korea kept its interest rate at a historically low level since 2000 in an effort to stimulate the economy after the Asian Financial Crisis and the collapse of the dot-com bubble in the United States. The low interest rate policy lowered households' intertemporal saving motive

and increased the supply of loans. Large banks and financial institutions aggressively marketed their credit products (e.g. credit cards, mortgages). (Shin and Lee, 2010). As a result, low-income households became net borrowers. Chung (2009) shows that, after the Asian Financial Crisis, the average saving rate of low-income households decreased to below zero, and that of middle-income households also decreased by 5 to 10 percentage points comparing to the pre-Crisis period, whereas the average saving rate of high-income households remained unchanged. Third, population ageing is putting downward pressure on aggregate saving. Several papers suggest that population ageing will lead to a decrease in aggregate saving (Weil, 1994; Bosworth and Chodorow-Reich, 2007). Kwack and Lee (2005) show that a one percent increase in the youth, old-age dependency decreases the saving rate by 0.15 and 0.34 percent, respectively. But Park and Rhee (2005) show that a simple aggregate demographic change (i.e. a change in the age structure) cannot explain the increasing saving rates in the survey data between 1970 and 1990 despite the falling total dependency ratio.⁵ Instead, Park and Rhee (2005) argue that the households saving decision depends on the consequences of ageing population. For example, while a longer lifespan would increase retirement saving, a higher cost of human capital investment would decrease saving.

Finally, the emergence of social insurance programs in the 1990s contributed to the decline in the household saving rate (Yoo and Seo, 2008;

⁵Park and Rhee (2005) also find that it is the surge in housing prices in the 1970s and 80s that explains the then high saving rates. Although there was another surge in housing prices in the early 2000s, the household saving rate did not rebound due to the development of the mortgage market in 1997 and 2004.

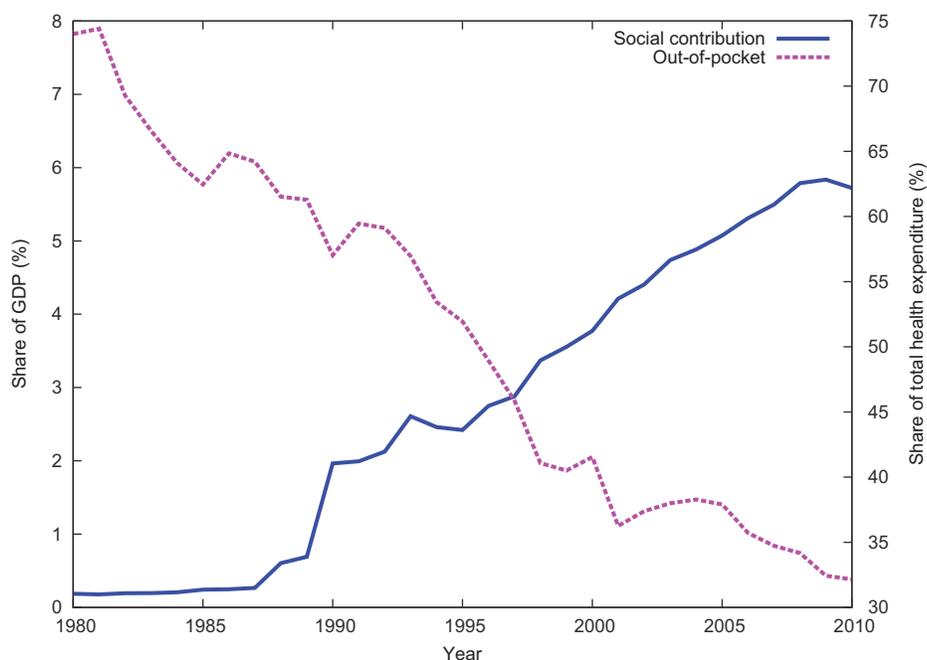


Figure 2.4: Social contribution as a share of GDP and out-of-pocket medical spending as a share of total health expenditure

Source: OECD(2013, 2014).

Shin and Lee, 2010). Figure 2.4 shows that the social contribution rate increased from less than 1 percent of GDP in 1989 to nearly 6 percent of GDP in 2010. The increase in social contribution lowers households' disposable income. During the same time, the share of out-of-pocket medical spending in total health expenditure decreased from 74 percent to 32 percent. A decrease in medical expenditure uncertainty reduces the households' precautionary saving motive.

In addition to public health insurance, the South Korean government implemented the national pension system in 1988 and the basic old-age security in 2008. Although the national pension enrollment reached 80

percent of the total population in 1999, the current pension benefits remain too small and will be matured fully by 2028. Low pension benefits and limited old-age security have resulted in about 40 percent of elderly population to live under the official poverty status, the highest elderly impoverishment among the OECD countries (Jones, 2012).

Chapter 3

Medical Consumption and Health: An Empirical Investigation

3.1 Introduction

Does self-reported health status depend on medical consumption? This question is important because health consumption in turn depends on whether the individual has access to medical services, which in turn partly depends on whether the individual has financial resources. In most industrialized economies, public health insurance helps to finance medical services whether that be a preventative or curative type of medical services. However, even under a universal public health insurance, high co-pay rates could become a barrier to access to medical services. This type of under-insurance has been studied mainly in the context of the uninsured non-elderly population of the United States. This chapter explores the link between insufficient medical consumption and health outcomes in the context of South Korea, where the universal public health insurance provides limited benefits and the co-payments and out-of-pocket medical expenditures take up a substantial share in total health expenditures.

The empirical model here in particular focuses on the effect of opting-out of medical consumption on self-reported health status in South Korea. Because the public health insurance benefit rate has been known to be

relatively low in South Korea, several studies find that South Koreans in general are vulnerable to large medical expenditure shocks, which lead some of them to opt out of medical consumption (Wagstaff, 2006; Kim, 2008). I estimate the effect of opting-out of medical consumption on health status using the Korean Welfare Panel Study data. This survey includes a rather unique question, which asks whether the surveyed household has in the recent past foregone medical consumption due to lack of financial resources or economic hardship. The results suggest that those who previously opted out of medical consumption due to a lack of financial resources are on average 10 percent less likely to report having a good health status, which is substantially large. This finding implies that financially-constrained individuals have opted out of what may be considered as “essential” medical services. The link between under-insurance and the lack of medical consumption appears to be strong in South Korea, despite its provision of universal public health insurance.

My study relates to two strands in the empirical literature in health economics. The first literature examines the link between the lack of health insurance and health outcomes. The second literature examines the link between the lack of health insurance and health care utilization. Most papers in these two strands in the literature focus on the previously uninsured population who attain a health insurance in the United States, largely by becoming eligible for Medicare at age 65. The literature finds that attaining a health insurance correlates positively with improvement in health. For instance, Card et al. (2009) find that Medicare eligibility

at 65 increases the number of medical procedures done on the patient and as a result reduces the mortality rate by 1 percent. Decker and Rentier (2004) compare U.S. seniors with Canadian seniors and find that at age 65 there is a reduction in self-reported morbidity by 4 percentage points for low-income U.S. seniors who attain the Medicare coverage. In terms of health care utilization, the literature finds that having greater health insurance benefits lead to greater health care utilization (e.g. ambulatory services, general visits to physicians) (Kim et al., 2005; Aron-Dine, Einav, and Finkelstein, 2013; Limwattananon, Neelsen, O'Donnell, Prakongsai, Tangcharoensathien, and Van Doorslaer, 2013), while the uninsured are less likely to undergo diagnostic and imaging services (Institute of Medicine, 2002).¹

In South Korea, all individuals are insured under universal public health insurance, which began in 1989. However, there exists the issue of underinsurance due to high co-pay rates (20-60 percent of total medical spending) and medical spending on uninsured services such as preventative medical check-up, and MRI services. The literature shows that high medical expenditures are concentrated among low-income households. For instance, Kim (2008) finds in *Kyung-Sang-Nam-do* a south-eastern province in South Korea that failure to qualify for the Medical Aid Programme increases by twofold the likelihood of incurring large medical expenditures (defined as 10% or more of annual disposable income). Kim (2008) also finds that

¹Kolstad and Kowalski (2012) shows that expanding health insurance in Massachusetts helped decreased the inpatient care utilization for preventable condition. The findings suggest that low-income households especially the working-age near retirement had opted out of preventative medical care prior to the reform.

having an additional chronic illness increases the likelihood of incurring large medical expenditures by 1.2 times. Son et al. (2010) use the first wave of the KOWEPS and find that large medical expenditure shocks are more frequent among the low-income households (income below 120% of the poverty line).

The literature finds that low-income households in South Korea tend to opt out of medical services, and thus face higher health risks. Kim et al. (2014) find that those patients of low socioeconomic backgrounds face a higher in-hospital mortality for cerebrovascular diseases, gastrointestinal bleeding, and pneumonia after controlling for comorbidity before admission. This may be due to the limited benefit of the public health insurance so that low-income households opt out of expensive non-covered services (Kim et al., 2014).² Kim et al. (2005) shows that in response to an increase in out-of-pocket medical expenditures, low-income households would reduce their visits to a physician by three times more than their high-income counterparts. The literature shows that the lack of health insurance benefits becomes a barrier to sufficient medical consumption, which in turn negatively affects health outcomes. Given the significance of the link between health insurance benefits and access to medical services, this chapter investigates the effect of opting-out of medical consumption on health outcomes.

The rest of the chapter is organized as follows. Section 3.2 describes

²Kim et al. (2014) note that opting-out of medical consumption may occur as the physicians do not offer the expensive non-covered services to low-income patients due to their inability to pay.

the Korean Welfare Panel Study (KOWEPS) data. Section 3.3 describes the model and presents the results. Section 3.4 investigates alternative specifications to the basic model. Section 3.5 concludes.

3.2 Data

I use the Korea Welfare Panel Study (KOWEPS). It follows 7000 households from rural and urban areas. The sampled households were stratified across two equally sized groups. These groups are representative of the sub-populations of households whose incomes are above or below 60% of average household income. The first survey was conducted in 2006.

The survey questions capture socio-demographic characteristics (age, gender, location, and education levels), health and medical history (self-reported health status, medical service utilization, and health insurance status), occupation, income, and expenditures (including subcategories of income and consumption), and financial circumstances (e.g., missed meals and missed hospital visits due to financial reasons). In particular, I use the question on missed hospital visits and medical consumption to estimate the effect of opting-out of medical consumption in the model.

I use the first two waves of the KOWEPS (2006 and 2007). I restrict the sample to households headed by non-disabled individuals between ages 25 and 84. I exclude those households whose head is disabled. I exclude those households who receive assistance from the Medical Aid Programme. These sample restrictions reduce the sample size to 5086 households. Table 3.1 reports the sample summary statistics. The mean age of household head

Table 3.1: Summary statistics of household head

Variables	Mean	Std. dev.
Age	53.5	15.4
Male (%)	78.2	41.3
Living in urban areas (%)	76.1	42.6
Good health status previously (%)	73.0	44.4
Good health status now (%)	75.4	43.1
Less than high school (%)	43.5	49.6
Graduated from high school (%)	29.9	45.8
Graduated from college (%)	26.5	44.2
Having chronic illness (%)	35.1	47.7
Large medical expenditure (%)	14.1	34.8
Have hospitalized for inpatient care (%)	9.2	29.0
Have received outpatient care (%)	75.0	43.4
Opted out of medical consumption (%)	6.3	24.2
Observations	5087	

Source: Korean Welfare Panel Study (2006, 2007).

Notes: The sample size is 5087 households. Self-reported health status ranges from 5 (very bad health) to 1 (excellent health), and good health is defined as the self-reported health status less than 4 (bad health).

is 54 years old. The share of those who reported to be in good health in the first wave is 73 percent, whereas the share of those in good health in the second wave is 75 percent. Good health is defined as a self-reported health status of “good”, “very good”, or “excellent”. Bad health is defined as those whose self-reported health status is either “bad”, or “very bad”. About 35 percent of the sample have suffered from a chronic illness, 14 percent have incurred large medical expenditure (at least 15 percent of their income), and 75 percent have gone to hospital for outpatient care. Approximately 6 percent of the sample reported that they have opted out of medical consumption due to financial difficulty.

3.3 Estimation

To estimate the health transition probability, I build a logit model

$$L_{i,t} = \ln\left(\frac{p_{i,t}}{1 - p_{i,t}}\right) = \beta_1 s_{i,t} + \beta_2 s^2_{i,t} + \beta_3 p_{i,t-1} + \beta_4 m_{i,t-1} + \epsilon_{i,t}, \quad (3.1)$$

where the subscript i indicates the individual and the subscript t indicates the time period. The dependent variable represents the odds ratio of having a good health status, which contains the probability of having good health $p_{i,t}$ and the probability of having bad health $1 - p_{i,t}$. s represents the individual's age, $p_{i,t-1}$ represents the lagged health outcomes dummy variable indicating whether the individual had a good health status at $t - 1$, $m_{i,t-1}$ represents the dummy variable indicating whether the household opted out of medical consumption at $t - 1$, and $\epsilon_{i,t}$ is a random error term. This specification yields the health transition probability over a 3-dimensional state space.

Table 3.2 presents the point estimates, standard errors, and marginal effects. The point estimates are significant at 1 percent level except for the quadratic term for age, which appears to be uncorrelated with health outcomes. As one should expect, the effects of age and opting out of medical services on health outcomes are both negative, whereas the effect of having good health previously on health outcomes is positive. The large coefficient for the lagged health status variable implies that health status is persistent over at least two years. The marginal effect for lagged health status indicates that good health status at baseline increases by 22 percent

Table 3.2: Estimation of the odds of having good health status

Variable	Coefficient	Marginal Effect
Age	-0.1157*** (0.0261)	-0.01
Age squared	0.0005** (0.0002)	0.00
Previous Health	1.7880*** (0.0843)	0.22
Opt out of Med	-0.8488*** (0.1470)	-0.10

Notes: Standard errors are in parentheses. I use the first two waves of the Korea Welfare Panel Study (2006, 2007). The sample size is 5087, which includes those who are of age between 25 and 84, and without disability. Control variables also include constant, which is not reported here.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

the probability of being in good health a year later. The marginal effect of opting out of medical consumption is a 10 percent reduction of being in good health a year later. Both marginal effects are statistically and economically significant.

For example, for a 50-year-old who opted out of medical consumption, the transition probability from good to good health status is 66 percent. By purchasing medical consumption, the same transition probability increases by about 18 percentage points. This gap in health transition created by medical consumption widens with age. I report the full health transition probability matrices in Appendix B.

The results suggest that the negative effect of opting-out of medical consumption is substantial on self-reported health status. Opting-out of medical consumption from the baseline results in 10 percentage-point-decline in the odds of having a good health status. This finding appears to be stronger than the 4 percentage-point-decline found by Decker and Rentier

(2004),³ The reason is that my findings are based on the survey that explicitly asks whether the household have opted out of medical consumption, whereas the findings by Decker and Rentier (2004) are based on the lack of health insurance for low-income households in the United States before age 65 who *may have* opted out of medical services.

3.4 Alternative Specifications

One important problem with this baseline specification is that a number of relevant control variables are omitted from the regression. For instance, it does not include household income, which may be correlated with previous health status. Also, the literature suggests that in South Korea those with chronic illnesses tend to incur large medical expenditures as a share of their income. I address these limitations in this section by adding several control variables including household income, and dummy variables that proxy for incurring large medical expenditures, and having a chronic illness. I then compare the point estimates of the baseline model with those of the more flexible model presented here.

Table 3.3 shows that the mean self-reported health status by categories of income, medical expenditure, and by the presence of a chronic illness. Low income is defined as households' income in the bottom 25 percent of income distribution, the middle income as households' income in the middle 50 percent, and the high income as households' income in the top 25

³Decker and Rentier (2004) use the triple difference interaction methods by age (Medicare eligibility at 65), income (low vs. high), and country (Canada vs. United States).

Table 3.3: Mean self-reported health status by various categories

	Observations	Health status in 2005	Health status in 2006
Low income	1066	3.1	3.1
Middle income	2646	2.6	2.7
High income	1375	2.1	2.2
Large medical expenditure	716	3.4	3.3
No large medical expenditure	4371	2.4	2.5
Having chronic illness	1787	3.6	3.4
Having no chronic illness	3300	2.0	2.2
All	5087	2.6	2.6

Source: Korean Welfare Panel Study (2006, 2007).

Notes: Self-reported health status is defined by 1 (excellent health), 2 (very good health), 3 (good health), 4 (bad health), 5 (very bad health). The low income group is the bottom 25%, and the high income group is the top 25%. Large medical expenditure is defined as those households whose annual medical expenditure exceeds 15 percent of its annual income.

percent. I define households with large medical expenditures as those who spend more than 15 percent of their income on medical services. Finally, the health outcomes seem to be very sensitive to the presence of chronic illness. The results show that self-reported health increases in income and declines when incurring large medical expenditures. Finally, self-reported health status is on average lower among those who have a chronic illness.

I control for the effects of chronic illness, income, and medical expenditures using the following specification

$$L_{i,t} = \beta_1 s_{i,t} + \beta_2 p_{i,t-1} + \beta_3 m_{i,t-1} + \beta_4 \ln(Y_{i,t-1}) + \beta_5 \text{l.med}_{i,t-1} + \beta_6 \text{ci}_{i,t-1} + \epsilon_{i,t} \quad (3.2)$$

where $\ln(Y_{i,t-1})$ represents the log of household income, “l.med” represents the dummy variable, which takes a value of 1 for households with medical

expenditures exceeding 15 percent of their income. “ci” represents the dummy variable, which takes a value of 1 for household heads who have a chronic illness.

Table 3.4 compares the point estimates of the basic model (Model 1) with the extended model (Equation (3.2)) in column 2, 3, and 4. I do not display the quadratic age term, because its coefficient estimates are nearly zero for all specifications.⁴ All point estimates are significant at the 1 percent level. Column (2) adds the log income only. The results show that controlling for income mitigates the impacts of lagged health and opting-out of medical consumption on subsequent health status.⁵ Because the likelihood of opting-out is concentrated among the low-income households, the models that do not control for income underestimate the effect of opting-out of medical consumption. However, the new coefficients are contained in the confidence interval of the coefficient estimates of the baseline specification.

As suggested by the literature on South Korean health insurance, including vulnerability to medical expenditure shocks and the presence of chronic illnesses matter for estimating the effect of medical consumption on health outcomes. Controlling for large medical expenditures in Model 3 reduces the point estimate for past health status. Because those households with large medical expenditures tend to have worse health outcomes, Model 1 overestimates the effect of previous health status. Controlling for

⁴The point estimates for the quadratic age term is between 0.0004 and 0.0006.

⁵Instead of continuous income control, I have tried grouping the income groups as control variable. The coefficient estimates are stable between these specifications.

the presence of chronic illness in Model 4 substantially changes the point estimates. It shows that the negative effect of having a chronic illness is even larger than that of opting-out of medical consumption. Also, not controlling for chronic illness greatly overestimates the effect of previous health status.⁶ Across these specifications, the coefficient estimates for opting-out of medical consumption does not deviate greater than one standard error. The average marginal effects of opting-out of medical consumption ranges between 9 and 10 percentage points decline in the odds of having good health. This finding adds a health outcome dimension to Kim (2008) who finds that the presence of chronic illness plays a significant role in explaining large medical expenditure shocks, and a concrete evidence to Kim et al. (2014) who suspect that opting-out of medical consumption explains the reason for a higher in-hospital mortality for patients from low socioeconomic backgrounds.

3.5 Conclusion

Using panel data and an empirical model of health outcomes, I find that the probability of having good health decreases with age, and depends substantially on the previous health status. Moreover, the effect of opting-out of medical consumption on health is economically important and statistically significant especially in old age.

⁶I have also checked if having a single specific disease would change the point estimates. There were no significant changes from having arthritis, high blood pressure, and diabetes. It seems that those individuals who report of having a chronic illness also suffer from several types of illnesses.

Table 3.4: Estimation of the odds of having good health status with additional control variables

Variable	Model 1	Model 2	Model 3	Model 4
Age	-0.12*** (0.03)	-0.12*** (0.03)	-0.12*** (0.03)	-0.09*** (0.03)
Previous Health	1.79*** (0.08)	1.75*** (0.08)	1.71*** (0.09)	1.34*** (0.09)
Opt out of Med	-0.85*** (0.15)	-0.75*** (0.15)	-0.78*** (0.15)	-0.79*** (0.15)
Having Chronic illness				-0.89*** (0.10)
Control				
Income level?	No	Yes	Yes	Yes
Large Med. Exp?	No	No	Yes	Yes
Chronic illness?	No	No	No	Yes

Notes: Standard errors are in parentheses. Model 1 and 2 are logit regression of the odds of having good health. Model 2 includes two income dummies. Low income represents the bottom 25% and middle income represents the middle 25-75%. Large medical expenditure represents those households which spend at least 15 percent of their disposable income on health care. Control variables also include constant, which is not reported here.

I use the first two waves of the Korea Welfare Panel Study (2006, 2007). The sample size is 5087, which includes those who are of age between 25 and 84, and without disability.

*** Statistically significant at the 1% level.

As an extension to the basic model, I explore several specifications including household income levels, medical expenditures, and the presence of chronic illness. One issue of not including income levels in the basic model is vulnerable to an endogeneity between previous health and household income. Although I do not explicitly control for the endogeneity, I show that adding income controls do not change the coefficients substantially. However, adding the presence of chronic illness shows that the basic model substantially overestimates the effect of the person's lagged health status in the basic model. The marginal effect of opting-out of medical services is

stable that having opted out of medical services predicts a 10-percentage-point decline in the likelihood of having good health. This negative effect appears to be stable in the alternative specifications.

The results suggest that the lack of public health insurance benefits has led to opting-out of certain “essential” medical services in South Korea, which is reflected by the substantially large negative effect on health outcomes. Given the significant role that medical consumption plays in determining health outcomes in South Korea, this chapter provides the ground work for building a life-cycle model with endogenous medical consumption and health outcomes. And a policy change that increases public health insurance benefits does not only prevent medical expenditure shocks, but also improves health outcomes – significant implications for household saving and welfare.

Chapter 4

Public Provision of Health Insurance and Aggregate Savings

4.1 Introduction

The link between income uncertainty and aggregate savings has long been recognized in economic theory, which suggests that in the presence of incomplete markets, households respond to idiosyncratic risk by increasing their precautionary savings (Aiyagari, 1994; Díaz, Pijoan-Mas, and Ríos-Rull, 2003). Empirically, Hubbard, Skinner, and Zeldes (1994), and Carroll and Samwick (1997) find that greater labour income uncertainty leads to higher household wealth. It has also been found by Strauss and Thomas (1998), Currie and Madrian (1999), and Smith (1999) that one of the critical determinants of labour income uncertainty for working-age adults is health. As access to health insurance and health status are intimately linked (Institute of Medicine, 2002, 2004; McWilliams, 2009), one should also expect a link between publicly-provided health insurance and aggregate savings. Based on this evidence, one can predict that public health insurance should reduce the demand for precautionary savings, and the objective in this chapter is to quantify the relevance of this channel in South Korea.

Public health insurance benefits in South Korea have been increasing

since the introduction of universal public health insurance in 1989. Figure 4.1 shows that, between 1989 and 2010, the insurance benefit rate, defined by the public share in total health expenditures, increased by 30 percentage points, while the household saving rate in South Korea declined by about 13 percentage points. These empirical observations seem to suggest a negative relationship between health insurance benefits and aggregate saving.

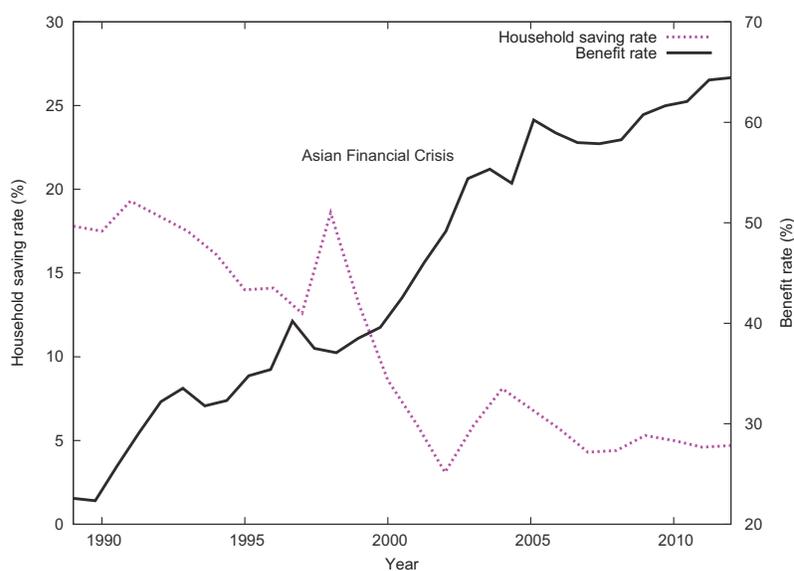


Figure 4.1: Household saving rate and National Health Insurance benefits in South Korea between 1980 and 2010

Notes: The benefit rate is defined as the share of public health expenditure in total health expenditure.

Source: Korean Statistical Information Service (2013).

To provide such a quantitative estimate, I develop a life-cycle model of consumption and saving decisions that includes incomplete health insurance markets, endogenous health, and idiosyncratic health risks. There is no aggregate uncertainty from health risks. Health risks are age-specific,

and they depend on previous medical consumption – here treated as investment in health capital. I estimate the impact of this preventative medical spending on future health risks using the Korean Welfare Panel Study (KOWEPS). The baseline quantitative results show that the introduction of universal health insurance in South Korea accounts for about 0.5 percentage points of the decline in the household saving rate between 1989 and 2010. Along similar lines, the precautionary savings due to lack of health insurance in 1989 amounts to about 2.5 percentage points of the saving rate. Moreover, according to the model the policy improves the access to health care, and in turn lowers the incidence of bad health for about 7 percent of the population.

While models of uninsurable idiosyncratic labour income risk make clear qualitative predictions about the relation between access to health insurance and precautionary saving, there is some uncertainty about this relation in the empirical literature. In particular, Chou, Liu, and Hammitt (2003) find that expansions to public health insurance in Taiwan cause a significant drop in the saving rate of newly enrolled households. Chamon and Prasad (2010) point to the decline in public expenditures on health care and education in China to explain the high saving rate for the elderly and near-elderly population. In contrast, Starr-McCluer (1996) for the United States, and Guariglia and Rossi (2004) for the United Kingdom, find a statistically significant, *positive* association between access to (private) health insurance and household savings. Hsu (2013) argues that the positive relation is largely driven by the social insurance programs in the

advanced economies, which reduces the demand for precautionary savings. Hsu (2013) shows that accounting for social insurance, there is a negative relation between health insurance benefits and savings. In this vein, Guariglia and Rossi (2004) find that those without private health insurance tend to accumulate greater savings in poor areas of the U.K. where the public health insurance is unreliable.

The macroeconomics literature related to this chapter includes Jeske and Kitao (2009), Hsu and Lee (2012), and Hsu (2013) Pashchenko and Porapakarm (2013). All of these papers in the context of the United States find a negative relationship between health insurance benefits and aggregate savings. In particular, Hsu and Lee (2012) show that increasing public health insurance benefits has a larger impact on the bottom half of the wealth distribution. A common feature of these models is that the main source of uninsurable idiosyncratic shocks is formulated in terms of exogenous medical expenditure shocks. This feature captures the risk of becoming ill, receiving medical treatment, and incurring medical expenditures, yet omits the occurrence of opting-out of medical treatment. Due to financial reasons, individuals may opt out of medical consumption and worsen their future health risks. To capture the health risks of becoming ill and opting-out of treatment, I allow future health risks to be determined by medical expenditures. Furthermore, I relate bad health status to ability to earn wage income in the labour market.

The novelty of my approach is that I allow for an interaction between future health risks and medical expenditures. One can envision this as

an investment in health capital (Grossman, 1972). More generally, this captures the fact that early diagnostic tests and preventative medicine significantly reduce future health risks (Institute of Medicine, 2002). These considerations also have distributional implications as well: low income individuals typically have less access to medical insurance and are more likely to opt out of preventative medical consumption (Institute of Medicine, 2002; Schoen, Collins, Kriss, and Doty, 2008; Kim, 2008). To the best of my knowledge, this chapter provides the first economic significance of health risks for aggregate savings with endogenous medical consumption in a stochastic OLG framework.¹

There are three papers that are most closely related to my approach of endogenous medical consumption and health risks. Jung and Tran (2009) examine the impact of universal health voucher program on welfare. Prados (2012) studies the earnings inequality arising from health shocks. And Zhao (2014) examines the contribution of social security to the rise of health spending. There exists a key difference in the modeling framework between these papers and mine. By choosing the health shock process, Jung and Tran (2009) and Zhao (2014) target the share of aggregate medical expenditures and the survival rate, respectively, whereas I estimate the health shock process directly from the data as in Chapter 3. Although Prados (2012) directly estimates the distribution of health shocks from the

¹The distinction between the risk of becoming ill and the risk of opting-out of medical consumption dates back at least to Arrow (1963).

Medical Expenditure Panel Survey, her paper focuses on the effect of curative medical services and omits the effect of preventative care on health outcomes. In addition, this chapter focuses on implications for aggregate saving in the context of South Korea.

The chapter is organized as follows. Section 4.2 introduces the model. Section 4.2.4 presents the calibrated parameters. Section 4.3 presents the results, and Section 4.4 concludes. Appendix A.1 describes the computational algorithm used in this chapter.

4.2 A Life-cycle Model of Medical Consumption

My model is based on Aiyagari (1994), with a few extensions. I consider a stochastic, general-equilibrium model with overlapping generations and health risks as the source of idiosyncratic shocks. Individuals spend the first part of their lives working, and they spend the second part in retirement. Throughout the life-cycle, individuals face uninsurable idiosyncratic health shocks, which affect their morbidity (health status). Specifically, if the individual is of working age, a negative health shock reduces their labour endowment. If the individual is retired, a negative health shock reduces their chances of survival. Either type of health uncertainty can be mitigated by consumption of medical services.

4.2.1 Model Economy

Demographics: Time is discrete. An agent's age is denoted by $s = 1, \dots, 60$, where 1 corresponds to 25 years and 60 to 84 years. Agents work

for the first 35 years and are retired for the remaining 25 years. Each period corresponds to 1 year. In each period, a new cohort of individuals ($s = 1$) enter the economy with zero asset holdings, while the oldest individuals ($s = 60$) exit the economy. The share of each cohort is denoted by $\mu(s)$ with $\sum_{s=1}^{60} \mu(s) = 1$. The share of each cohort is also the relative size of each cohort so that the population mass is constant at 1.

Preferences: Each individual draws utility from consumption of non-medical goods c and health status h . The health status here represents morbidity. The flow utility function is as follows

$$u(c_t, h_t) = u(c, h) = \left[(1 - \lambda)c^{\frac{\nu-1}{\nu}} + \lambda h^{\frac{\nu-1}{\nu}} \right]^{\frac{\nu}{\nu-1}}, \quad (4.1)$$

where ν is the elasticity of substitution between health status and consumption, and λ is the weight of health status in the utility function. I restrict the value of ν less than 1 so that health status and consumption are complements, as suggested by Finkelstein, Luttmer, and Notowidigdo (2013).

Health risks and mortality: There are two sources of uncertainty in the model: health risks and mortality. Health status h follows a 2-state Markov process, which is defined by either good (h_g) or bad (h_b) health. The current health status depends on age, health status in the previous period, and the lagged medical consumption decision \mathbb{I}_m . Whether in good or bad health status, individuals can buy medical services to mitigate future health shocks.

The health shock h_{t+1}^{s+1} for an age s individual who consumes medical services at time t is a Markov chain with the following transition matrix

$$\Theta_{\mathbb{I}_{m_t}=1}(h'|h) = \text{Prob}\{h_{t+1}^{s+1} = h' | h_t^s = h\} = \begin{pmatrix} p_{gg}^s & p_{gb}^s \\ p_{bg}^s & p_{bb}^s \end{pmatrix}, \quad (4.2)$$

where $\mathbb{I}_{m_t} = 1$ indicates that the individual consumes medical services at time t . For instance, in the above expression, p_{bg}^s represents the probability of an individual aged s having bad health status in period t and good health status in period $t + 1$, conditional on medical spending in period t .

The transition matrix for those who opt out of medical consumption is

$$\Theta_{\mathbb{I}_{m_t}=0}(h'|h) = \text{Prob}\{h_{t+1}^{s+1} = h' | h_t^s = h\} = \begin{pmatrix} q_{gg}^s & q_{gb}^s \\ q_{bg}^s & q_{bb}^s \end{pmatrix}, \quad (4.3)$$

where $\mathbb{I}_{m_t} = 0$ indicates that the individual opt out of medical consumption at time t . By assumption $p_{bg}^s > q_{bg}^s$, $p_{gg}^s > q_{gg}^s$ so that $\Theta_{\mathbb{I}_{m_t}=1}$ is more “favourable” than $\Theta_{\mathbb{I}_{m_t}=0}$.

The mortality shock process $\chi(s, h)$ applies to the retired generations. The mortality shock is non-accidental by applying to those who are in bad health only. This implies that the probability of dying can be reduced by medical consumption, which reduces the likelihood of bad health. The probability of dying increases with age. And at the terminal age $s = 60$, the mortality rate equals to 1. The asset holdings of the deceased are treated as accidental bequests, which are equally distributed to the rest of the population.

Firms: There are two competitive sectors in the economy. The health sector produces medical services, and the non-health sector produces the consumption good. Firms in both medical (m) and non-medical (n) sectors use a Cobb-Douglas production function

$$Y_t^i = Z^i L_t^{1-\alpha} K_t^{i\alpha}, \quad i = \{m, n\}, \quad (4.4)$$

where K_t^i represents the capital stock in sector i and period t , L_t^i is labour, and Z^i is total factor productivity in sector i . The share of capital α is the same across sectors.

Firms rent labour and capital from households. Factor markets are competitive, hence factors of production are compensated at their marginal value product

$$r_t = \alpha Z^n \left(\frac{L_t^n}{K_t^n} \right)^{1-\alpha} - \delta = \alpha Z^m \left(\frac{L_t^m}{K_t^m} \right)^{1-\alpha} P^m - \delta \quad (4.5)$$

$$w_t = (1 - \alpha) Z^n \left(\frac{K_t^n}{L_t^n} \right)^\alpha = (1 - \alpha) Z^m \left(\frac{K_t^m}{L_t^m} \right)^\alpha P^m, \quad (4.6)$$

where r_t is the net rate of return to capital, w_t the wage rate, and δ the capital depreciation rate. The non-medical consumption good is the numeraire and P^m is the relative price of medical services. Perfect factor mobility ensures the equality of the marginal rates of transformation and the capital-labour ratios across sectors

$$\frac{K_t^n}{L_t^n} = k_t^n = \frac{K_t^m}{L_t^m} = k_t^m.$$

Given Equations (4.5) and (4.6), the relative price of medical service is the ratio of the TFPs

$$P^m = \frac{Z^n}{Z^m}. \quad (4.7)$$

Health insurance: All individuals have access to a publicly provided health insurance, fully-funded by a payroll tax. The health insurance program is fully specified by η the benefit rate. Agents consuming medical services pay $1 - \eta$ the co-pay rate of medical services. I assume that the health insurance program is managed under a balanced budget rule and therefore there exists a unique equilibrium payroll tax τ_m that covers the outlays.

The government also runs a Medical Aid Programme, which pays for the co-pay rate. The eligibility for this program and only those is asset-tested, and in the model I assume that eligibility is restricted to the bottom 10 percent of the wealth distribution. I differentiate the eligible groups into two. The first group is the retired poor, who receive co-pay assistance whether their health status is good or bad. The second group is the working-age poor, who receive co-pay assistance when their health status is bad.

Aggregate resource constraints: The sum of the resources used in both sectors make up the aggregate capital K_t and the labour supply L_t . The

aggregate resource constraints are

$$K_t^n + K_t^m = K_t,$$

$$L_t^n + L_t^m = L_t.$$

Medical services can only be consumed and non-medical output can be either consumed or invested

$$P^m M_t + P^m(\text{Medical Aid Class 1} + \text{Medical Aid Class 2}) = Y_t^m,$$

$$K_{t+1} = Y_t^n - N_t + (1 - \delta)K_t,$$

where N_t represents the aggregate consumption of non-medical goods.

Health insurance and Medical Aid Programme outlays equal to the tax revenue collected by the payroll tax

$$\tau_m wL = \eta P^m M + \eta_{\text{aid}} P^m M_{\text{aid}}, \quad (4.8)$$

$$M_{\text{aid}} = \text{Medical Aid Class 1} + \text{Medical Aid Class 2}.$$

4.2.2 Individual's Problem

Each individual maximizes their lifetime utility

$$\max \mathbb{E}_t \left[\sum_{s=1}^{60} \beta^{t+s-1} (1 - \chi(s, h)) u(c_{t+s}, h_{t+s}) \right],$$

$$\chi(s, h) = 0 \text{ for } s \leq 35,$$

where β is the time discount factor, \mathbb{E}_t is the expectation operator, and $(1 - \chi(s, h))$ is the probability of survival. Working-age individuals are not subject to mortality in the model such that their survival is certain. As described in Equation (4.1), flow utility comes from consumption of non-medical goods and health status.

The recursive formulation of the individual problem is

$$V(s, k, h) = \max_{k', c, \mathbb{I}_m} u(c, h) + \beta (1 - \chi(s, h)) \mathbb{E}[V(s', k', h')] \quad (4.9)$$

subject to

$$\begin{aligned} k' &= (1 + r)k + (1 - \tau_m)l(h)\mathbb{I}_w(s)e(s)w + b - c - \omega, \\ \omega &= (1 - \eta)P^m\mathbb{I}_m\pi(s, h), \\ k &\geq 0, \end{aligned} \quad (4.10)$$

where $\mathbb{I}_w(s)$ is the indicator function, which takes the value of 1 if the individual is of working age, and zero if the individual is retired; $e(s)$ is an age-specific efficiency parameter; $l(h)$ is a shift parameter that governs the relative labour endowment in bad health; b represents accidental bequests from the deceased; c represents consumption of non-medical goods; ω represents the medical out-of-pocket spending. When the individual opts out of medical services, the indicator function takes the value of zero $\mathbb{I}_m = 0$, otherwise one. $\pi(s, h)$ represents the cost of medical consumption, which varies by age and health status. The cost increases with age ($\pi(s', h) > \pi(s, h)$ for $s' > s$). Also the cost is higher in bad health status

($\pi(s, h = h_b) > \pi(s, h = h_g)$). The last line in the budget constraint shows that individuals cannot borrow (not allowed to have negative asset holdings). This is naturally binding for retired generations whose natural debt limit is zero due to mortality risks. Similarly by introducing a slight mortality risk to the working-age, the non-negative natural debt limit would be binding as well.

4.2.3 Steady State Equilibrium

DEFINITION: Let $X = \{1, \dots, 60\} \times \mathbb{R}_+ \times \{h_g, h_b\}$. A recursive equilibrium is a probability distribution Γ of households over X , a value function $V : X \rightarrow \mathbb{R}$, a policy function $g : X \rightarrow \{0, 1\} \times \mathbb{R}_+$, a tax rate τ_m , and an amount of accidental bequests b such that:

1. The value and policy functions solve the individual optimization problem Equation (4.9);
2. The labour and capital markets clear:

$$K = \int_X k \, d\Gamma, \quad (4.11)$$

$$L = \int_X l \, d\Gamma; \quad (4.12)$$

3. The outlays for health insurance and Medical Aid Programmes are equal to revenues raised by the payroll tax (Equation (4.8));
4. The goods market clears

$$Y = C + K' + P^m M + P^m M_{aid} - (1 - \delta)K, \quad (4.13)$$

where

$$C = \int_X g_c d\Gamma, \quad (4.14)$$

$$K' = \int_X g_k d\Gamma, \quad (4.15)$$

$$M = \int_X P^m g_m m d\Gamma; \quad (4.16)$$

5. Γ is the probability density function over X of a randomly drawn individual from the living population

4.2.4 Parametrization

To numerically solve the model, I calibrate the parameters to the Korean economy. Table 4.1 reports the calibrated parameters, and their source. In what follows, I discuss how I parameterize the model in detail.

Table 4.1: Parameters

Parameter	Description	Values	Source
α	Share of capital	0.3	Young (1995)
β	Discount factor	0.97	Baseline
d	Mortality hazard rate	0.002	Baseline
δ	Depreciation rate	0.05	Pyo, Rhee, and Ha (2006)
P^m	Relative price of medical care	1.103	Pyo et al. (2006)
$\pi(s, h)$	Cost of medical services	See text	KOWEPS (2006-2010)
p_{gg} and p_{gb}	Health transition probability	See Chapter 3	KOWEPS (2006,2007)
q_{gg} and q_{gb}	Health transition probability	See Chapter 3	KOWEPS (2006,2007)
ν	Elasticity of substitution	0.5	Baseline
λ	Health weight in utility	0.6	Baseline
$l(h = h_g)$	Labour supply in good health	1	Baseline
$l(h = h_b)$	Labour supply in bad health	0.75	Baseline

Sources: Korean Statistical Information Service (KOSIS, 2013), Korea Welfare Panel Study (KOWEPS).
Notes: The relative price of medical care is the ratio of labour productivity in health sector and economy-wide.

Demographics: The birth age of the individual in the model $s = 1$ corresponds to biological age 25. This is reasonable given that most South Koreans receive post-secondary education and males fulfill mandatory military service. The retirement age $s = 36$ corresponds to biological age 60, which is the official retirement age in South Korea.

The share of each age in total population μ is computed by the population growth rate. I set the population growth rate at 2.8 percent based on the data (1970-2010) from the Korean Statistical Information Service (KOSIS). The population growth rate generates the share of retired generations in the population to be 23 percent.

Preferences: In the baseline, I target the capital-output ratio at 3.56 by setting the time discount factor β at 0.98. The particular capital-output ratio corresponds to the household saving rate in 1989 according to the national accounts.² I have chosen 1989 as the base year of the quantitative analysis, which also coincides with the year that South Korea began its universal public health insurance.

In the utility function, there are two parameters to be calibrated. The value of elasticity of substitution ν is 0.5 in the baseline, which means that health status and consumption are complements. To target the share of medical spending in output in 1989 of 4 percent according to the national accounts³, the health weight λ is set to 0.6.

²According to the KOWEPS survey data, the average household saving rate between 2006 and 2010 was 22 percent, which is much higher than the figure suggested by the national accounts.

³In the KOWEPS survey data (2006-2010), the share of medical spending in income on average was found to be higher at 14 percent.

The value of health status is taken from the quality-of-life weights in Nyman, Barleen, Dowd, Russell, Coons, and Sullivan (2007). They use the time trade-off methods, which ask the survey correspondents, ‘how many of 10 years of life in the current health status would you trade to live in full health?’ Then the results are mapped with the self-reported health status to calculate the quality-of-life (QOL) weights in the scale of 0 to 1. I take the average of the QOL weights for ‘excellent’ and ‘very good’, and ‘good’ as good health status in the model. And I take the average of the QOL weights for ‘fair’ and ‘poor’ as bad health status in the model.

Mortality shock: The mortality shock process $\chi(s, h)$ follows an exponential form

$$\chi(s \geq 36, h = h_b) = e^{sd} - 1, \quad (4.17)$$

where I target the non-accidental death rate for an elderly group (80-84 years old) at 7.5 percent by setting the mortality hazard rate d at 0.002. The death rate is defined as the number of population who are dead divided by the number of total population in each age group. Figure 4.2 shows that the model slightly overestimates the death rate in the early part of retirement. However, the largest deviation is less than 2 percentage point.

Health transition: I use the first two waves (2006, 2007) of the KOWEPS data to estimate the health transition matrix. The health transition depends on age, past health status and opting-out of medical consumption reported for financial reason in the survey. In particular, the KOWEPS

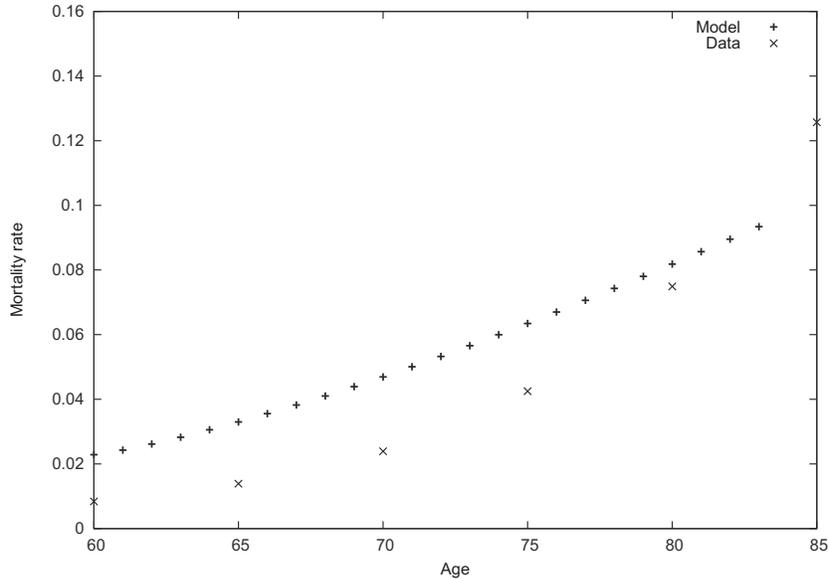


Figure 4.2: Share of individuals : Model versus data
 Source: Korean Statistical Information Service (2013)

includes questionnaires to gauge whether an individual has economic hardship. The survey provides several categories to control for economic hardship including: “insufficient medical fund”, “skipped meals”, “no heating in winter”. I use the insufficient medical fund to control for opting-out of medical consumption, which are less likely to be discretionary.

I build a logistical regression model to estimate the health transition

$$\ln \left(\frac{P_{g,t}^i}{1 - P_{g,t}^i} \right) = \beta_1 s_t^i + \beta_2 s_t^{2i} + \beta_3 P_{g,t-1}^i + \gamma m_{0,t-1}^i, \quad (4.18)$$

where the dependent variable is the odds of having good health in the regression model. I control for age s , health status in the previous period $P_{g,t-1}^i$, and opting-out of medical consumption in the previous period $m_{0,t-1}^i$. I provide the further detail on the estimation in Chapter 3.

Relative labour supply in bad health status: In the baseline, I calibrate the impact of bad health status on labour endowment such that individuals in bad health status lose a quarter of their labour endowment (i.e. $h(h = h_g) = 1, l(h = h_b) = 0.75$). The literature on health and earnings outcomes (Strauss and Thomas, 1998; Currie and Madrian, 1999) suggests that this parameter value varies by types of illness, gender, and race. For example, in terms of wage, Mitchell and Burkhauser (1990) find that having an arthritis reduces wages by 28 percent for men and 42 percent for women, and Berkovec and Stern (1991) find that having a poor health reduces wage by 17 percent. In terms of labour supply, Mitchell and Burkhauser (1990) find that having an arthritis reduces work hours by 42 percent for men and 37 percent for women. And Chirikos and Nestel (1985) find that having a poor health decreases work hours by 13 percent for white men, 21 percent for black men, 6 percent for white women, and 27 percent for black women. Because of this wide range of variability, I conduct an extensive sensitivity analysis on this parameter and consider also 10 and 50 percent loss of labour endowment.

Labour efficiency over the life-cycle: I estimate the labour efficiency parameter $e(s)$ according to

$$e(s) = \ln \text{wage}_t^i = \varrho_1 s_t^i + \varrho_2 s_t^{2i} + \varrho_3 s_t^{3i}, \quad (4.19)$$

where $\ln \text{wage}_t^i$ is the log of wage income of the head of household, and s_t^i the age of the head of household. Figure 4.3 shows that the life-cycle

labour efficiency follows a hump-shape pattern over working-age.⁴

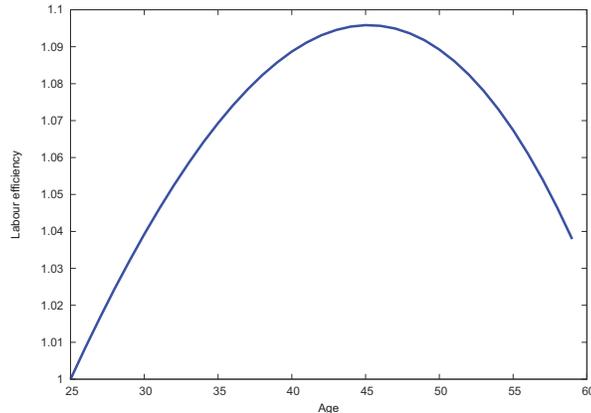


Figure 4.3: Labour efficiency over the life-cycle

Source: Estimation of Equation (4.19) using data from the Korean Welfare Panel Study (wave 1 (2006) – wave 5 (2010)).

Cost of medical consumption: I estimate the cost of medical consumption parameter $\pi(s, h)$ according to

$$\pi(s, h) = q_t^i = \rho_1 s_t^i + \rho_2 h_{g_t}^i, \quad (4.20)$$

where q_t^i is the medical expenditure of a household i normalized by the average income at time t , s_t^i the age of the head of household, $h_{g_t}^i$ is the dummy variable whether the household head is in good health status or in bad health status. Table 4.2 shows that the cost of medical expenditure increases with age and decreases with good health status.

Firms: In the production function, I set the capital income share α at 0.3 as in Young (1995). I calculate the capital depreciation rate δ as 0.05, using the sector-specific depreciation rates in Pyo et al. (2006) and the national accounts from the KOSIS. The relative price of medical services

⁴To account for a non-linearity, I control for age in higher powers.

Table 4.2: Estimation of the cost of medical expenditure over the life-cycle

Variable	Coefficient
Age	0.0017*** (0.000)
Good health	-0.072*** (0.010)

Notes: I use the Korea Welfare Panel Study (2006, 2008-2010). The 2007 wave does not include a questionnaire on the expenditure information specific to medical services. The sample size is 7430, which includes those who are of age between 25 and 84, and without disability.

*** Statistically significant at the 1% level.

P^m is estimated to be 1.103 based on sector-specific productivity in Pyo et al. (2006).

4.3 Quantitative Analysis

This section presents the effects of increasing health insurance benefits on aggregate saving. I organize the section as follows. First, I compare the results from the model with the data. Second, I examine the macroeconomic effects of the recent health insurance reforms. Third, I present the implications for aggregate saving of the current policy proposal. Finally, I provide the model's sensitivity analysis.

4.3.1 Baseline Model

The calibrated model is able to replicate a hump-shape pattern of life-cycle asset accumulation in the data. Figure 4.4 shows the asset accumulation over the lifetime. The model matches the peak asset accumulation at around the retirement age of 60. The model underestimates the wealth of the younger age groups (between 25 and 50) and of the older ones (after

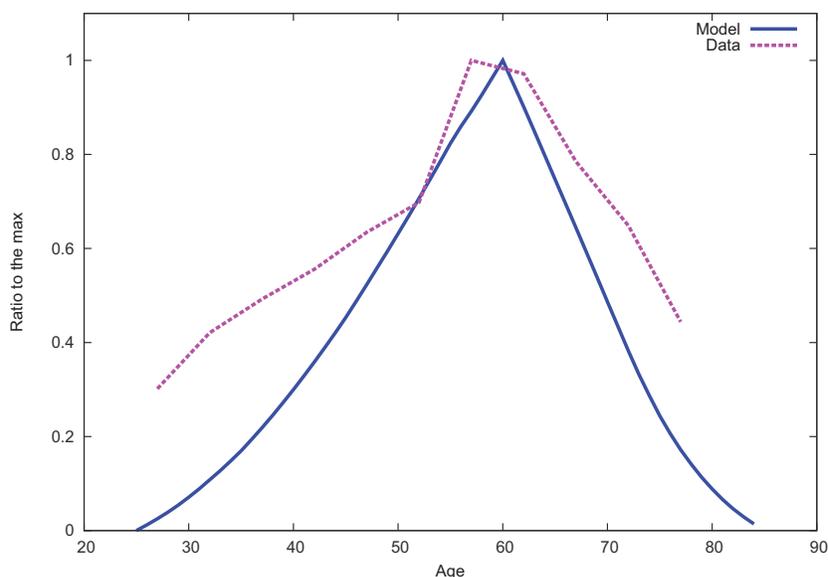


Figure 4.4: Average asset holding over lifetime: Model versus data
 Source: Korean Welfare Panel Study (wave 2 (2007) – wave 7 (2012)).

65). This is explained by transfers between family members, which tend to concentrate in the tail ends of the life-cycle. The model abstracts from these considerations, because they are not central to the question addressed here.

Figure 4.5 shows that the health shock process produces a distribution of health status similar to the data. The solid line represents the fraction of population in bad health by age. The dotted line represents the share of individuals in good health by age in the KOWEPS (2007). The data shows that the probability of having good health declines over age. The probability of having good health implied by the model also decreases over age, except for an increase at age 45.⁵

⁵This is driven by a relatively concentrated distribution of wealth at the early stage of life-cycle. At age 45, there are many young individuals at a similar asset level who begin to engage in preventative medicine.

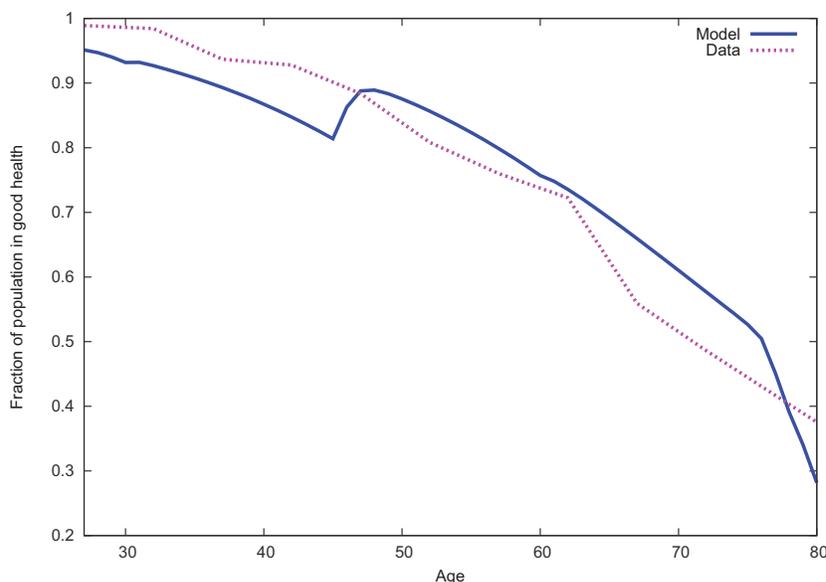


Figure 4.5: Fraction of population in good health over lifetime: Model versus data
Source: Korean Welfare Panel Study (wave 2 (2007)).

There are two targeted statistics, which are the share of medical spending in output M/Y and the saving rate $K/Y * \delta$. Table 4.3 shows in the first column the targeted moments in the data in 1989. They are the same as the model results under the baseline parametrization (in the second column). I show in the third column the moments in the data in 2010. The data shows that the share of health spending in output rose from 4 to 7 percent between 1989 and 2010. Although the share of medical spending in output in 2010 is not targeted, it is matched by the model (in the fourth column). However, the saving rate in the model in 2010 significantly deviates from the data. In what follows, I explain the effects on aggregate saving of the recent health insurance reform.

Table 4.3: Targeted moments and matched moments

Moments	Data (1989)	Model (1989)	Data (2010)	Model (2010)
M/Y	0.04	0.04	0.07	0.07
Saving rate	17.8	17.8	5.0	17.4

Source: Korean Statistical Information Service (2103), OECD (2013).

Notes: M/Y represents the share of medical expenditure in output. Saving rate is computed by the product of the capital-output ratio and the capital depreciation rate.

4.3.2 Recent Policy Changes and Saving

Reforms in South Korea increased the benefit rate from 35 percent in 1989 to 64 percent in 2010. Table 4.4 presents the macroeconomic variables of the steady states, which are characterized by the benefit rates in 1989 and 2010. I label the steady state in 1989 as “Low Benefit”, and in 2010 as “Middle Benefit”. In the third column, I provide the percentage change in the macroeconomic variables when the benefit rate increases from 35 to 64 percent. It shows that the capital-output ratio K/Y decreases by 3 percent, which is a 0.5 percentage points decline in the saving rate. Given there was a decline of 13 percentage points between 1989 and 2010, the magnitude of decline implies that the policy reform has led to a small crowding-out effect on private savings.

To understand the decline in aggregate savings, I assess the contributing factors:

1) Medical expenditure risk reduction: The policy change increases the benefit rate η , also means that it decreases the co-pay rate $1 - \eta$. Because individuals pay a smaller portion of the total cost of medical services,

Table 4.4: Macroeconomic impact of health insurance benefits, Low Benefit versus Middle Benefit

	Low Benefit ($\eta = 0.35$)	Middle Benefit ($\eta = 0.64$)	Change from Low to Middle
K/Y	3.56	3.47	-2.7%
L	0.73	0.74	+1.8%
M/Y	0.04	0.07	+82.7%
w	1.21	1.19	-1.2%
r	3.4%	3.6%	+6.7%
τ_m	2.6%	7.1%	+176.6%
μ_{h_b}	18%	11%	-38.9%
Gini Coefficient	0.465	0.453	-8.9%

Notes: K/Y represents the capital-output ratio; L represents aggregate employment; M/Y represents the share of medical expenditure in output; w and r are the equilibrium wage and interest rate; τ_m is the equilibrium tax rate; μ_{h_b} represents the share of bad health in the population; Gini Coefficient represents the degree of wealth inequality.

they also decrease their demand for precautionary saving against medical expenditure. The net effect on aggregate saving is negative.

2) General equilibrium effect: The policy change increases the rate of return to capital by 6.7 percent and decreases the wage rate by 1.2 percent. While the increase in interest rate increases the intertemporal saving motive, the decrease in wage rate decreases saving. The net effect on aggregate saving is ambiguous.

3) Tax effect: The policy change increases the tax rate almost three-times. The main driver of the increase in tax rate is an increase in demand for medical services and a proportional increase in the outlays for public health insurance. The net effect on aggregate saving is negative, as the increase in tax rate reduces disposable income.

4) Health risk reduction: The policy change lowers the population share of individuals with bad health status by 40 percent. This improvement

Table 4.5: Precautionary savings, comparing against the complete market (fully insured medical expenditure shocks)

	Complete market ($\eta = 1$)	To Low Benefit	To Middle Benefit
K/Y	3.28	+8.5%	+5.6%
L	0.75	-2.6%	-0.9%
M/Y	0.12	-67.0%	-39.8%
w	1.17	+3.6%	+2.4%
r	4.1%	-17.3%	-11.7%
τ_m	17.5%	-85.4%	-59.7%
μ_{hb}	7.1%	+152.7%	+54.4%

Notes: K/Y represents the capital-output ratio; L represents aggregate employment; M/Y represents the share of medical expenditure in output; w and r are the equilibrium wage and interest rate; τ_m is the equilibrium tax rate.; μ_{hb} represents the share of bad health in the population.

in public health implies that the policy change reduces the loss in labour endowment.

Due to incomplete risk-pooling in the health insurance markets, there exists over-accumulation of capital. This is the precautionary saving motive that leads individuals to withhold consumption and accumulate a rainy-day fund in case of negative health shocks. To measure the amount of precautionary savings, I shut off the source of medical expenditure uncertainty while maintaining health shocks and mortality risks. I compare each steady state with the complete market case where medical expenditure is fully insured by publicly provided health insurance. Table 4.5 shows in the second column that the capital-output ratio in Low Benefit is about 9 percent larger than the complete market case. This over-accumulation of capital translates to about 2.5 percentage points in the saving rate, which is comparable to the additional saving rate of 4 percentage points found by Aiyagari (1994) in the case of labour income uncertainty.

Table 4.6 shows the redistributive implications of the reforms grouped by age, wealth level, and health status. In Panel A, the middle-age group experiences a relatively large decline in asset holdings, whereas the retired group experiences a gain in asset holdings. The positive net effect on asset holdings for the retired can be explained by the rise in rate of return to capital (the second factor) and the reduction in negative health shocks (the fourth factor). In Panel B, the wealthiest top quintile experiences a decline in asset holdings by 3 percent, whereas the bottom quintile experiences a gain in asset holdings by 1.5 percent. This finding is contrary to Hsu and Lee (2012) who find that an expansion in public health insurance leads to a larger decline in asset holdings of the poor. Their finding is based on the fact that the poor have a higher marginal utility of consumption and therefore experience faster consumption growth. However, I consider the positive effect on saving by reducing health risks. The main beneficiary of the policy change is the poor who would otherwise have opted out of medical consumption, and in turn realized lower labour endowment. Panel C reflects that the policy change reduces the gap in asset holdings caused by health shocks. It shows that the average asset holdings for those in good health status declines by 3 percent, whereas the average asset holdings for those in bad health status declines by 2.2 percent. Table 4.4 in the bottom row shows that the policy change decreases the Gini coefficient for wealth inequality by 9 percent, which indicates a convergence in wealth distribution.

Table 4.6: Average asset holdings across age, wealth, and health status, Low Benefit versus Middle Benefit, normalized by output

	Low Benefit ($\eta = 0.35$)	Middle Benefit ($\eta = 0.64$)	Change from Low to Middle
B. Age			
Young	1.54	1.51	-2.0%
Middle-age	6.31	5.95	-5.6%
Retired	4.87	4.94	+1.4%
C. Wealth			
Bottom Quintile	0.36	0.36	+1.5%
Middle quintile	3.55	3.54	-0.3%
Top quintile	8.61	8.36	-3.0%
A. Health status			
Good health	3.59	3.48	-3.0%
Bad health	3.51	3.43	-2.2%

Notes: The age groups are categorized by young (25-44), middle-age (45-59), retired (60-84). The asset groups are in quintile, bottom quintile (bottom 20 percentile), middle quintile (40-60 percentile), and top quintile (80-100 percentile).

4.3.3 Future Policy Changes and Saving

In this section, I estimate the consequences of the policy proposal to increase the benefit rate from 64 percent to 80 percent. I denote the steady state characterized by the benefit rate 80 percent as “High Benefit”. Table 4.7 shows the macroeconomic variables in the steady states. The policy proposal decreases the capital-output ratio by 2 percent, which amounts to a 0.4 percentage point decline in the saving rate. This finding suggests that further increasing the benefit rate would not lead to a large crowding-out effect on private savings.

Table 4.7: Macroeconomic impact of health insurance benefits, Middle Benefit versus High Benefit

	Middle Benefit ($\eta = 0.64$)	High Benefit ($\eta = 0.80$)	Change from Middle to High
K/Y	3.47	3.39	-2.1%
L	0.74	0.75	+0.5%
M/Y	0.07	0.09	+25.5%
w	1.19	1.18	-0.9%
r	3.6%	3.8%	+5.1%
τ_m	7.1%	10.8%	+52.8%
μ_{hb}	11%	8.9%	-18.8%
Gini Coefficient	0.453	0.448	-1.1%

Notes: K/Y represents the capital-output ratio; L represents aggregate employment; M/Y represents the share of medical expenditure in output; w and r are the equilibrium wage and interest rate; τ_m is the equilibrium tax rate; μ_{hb} represents the share of bad health in the population; Gini Coefficient represents the degree of wealth inequality.

The four factors that contribute to the decline in aggregate saving operate similarly in this policy experiment. The policy proposal reduces the co-pay rate from 36 percent to 20 percent, thereby reducing the precautionary saving motive. The policy proposal increases the rate of return to capital by 5 percent and decreases the wage rate by 1 percentage. The net effect of the changes to factor prices on aggregate saving is ambiguous. The policy proposal increases the demand for medical services by 26 percent. The resulting increase in the public health insurance outlays increases the tax rate by 53 percent – a negative effect on saving. Moreover, the increase in medical spending reduces the population share of individuals with bad health status by 2.1 percentage points. This indicates that the policy proposal reduces the loss in labour endowment due to health shocks.

Although the effects of the policy proposal on aggregate saving seem to

be similar to the previous analysis, redistributive implications are different. Table 4.8 shows the average wealth of the various groups. Panel A shows that, unlike the previous analysis, the policy proposal decreases the average asset holdings for the retired by 0.4 percent. This suggests that the positive effect of reducing health risks and rising rate of return to capital does not compensate the negative effect of reducing precautionary saving motive. In Panel B, the policy proposal increases the average asset holdings for the bottom quintile by 1.6 percent. The positive effect of reducing health risks on saving benefits the poor who consume preventative medicine at the relative age. If the projected benefit rate increase were to continue, it will improve the asset holdings for the poor by avoiding the risk of opting-out of medical consumption. Table 4.7 shows that the Gini coefficient for wealth inequality declines by 1 percent. Comparing to the previous analysis, the policy proposal has a relatively weak convergence effect on wealth inequality.

One possible concern to further expanding health insurance benefits is the issue of moral hazard and the associated increased tax burden on the working-age. Table 4.9 shows in the first row that the benefit rate elasticity of medical spending is fairly elastic in Low Benefit, 1.24 percent increase in medical spending in response to 1 percent increase in the benefit rate. The elasticity decreases to less than half in Middle Benefit, and even lower in High Benefit. In the second row, the income elasticity of medical spending remains slightly above 1, so that medical services are a normal good. These results suggest that the level of moral hazard will diminish as the health

Table 4.8: Average asset holdings across age, wealth, and health status, Middle Benefit versus High Benefit, normalized by output

	Middle Benefit ($\eta = 0.64$)	High Benefit ($\eta = 0.80$)	Change from Middle to High
A. Age			
Young	1.51	1.48	-2.4%
Middle-age	5.95	5.75	-3.4%
Retired	4.94	4.92	-0.4%
B. Wealth			
Bottom Quintile	0.36	0.37	+1.6%
Middle quintile	3.54	3.54	0%
Top quintile	8.36	8.25	-1.3%
C. Health status			
Good health	3.48	3.40	-2.2%
Bad health	3.43	3.36	-2.1%

Notes: The age groups are categorized by young (25-44), middle-age (45-59), retired (60-84). The asset groups are in quintile, bottom quintile (bottom 20 percentile), middle quintile (40-60 percentile), and top quintile (80-100 percentile).

insurance benefit increases.

Table 4.9: Elasticity of medical spending

	Low Benefit ($\eta = 0.35$)	Middle Benefit ($\eta = 0.64$)	High Benefit ($\eta = 0.80$)
Benefit rate	1.24	0.61	0.50
Income	1.13	1.08	1.18

Notes: Benefit rate elasticity is the percentage increase in medical spending in response to 1 percent increase in the benefit rate. Income elasticity is the percentage increase in medical spending in response to 1 percent increase in income.

4.3.4 Sensitivity Analysis

I check the sensitivity of the model with respect to two parameters: the relative labour supply in bad health $l(h_b)$, and the parameter for the elasticity

of substitution ν . Table 4.10 reports the changes to capital-output ratio and the share of medical expenditure in output under different parametrization. The second and third rows relate to the relative labour endowment in bad health status. This parameter is important in determining the size of health shocks to labour endowment, which affects the positive effect on aggregate saving. It shows in the second row that more severe health shocks to labour endowment result in lower capital-output ratios. This pattern is confirmed in the third row where less severe health shocks to labour endowment result in higher capital-output ratios. The share of medical expenditure in output is higher in the case of more severe health shocks, and lower in the case of less severe health shocks.

I check for the sensitivity of the model to the elasticity of substitution, which is important for individuals' saving and medical consumption decision. As the value of elasticity of substitution increases, the marginal utility of consumption depends less on health status. Also, it increases the utility difference between good and bad health, holding consumption constant. Rows 4-6 of Table 5.4 show that increasing the elasticity of substitution decreases the capital-output ratios. There is no noticeable difference in terms of medical consumption.

I also conduct a sensitivity check relating to the alternative utility function by Hall and Jones (2007), which considers health status and consumption to be separable and additive. Comparing to the baseline flow utility

function, their specification assumes that the marginal utility of consumption is independent of health status. The function form I use is

$$u(c_t, h_t) = \xi + \frac{c_t^{1-\sigma_c}}{1-\sigma_c} + \frac{h_t^{1-\sigma_h}}{1-\sigma_h}, \quad (4.21)$$

where ξ represents the value of being alive a life-year. I target the public share of health spending by fixing the value of ξ to 7. σ_c and σ_h are the inverse of the elasticity of intertemporal substitution. I set them equal to 2, which is within a reasonable range suggested by the literature. The calibration targets (capital-output ratio, public share of medical spending, and mortality in Low Benefit) are the same. Table 4.10 shows in the bottom row the results from the model with the alternative utility function. The capital-output ratio declines by 5.5 percent, which is equal to 1 percentage point decline in household saving rate. While the decline in capital-output ratio is larger than the baseline, the change in the share of medical expenditure in output is the same as the baseline.

The results based on the alternative parametrization and utility function suggest that the model is robust. The deviation in the decline in capital-output ratio is in the range of 0.3 to 2.8 percentage points. And the increase in the share of medical spending in output is almost identical.

Table 4.10: Sensitivity analysis

	Low K/Y	Middle K/Y	% Change from Low to Middle	Low M/Y	Middle M/Y
Baseline	3.56	3.47	-2.7%	0.04	0.07
$l(h_b) = 0.5$	3.54	3.46	-2.4%	0.07	0.09
$l(h_b) = 0.9$	3.58	3.53	-1.2%	0.04	0.04
$\nu = 0.3$	3.67	3.54	-3.7%	0.04	0.07
$\nu = 0.7$	3.51	3.44	-1.9%	0.04	0.07
$\nu = 1$	3.46	3.41	-1.3%	0.04	0.07
Separable	3.56	3.37	-5.5%	0.04	0.07

Notes: In the baseline, I set the parameter for the relative labour endowment when in bad health at 0.75, and the parameter for the elasticity of intertemporal substitution at 0.5. Separable represents the model with a separable, additive utility function in Equation (4.21).

4.4 Conclusions

This chapter examines the effect of expanding public health insurance on aggregate savings. Based on empirical observations in South Korea, I measure the contribution of the recent expansion in public health insurance benefits to the decline in household saving rate. I build a life-cycle model with endogenous health. My estimates show that the contribution explains about 0.5 percentage points of the total decline of 13 percentage points in the household saving rate. This finding suggests a small crowding-out effect on private savings, despite the large reduction in medical expenditure uncertainty.

To explain the small crowding-out effect, the model I consider captures the positive effect of reducing health risks on individual savings. Because the recent health insurance reform has improved the access to health care,

the policy change has reduced the risk of opting-out of medical consumption especially for the poor. As a result, the introduction of publicly provided health reduces not only the precautionary saving motive, but also health-related shocks to labour endowment. The policy change is also a redistributive mechanism that pools not only medical expenditure risks but also health risks. The rich and the working-age adults help the poor and the old to improve their health by not opting-out of medical consumption.

Chapter 5

Public Provision of Health Insurance and Welfare

5.1 Introduction

Rapidly ageing populations have been observed not only in developed countries but also in a number of emerging economies. In the face of high old-age dependency, one of the recommendations for emerging economies is to provide affordable health care through public health insurance (United Nations, 2012). Through health insurance, the elderly and poor would have better access to health care, which improves their welfare. However, the current demographic transition itself implies a rising demand for health care, which is already a threat to financing the existing public health insurance systems in these emerging economies. A further expansion of public health insurance would necessitate tax increases, holding constant spending in other government programs. This trade-off between health improvements and higher taxes makes it unclear as to whether more generous public health insurance benefits will yield positive net benefits. To give a quantitative answer, this chapter examines an expansion in public health insurance in an economy with a high old-age dependency.

Since the 1990s, South Korea has been experiencing rapid growth in total medical expenditure and rising old-age dependency. Figure 5.1 shows

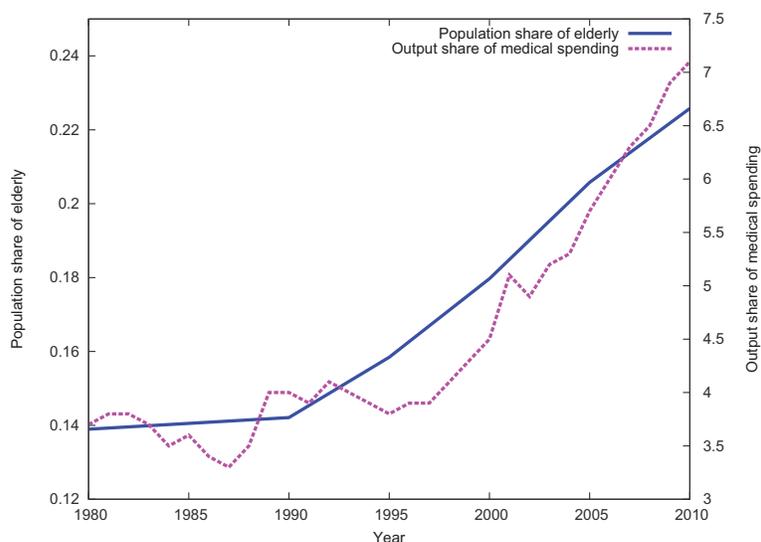


Figure 5.1: Share of elderly in South Korea between 1970 and 2010

Notes: The share of elderly is computed as the number of 60 and older divided by the number of 25 and older.

Source: Korean Statistical Information Service (2013).

that the share of elderly (60 years old and older) in the total adult (25 years and older) population increased from 14 percent in 1990 to 23 percent in 2010. This pace of population ageing makes South Korea the fastest ageing country in the OECD. Moreover, the United Nations (2012) projects that this share will increase to 40 percent by 2050. This rise in old-age dependency has coincided with growth in long-term care expenditures. For example, Lee (2011) reports that the share of long-term care in total health care expenditures increased from 24 percent to 34 percent in 2010. This trend coincides with growth in the prevalence of age-related chronic illnesses such as high blood pressure, diabetes, dementia, cataract, and arthritis.

South Korea is an interesting case study because of its unique combination of universal health insurance with low benefits (high co-pay rates) and partial coverage of health care services, which often result in high out-of-pocket medical expenditures. Several studies find that South Koreans are vulnerable to medical bankruptcy (Ruger and Kim, 2007; Son et al., 2010), or tend to opt out of necessary medical treatments (Kim, 2008), and consequently face high health risks (Kim et al., 2014). It is thus not surprising that reducing medical expenditure shocks and improving access to health care have received widespread political support in South Korea. For instance, the current conservative government has introduced a policy that would increase the current public health insurance benefit rate from about 65 percent to 80 percent by 2016.¹ However, reaching the target benefit rate by 2016 is questionable given that the same target of 80 percent was set in 2002 but to be revised in 2006 to 72 percent by 2017. In fact, benefit rates have hovered around 53 percent between 2005 and 2012, reflecting a prolonged unwillingness to expand benefits. Further postponement of the current target of 80 percent is likely to result in health care reform occurring within a context of high old-age dependency.

To understand the macroeconomic impact of the proposed policy, I build a general-equilibrium, overlapping generations (OLG) model with incomplete health insurance markets. In the model, there is a universal public health insurance, but it only covers a certain fraction of medical costs.

¹In 2013, the government proposed a policy change that would reduce catastrophic health expenditure borne out of four major illnesses (cancer, heart disease, stroke, orphan diseases). This proposal also includes coverage for associated imaging services (CT scan, MRI, PET scan), chemotherapy, and other related services, which are not currently covered.

Individuals in the model faces idiosyncratic health risks that affect the individuals to be in good or bad health status. There is no aggregate uncertainty from health risks (e.g. epidemics). If they are in good (bad) health, they can buy preventative (curative) medical services by committing to pay for the co-payment, or opt out of medical consumption. This decision is akin to investment in health to the extent that medical consumption mitigates future idiosyncratic health shocks. While opting-out of medical consumption provides the individual with more resources available for non-health spending, they also face worse health shocks in the future. I estimate the dependency of health status on access to and use of past medical treatment using the Korean Welfare Panel Study (KOWEPS). This survey asks specifically whether the household had recently opted out of medical consumption due to financial reasons. I estimate that the likelihood of good health falls by 10 percent on average for those who have opted out relative to those who did not. This finding suggests that opting-out of medical consumption has a direct negative effect on welfare in terms of health status.

To understand the effect of increasing the benefit rate on intergenerational welfare, I conduct a transition path analysis. This methodology, instead of simply comparing the steady states, tracks the policy impact on the economy until it reaches a new steady state. Because the policy impact tends to be large at the onset of transition and subsides over time, simply comparing steady states misses the large impact on welfare immediately after the policy impact. The policy impact here is caused by an increase

in the public health insurance benefit rate, which would increase the tax rate and medical consumption. Because of these simultaneous movements in tax rate and medical consumption, the short-run impact on average welfare is ambiguous.

Moreover, to justify implementing such a policy, one has to examine not only the impact on the average welfare in each post-policy period but also the impact on the lifetime welfare of those individuals who experience the policy change in their lifetime. The baseline estimates show that at the onset of policy change the retired and older working-age generations would experience welfare gains, whereas younger working-age generations would experience welfare losses. However, these welfare measurements are sensitive to the degree of old-age dependency and the choice of flow utility function. Therefore, I expand my analysis using various old-age dependencies and an alternative utility function.

The chapter is organized as follows. Section 5.2 discusses the literature on the effects of providing health insurance on individuals' health outcome and welfare. In Section 5.3, I present the model in steady state and on transition path, and show the parametrization. In Section 5.4, I present the baseline results, and the results after several modifications to the model. Section 5.5 concludes. In Appendix A.1 and A.2, I describe the computational algorithm used in this chapter.

5.2 Related Literature on Health Insurance and Welfare

There is a large empirical literature on the impact of increasing health insurance on health care utilization and health outcomes. McWilliams (2009) provides an extensive survey of the literature in the context of the United States, which finds that having greater health insurance benefits leads to greater health care utilization. These medical services include various preventative and diagnostic services such as blood pressure checks, flu vaccination, and mammography. A large study by the Institute of Medicine (2004) finds that uninsurance in the United States leads to greater morbidity and mortality from various chronic illnesses such as cardiovascular disease and diabetes. Similarly in South Korea, Kim et al. (2014) find that patients from low socio-economic backgrounds suffer from higher in-hospital mortality even after controlling for their health status. They interpret this as an outcome of poor patients opting-out of expensive, yet life-saving medical services. These findings in the empirical literature suggest that uninsured (or underinsured) individuals often opt out of medical consumption by financial considerations and become prone to greater morbidity and mortality shocks.

There is no consensus on how to measure the welfare improvement in health. I approach this with several tools available in the macroeconomics/health literature. First, I compare the consumption equivalence of average welfare between the pre- and post-policy steady states. This particular method measure the amount of foregone (excessive) consumption

necessary to compensate for the welfare loss (gain) due to policy change. Second, I explore at least two flow utility functions that describe the relation between health and consumption. Several papers consider the relation to be complementary (Finkelstein et al., 2013; Murphy and Topel, 2005; De Nardi, French, and Jones, 2010), whereas some others consider it to be separable and additive (Hall and Jones, 2007; Kashiwase, 2009; Ozkan, 2011). And there are many papers taking an agnostic view that do not include health status in their utility function (Jeske and Kitao, 2009; Hsu and Lee, 2012; Hsu, 2013). However, health status and health risks are inherently connected to welfare and omitting health status from the utility function is undesirable for welfare analysis. Finally, the measurement of health status in flow utility function is borrowed from the medical literature that provides a quality-of-life weights based on self-reported health status (Nyman et al., 2007).²

There are four factors in the mechanisms of my model through which the policy change influence welfare.

1. Insurance effect: Increasing the benefit rate reduces the co-pay rate for all individuals. This increases their non-medical expenditures, thus improving their welfare.
2. General-equilibrium effect: The policy change reduces individuals' precautionary savings and hence aggregate capital. The decline in aggregate capital increases the rate of return to capital and decreases

²Similarly, (Kashiwase, 2009) employs the quality of life weights in his model.

the wage rate. While the rising rate of return to capital improves the welfare of the asset-rich retired generations, the falling wage rate reduces the welfare of the working-age. The effect on average welfare is ambiguous.

3. Tax effect: The policy change could lead to a rise in tax rate to finance outlays for expended public health insurance. An increase in the tax rate reduces the disposable income and thus the welfare of working-age.³
4. Health effect: The policy change improves the health of individuals who would have otherwise opted out of medical consumption. By inducing medical consumption, the policy helps individuals improve their health status, which is a direct improvement in welfare.

The baseline result shows that in a high old-age dependency the negative tax effect dominates the positive effects of the first and fourth factors. However, this finding is sensitive to demographic structures. In particular, if the policy change were to take place under the current old-age dependency, it would increase average welfare. Increasing the benefit rate in the current demographic structure reduces the negative tax effect due to the relatively large tax base compared to a higher old-age dependency in the future.

Several papers in the macroeconomics/health literature find that in the

³Theoretically, the policy change may expand the tax base by improving the health of working-age and thus their ability to supply labour. This is especially relevant in the context of developing countries, which suffer from infectious diseases.

current U.S. context the effect of expanding public health insurance benefits on welfare is positive (Jeske and Kitao, 2009; Hsu and Lee, 2012; Kopecky and Koreshkova, 2013; Pashchenko and Porapakkarm, 2013). Although these papers consider different policy changes, but they all find that the positive health insurance effect (first factor) outweighs the negative tax effect (third factor). In contrast, Attanasio, Kitao, and Violante (2009) find that in an economy with high old-age dependency the positive health insurance effect falls short of the negative tax effect on welfare. However, none of these papers considers the positive effect on health of the policy by omitting health status from their utility function. Moreover, in all these papers health shocks are equivalent to exogenous medical expenditure shocks, and are independent of past (preventative) medical consumption. By contrast, the analysis pursued here includes health in the utility function and endogenous medical consumption.

The well-established link between health insurance and health outcomes is likely to be significant in the context of South Korea.⁴ Specifically, in South Korea public health insurance benefits are still below the OECD average: the benefit rate defined by the share of public expenditure in total health expenditure was 64 percent in 2010, whereas the OECD average in 2010 was 80 percent. This suggests that there are still relatively high returns on health from further expanding public health insurance in South Korea.

⁴For those studies that report the impact of opting-out of diagnostic and preventative care on health in the United States, see Institute of Medicine (2002, 2004); Baker, Sudano, Albert, Borawski, and Dor (2001); Baker, Sudano, Durazo-Arvizu, Feinglass, Witt, and Thompson (2006); Schoen et al. (2008).

There are also several papers that allow for endogenous medical consumption and health outcomes under a general-equilibrium, overlapping generations framework (Jung and Tran, 2009; Prados, 2012; Zhao, 2014). The common aspect of these papers and mine is that health shocks are not equivalently exogenous medical expenditure shocks. Instead, individuals may choose to consume medical services, which then affect their health outcomes. However, there are several methodological differences between these papers and mine. First, I directly estimate the model's health transition process from the data, whereas Jung and Tran (2009) pin down the health shock process by targeting aggregate health expenditures, and Zhao (2014) pins it down by targeting the survival probabilities. Although Prados (2012) directly estimates the distribution of health shocks from the Medical Expenditure Panel Survey in the United States, her paper focuses on the effect of curative medical services and omits the effect of preventative care on health outcomes. In addition, the key contextual difference is that these papers consider policy changes in the United States⁵, whereas my analysis is in the context of an emerging economy with a high old-age dependency.

5.3 The Life-cycle Model

To quantify the effect of medical consumption on welfare, I build a life-cycle model with endogenous health outcomes. Individuals enter the model as

⁵Prados (2012) studies the earnings inequality arising from health shocks, whereas Zhao (2014) examines the contribution of social security to the rise of health spending. Jung and Tran (2009) offer a transition path analysis on the impact of universal health voucher program on welfare.

working-age adults. They spend the first part of their life working, and the last part in retirement. Throughout their life, they face idiosyncratic health shocks, which affect their labour endowment when in working-age, and mortality when in retirement-age. By consuming medical services, individuals can prevent some of the bad health shocks in the future.

I consider a concrete and current policy proposal in South Korea, which intends to increase the benefit rate from 64 percent to 80 percent. The policy change would result in an increase in medical consumption, which in turn produces two conflicting effects on average welfare. First, an increase in medical consumption increases welfare by improving health outcomes. Second, an increase in medical consumption increases outlays for public health insurance and the tax rate.⁶ I track the impact of the policy change on welfare over time until the economy reaches a new steady state.

5.3.1 The Economic Environment

Demographics: Time is discrete and denoted by $t = 0, 1, \dots, \infty$. Each period corresponds to 5 calendar years. An agent's age consists of maximum 12 periods with each period denoted by $s = 1, \dots, 12$. Individuals work during the first seven periods, and then retire for the remaining five periods. In each period, a new generation of individuals ($s = 1$) enter the economy with zero asset holdings, and the oldest generation ($s = 12$) exits

⁶The tax rate could decrease if the health gains to working-age population is substantially high. Then the policy change may increase labour supply and broaden the tax base.

the economy after exhausting all their wealth. The share of each generation is denoted by $\mu(s)$ with $\sum_{s=1}^{12} \mu(s) = 1$. The size of each cohort is equal to the population share of the cohort, so that the population mass is 1.

Preferences: Preferences are defined over the consumption of a composite non-medical good c and health status h . Health status can be “good” h_g or “bad” h_b . Bad health corresponds to utility loss due to morbidity: thus utility from good health is higher than that from bad health, holding age constant. In particular, individual preferences are represented by a constant elasticity of substitution (CES) utility function of the following form

$$u(c_t, h_t) = u(c, h) = \left[(1 - \lambda)^{1/\nu} c^{\frac{\nu-1}{\nu}} + \lambda^{1/\nu} h^{\frac{\nu-1}{\nu}} \right]^{\frac{\nu}{\nu-1}}, \quad (5.1)$$

where $0 < \lambda < 1$ is the weight of health status in utility; ν is the elasticity of substitution between c and h . I consider health status and consumption to be gross complements ($0 < \nu < 1$). The complementarity between health and consumption is also used by Finkelstein et al. (2013) who find empirical evidence supporting the assumption that marginal utility increases in health.

However, the complementarity between consumption and health status is not the only specification used in the literature. For instance, Hall and Jones (2007) argue that that the marginal utility of consumption can theoretically increase with deteriorating health.⁷ They instead take an

⁷They use the example of having a ready-made meal and nursing care services for those in bad health.

agnostic stance that health and consumption are separable and additive. Such a specification is adopted by Kashiwase (2009) and Ozkan (2011). Because the choice of utility function matters for welfare analysis, I also consider a separable, additive utility function

$$u(c_t, h_t) = \frac{c_t^{1-\sigma_c}}{1-\sigma_c} + \frac{h_t^{1-\sigma_h}}{1-\sigma_h}, \quad (5.2)$$

where σ_c and σ_h describe the curvature of utility function with respect to consumption and health, respectively. Note that the separable and additive utility function ((5.2)) implies that the marginal utility of consumption is independent of health status.

Health and mortality: There are two shocks in the model: health and mortality. Health status h follows a 2-state Markov process, which is defined by either good (h_g) or bad (h_b) health. Future health status is a function of the individual's age, current health status, and current medical consumption, which is assumed to be binary. An individual can either choose medical consumption or opt out of medical consumption. I think of medical consumption broadly including preventative care, and as a result individuals both in good or bad health status can purchase medical consumption. The concrete implication of medical consumption today is that it reduces the likelihood of bad health shocks in the future.

The health and mortality shocks follow the same processes as in Chapter 4, which provides the mathematical presentation of the health transition matrix in Equations (4.2) and (4.3). The transition probability is less

favourable for those who opt out of medical consumption. The mortality shock process $\chi(s, h)$ applies to the retired generations who are in bad health status. The probability of dying increases with age and it equals to 1 if $s = 12$. The asset holdings of the deceased are treated as accidental bequests, equally distributed to the rest of the population. In Chapter 4 each period represents one year. In this chapter, I adjust the shock processes to 5 calendar years per period.

Firms: There are two perfectly competitive sectors, medical (m) and non-medical (n) sectors with a Cobb-Douglas production function

$$Y_t^i = Z^i L_t^{i1-\alpha} K_t^{i\alpha}, \quad i = \{m, n\}, \quad (5.3)$$

where K_t^i represents the capital stock in sector i and period t , L_t^i is labour, and Z^i is the total factor productivity in sector i . The elasticity of output with respect to capital α is the same across sectors.

Firms rent labour and capital from households. Factor markets are competitive, hence factors are compensated at their marginal product. The price of non-medical commodity is normalized to one, P^m the relative price of medical services, which is the ratio of the TFPs between medical and non-medical sectors.⁸

Health insurance: All individuals have access to a publicly provided health insurance, fully-funded by a payroll tax. The health insurance program is fully specified by η the benefit rate. Agents consuming medical

⁸Please refer to Section 4.2.

services pay $1 - \eta$ – the co-pay rate of medical services. The health insurance program is managed under a balanced budget rule and therefore there exists a unique equilibrium payroll tax τ_m that covers the outlays

$$\tau_m = \frac{\eta_t P^m M_t}{w_t L_t}, \quad (5.4)$$

where M is the aggregate medical demand, and L is the aggregate labour supply.

Aggregate resource constraints: The sum of the resources used in both sectors make up the aggregate capital K_t and the labour supply L_t . The aggregate resource constraints are

$$K_t^n + K_t^m = K_t,$$

$$L_t^n + L_t^m = L_t.$$

Medical services can only be consumed and non-medical output can be either consumed or invested

$$P^m M_t = Y_t^m,$$

$$K_{t+1} = Y_t^n - N_t + (1 - \delta)K_t,$$

where N_t represents the aggregate consumption of non-medical goods.

5.3.2 Individual's Problem

Individuals maximize their lifetime utility

$$\max \mathbb{E}_t \left[\sum_{s=1}^{12} \beta^{t+s-1} (1 - \chi(s, h)) u(c_{t+s}, h_{t+s}) \right],$$

where β is the time discount factor, \mathbb{E}_t is the expectation operator, and $(1 - \chi(s, h))$ is the probability of survival. Individuals draw utility from health status h and consumption of non-medical goods c .

The state space for individuals contains three dimensions: age, asset, and health status ($x = \{s, k, h\}$). Individuals' choice variables are consumption c , savings k' and medical consumption \mathbb{I}_m . The recursive formulation of the individual's problem is

$$V(x) = \max_{c, \mathbb{I}_m, k'} u(c, h) + \beta (1 - \chi(s, h)) \mathbb{E}[V(x')] \quad (5.5)$$

subject to

$$k' = (1 + r)k + (1 - \tau_m)l(h)\mathbb{I}_w(s)e(s)w + b - c - \omega, \quad (5.6)$$

$$\omega = (1 - \eta)P^m \mathbb{I}_m \pi(s, h),$$

$$k \geq 0,$$

where $\mathbb{I}_w(s)$ is the indicator function, which takes the value of one if the individual is of working age, and zero if individual is retired; $e(s)$ is an age-specific efficiency parameter, which captures, in part, returns to experience; $l(h)$ is a shift parameter that governs the labour endowment in bad health

relative to good health; ω represents the medical out-of-pocket spending. When the individual opts out of medical services, the indicator function takes the value of zero $\mathbb{I}_m = 0$, otherwise one. $\pi(s, h)$ represents the cost of medical consumption, which varies by age and health status. The cost increases with age ($\pi(s', h) > \pi(s, h)$ for $s' > s$). Also the cost is higher in bad health status ($\pi(s, h = h_b) > \pi(s, h = h_g)$). As in Chapter 4, I assume that individuals in the model cannot borrow.

5.3.3 Steady State Equilibrium

DEFINITION: Let $X = \{1, \dots, 12\} \times \mathbb{R}_+ \times \{h_g, h_b\}$. A recursive equilibrium is a probability distribution Γ of households over X , a value function $V : X \rightarrow \mathbb{R}$, a policy function $g : X \rightarrow \{0, 1\} \times \mathbb{R}_+$, a tax rate τ_m and, an amount of accidental bequests b such that:

1. The value and policy functions solve the individual optimization problem (5.5)
2. The labour and capital markets clear

$$K = \int_X k \, d\Gamma, \quad (5.7)$$

$$L = \int_X l \, d\Gamma; \quad (5.8)$$

3. The outlays for public health insurance are equal to the revenues raised by the payroll tax

$$\tau_m \omega L = \eta P^m M; \quad (5.9)$$

4. The goods market clears

$$Y = C + K' + P^m M - (1 - \delta)K, \quad (5.10)$$

where

$$C = \int_X g_c d\Gamma, \quad (5.11)$$

$$K' = \int_X g_k d\Gamma, \quad (5.12)$$

$$M = \int_X P^m g_m m d\Gamma; \quad (5.13)$$

5. Γ is the probability density function over X of a randomly drawn individual from the living population

5.3.4 Transition Path

My interest is to model the transition path of a policy change that increases public health insurance benefits. In response to the policy change, individuals revise their saving and medical consumption over time. Such revisions take place until the economy reaches a new steady state. For this purpose, I use the time path iteration (TPI) algorithm by Nishiyama and Smetters (2007) who also compute the transition path in a stochastic general-equilibrium OLG framework. The TPI method assumes that all individuals share a common belief in the future population distribution over the state space Γ . This gives all individuals the same projected path of factor prices and tax rates, which are used in their dynamic optimization.

In the following, I describe the equilibrium outcomes along the transition path. The solution algorithm for transition path is in Appendix A.2.

The equilibrium along the transition path is defined similarly to the steady-state equilibrium. In each period, a generation of individuals enters the economy, and the oldest generation fully exits the economy. The population size is 1, which is the sum of each generation's population share. Individuals' preferences are described by the CES utility function (Equation (5.1)) – the baseline. There are two sectors: the non-medical sector n and medical sector m . They operate under the Cobb-Douglas production (Equation (5.3)). The health shock process and mortality risks are conditional on medical consumption. The publicly-provided health insurance system covers a fraction of medical expenditure η , which is financed by the payroll tax rate τ_m . The only difference arises from the fact that the macroeconomic variables $\{K, L, M, r, w, \tau_m, b\}$ are changing over time along the transition path. Suppose the convergence to a new steady-state after a perturbation takes $T < \infty$ periods. In the steady state, there is a single set of macroeconomic variables, whereas there are T sets of macroeconomic variables along the transition path.

Individuals at time t share a common belief in the future distribution of population in terms of age, health status, and asset holdings Γ

$$\Gamma_{t+i}^e = \Omega^i(\Gamma_t) \quad \forall t \quad i \geq 1,$$

where the shared belief Ω^i gives all individuals with the same expected

distribution Γ_{t+i}^e in i periods. With knowledge of $\Gamma_{t=1,\dots,T}^e$, one can calculate the corresponding set of factor prices and tax rates over the transition path. Using this information, individuals compute their policy rule $k' = g(s, k, h|\Omega)$, which yields the optimal intertemporal consumption/saving decision. Given that convergence to the new steady state occurs within T periods, the shared-belief Ω^i allows the economy to move along a unique transition path.

The solution to an individual's problem on a transition path is also similar to that in steady state. To solve the optimal saving and medical consumption decision, I use the backward induction methods for each birth cohort. The solution on transition path involves T sets of factor prices and tax rates, whereas the steady-state solution involves only one set of factor prices and tax rate. In the recursive form, an individual's problem on the transition path is

$$V(x)_t = \max_{c_t, \mathbb{I}_{m,t}, k_t} u(c, h)_t + \beta (1 - \chi(s, h)) \mathbb{E}[V(x)_{t+1}] \text{ for } s < S \quad (5.14)$$

subject to

$$k_{t+1} = (1 + r_t(\Gamma_t))k_t + (1 - \tau_{m,t}(\Gamma_t))l(h)\mathbb{I}_w(s)e(s)w_t(\Gamma_t) + b_t(\Gamma_t) - c_t - \omega_t, \quad (5.15)$$

$$\omega_t = (1 - \eta_t)P^m \mathbb{I}_m \pi(s, h),$$

$$k_t^1 = 0,$$

$$k_t \geq 0,$$

Table 5.1: Parameters

Parameter	Description	Values	Source
α	Share of capital	0.3	Young (1995)
β	Discount factor	$0.9 = 0.98^5$	Baseline
d	Mortality hazard rate	0.002	Baseline
δ	Depreciation rate	$0.23 = 1 - (1 - 0.05)^5$	Pyo et al. (2006)
P^m	Relative price of medical care	1.103	Pyo et al. (2006)
$\pi(s, h)$	Cost of medical expenditure	See text	KOWEPS (2006-2010)
p_{gg} and p_{gb}	Health transition probability	See Chapter 3	KOWEPS (2006,2007)
q_{gg} and q_{gb}	Health transition probability	See Chapter 3	KOWEPS (2006,2007)
ν	Elasticity of substitution	0.5	Baseline
λ	Health weight in utility	0.6	Baseline
$l(h = h_g)$	Labour supply in good health	1	Baseline
$l(h = h_b)$	Labour supply in bad health	0.75	Baseline

Sources: Korean Statistical Information Service (KOSIS, 2013), Korea Welfare Panel Study (KOWEPS).
Notes: The relative price of medical care is the ratio of labour productivity in health sector and economy-wide.

where the factor prices, accidental bequest, tax rate depend on the distribution of population in the state space Γ .

5.3.5 Parametrization

To solve the model numerically, I calibrate the model to the Korean economy. Table 5.1 summarizes the parameters used in the model, and what follows discusses the parametrization in detail.

Demographics: Each period in the model corresponds to five calendar years. The birth age in the model $s = 1$ corresponds to biological ages between 25 and 29. The retirement age in the model $s = 8$ corresponds to biological ages between 60 and 64. The terminal age $s = 12$ corresponds to ages between 80 and 84.

The share of the retired generations in total population in the baseline is 36 percent. This reflects a high old-age dependency in South Korea around

2030. This population projection is based on the United Nations World Population Prospects data (2010) using current fertility rates. To attain this high old-age dependency, I set the population growth rate to 0.67 percent, which is the average population growth rate between 1991 and 2010, a period in which the old-age dependency ratio increased sharply. The baseline model assumes a considerable delay in implementing the policy change as observed since 2001.

I also consider three other demographic structures: the first one is equivalent of the 2010 level with the population share of elderly at 23 percent. The second demographic structure is slightly older than the 2010 level with the population share of elderly at 26 percent, the level South Korea is expected to reach between 2015 and 2020. And the third demographic structure is older than the baseline with the population share of elderly at 38 percent, the level South Korea is expected to reach between 2030 and 2035. I consider the first two alternative demographic structures as ‘contemporary’, whereas the baseline and third demographic structures as ‘distant’.

Preferences: In the baseline, I set the time discount factor β to 0.9. This is equivalent of 5-year discount factor at annual rate of 0.98.

In the baseline utility function Equation (5.1), there are two parameters to be calibrated. I target the share of medical spending in total output at 0.07, which corresponds to the 2010 level in the national accounts. To achieve the target, I set the weight of health in utility λ at 0.6. In the baseline I set the elasticity of substitution ν to be 0.5, which means that health

status and consumption are gross complements. To check the model's sensitivity, I examine alternative values to these parameters in Section 5.4.5.

I use the following additive, separable utility function

$$u(c_t, h_t) = \xi + \frac{c_t^{1-\sigma_c}}{1-\sigma_c} + \frac{h_t^{1-\sigma_h}}{1-\sigma_h}, \quad (5.16)$$

where ξ represents the value of a life-year lived. I target the share of medical spending in output at 0.07 by setting the value of the life-year parameter ξ to 9. I set the risk aversion coefficients for consumption σ_c and health status σ_h equal to 2. However, these values do not have to be identical. Hall and Jones (2007) sets σ_h equals to 1.05⁹, while σ_c is set at 2. This allows a non-homothetic preference for health, which explains the rise in total health spending in their paper. Kashiwase (2009) pins the share of uninsured in total population by fixing the values of σ_c and σ_h to be 3.7.

The value of health status is taken from the quality-of-life weights in Nyman et al. (2007). They use time trade-off methods, which ask survey respondents ‘how many of 10 years of life in the current health status would you trade to live in full health?’ Respondents to this question are then mapped to the respondent’s self-reported health status to calculate the quality-of-life (QOL) weights in a scale from 0 to 1. I use the average of the QOL weights for ‘excellent’ and ‘very good’, and ‘good’ as good health status in the model. And I use the average of the QOL weights for ‘fair’

⁹Hall and Jones (2007) identifies the values of the life-year parameter, the utility weight for health, and the curvature parameter for health by comparing the flow utility of an individual with a particular illness to an individual with perfect health.

and ‘poor’ as bad health status in the model.

Mortality shock: The mortality shock process $\chi(s, h)$ follows an exponential form

$$\chi(s \geq 8, h = h_b) = e^{sd} - 1, \quad (5.17)$$

where I target the share of the most elderly group (80-84 years old) at 7.5 percent by setting the mortality hazard rate d at 0.002. The mortality shock applies to the elderly in bad health only.

Health transition: I estimate the health transition matrix using the first two waves of the KOWEPS (2006-07). The health transition depends on age, past health status, and past opting-out of medical consumption. The KOWEPS includes questionnaires on economic hardship including: “insufficient medical fund”, “skipped meals”, “no heating in winter”. I use the variable on insufficient medical funds to control for opting-out of medical consumption, which are less likely to be discretionary.

I build a logistical regression model to estimate the health transition

$$\ln \left(\frac{P_{g,t}^i}{1 - P_{g,t}^i} \right) = \alpha + \beta_1 s_t^i + \beta_2 (s^2)_t^i + \beta_3 P_{g,t-1}^i + \gamma m_{0,t-1}^i, \quad (5.18)$$

where the dependent variable is the odds of having the good health status. The independent variables are age s , health status in the previous period $P_{g,t-1}^i$, and opting-out of medical consumption in the previous period $m_{0,t-1}^i$. The odds of having the good health status decreases with age. Health status is persistent over time. The negative effect of opting-out of medical consumption is substantial and widens as the individual ages. I

provide a further detail on the estimation in Chapter 3.

Relative labour supply when in bad health: In the baseline model, I calibrate the impact of bad health on labour endowment such that individuals in bad health status lose a quarter of their labour endowment (i.e. $h(h = h_g) = 1, l(h = h_b) = 0.75$). The literature on health and earnings outcomes (Strauss and Thomas, 1998; Currie and Madrian, 1999) suggests that this parameter value varies by types of illness, gender, and race. For example, in terms of wage, Mitchell and Burkhauser (1990) find that having an arthritis reduces wages by 28 percent for men and 42 percent for women, and Berkovec and Stern (1991) find that having a poor health reduces wage by 17 percent. In terms of labour supply, Mitchell and Burkhauser (1990) find that having an arthritis reduces work hours by 42 percent for men and 37 percent for women. And Chirikos and Nestel (1985) find that having a poor health decreases work hours by 13 percent for white men, 21 percent for black men, 6 percent for white women, and 27 percent for black women. Because of this wide range of variability, I conduct a sensitivity analysis on alternative parameter values for loss of labour endowment due to a bad health shock.

Labour efficiency over the life-cycle: I estimate the labour efficiency parameter $e(s)$ using the following empirical specification

$$e(s) = \ln \text{wage}_t^i = \varrho_1 s_t^i + \varrho_2 s_t^{2i} + \varrho_3 s_t^{3i}, \quad (5.19)$$

where $\ln \text{wage}_t^i$ is the log of wage income of the head of household, and

s_t^i the age of the head of household. Figure 5.2 shows that the estimated life-cycle labour efficiency follows a hump-shape pattern over working-age.

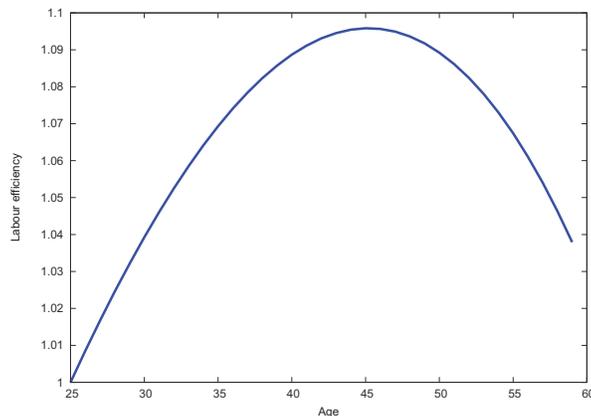


Figure 5.2: Labour efficiency over the life-cycle

Source: Estimation of Equation (5.19) using data from the Korean Welfare Panel Study (wave 1 (2006) – wave 5 (2010)).

Cost of medical consumption: I estimate the cost of medical consumption parameter $\pi(s, h)$ according to

$$\pi(s, h) = q_t^i = \rho_1 s_t^i + \rho_2 h_{gt}^i, \quad (5.20)$$

where q_t^i is the medical expenditure of a household i normalized by the average income at time t , s_t^i is the age of the head of household, h_{gt}^i is the dummy variable whether the household head is in good health status or in bad health status. Table 5.2 shows that the cost of medical expenditure increases with age and decreases with good health status.

Production parameters: In the production function, I set the capital income share α at 0.3 as in Young (1995). I set the capital depreciation rate δ at 0.23. This is equivalent to a 5-year depreciation rate at an annual rate of 0.05. The relative price of medical services P^m is estimated to be

Table 5.2: Estimation of the cost of medical expenditure over the life-cycle

Variable	Coefficient
Age	0.0017*** (0.000)
Good health	-0.072*** (0.010)

Notes: I use the Korea Welfare Panel Study (2006, 2008-2010). The 2007 wave does not include a questionnaire on the expenditure information specific to medical services. The sample size is 7430, which includes those who are of age between 25 and 84, and without disability.

*** Statistically significant at the 1% level.

1.103 based on sector-specific productivity in Pyo et al. (2006).

5.4 Quantitative Analysis

In this section, I report the results concerning the effect on welfare of increasing the health insurance benefit rate in South Korea. I first compare the lifetime asset accumulation and the health shock process between the model and the data. After evaluating the model's performance, I assess the effects on the macroeconomic variables of increasing the benefit rate from 64 percent (2010 level) to 80 percent. I first examine the steady states separately and then track the transition path between the steady states. In particular, I measure the effect of the policy change on welfare along the transition path. Lastly, I extend my analysis to using alternative demographic projections and employing an alternative utility function.

5.4.1 Baseline Results

There are two aspects of the model, which are important to my welfare analysis. I seek to match asset accumulation over life-cycle, which determines the level of non-medical consumption and medical consumption. Second, I compare the health outcomes in the model and the data. The calibrated model is able to replicate a hump-shape pattern of life-cycle asset accumulation in the data. Figure 5.3 compares the life-cycle asset accumulation as implied by the calibrated model with that in the data. There are two model profiles: one represents the initial steady-state, and the other the final steady-state. All profiles illustrate the average asset accumulation of each age group with respect to the maximum asset level during the lifetime. It shows that both in the model and data the maximum asset level occurs around the retirement age of 60. The model underestimates the asset accumulation in the early part of life-cycle, because the model abstracts from family transfers from the old to the young, for example, a downpayment for purchasing a house or automobiles.

There are two health outcomes possible in the model: good or bad health status. Figure ?? shows the likelihood of having good health at a given age both in the model and the data. As shown in Chapter 3, I adjust the health transition probability from the annual to the five-year period. The middle dotted line represents the average probability of having the good health status in the KOWEPS (2007) data. The top solid line represents the health transition probability from good health to good health conditional

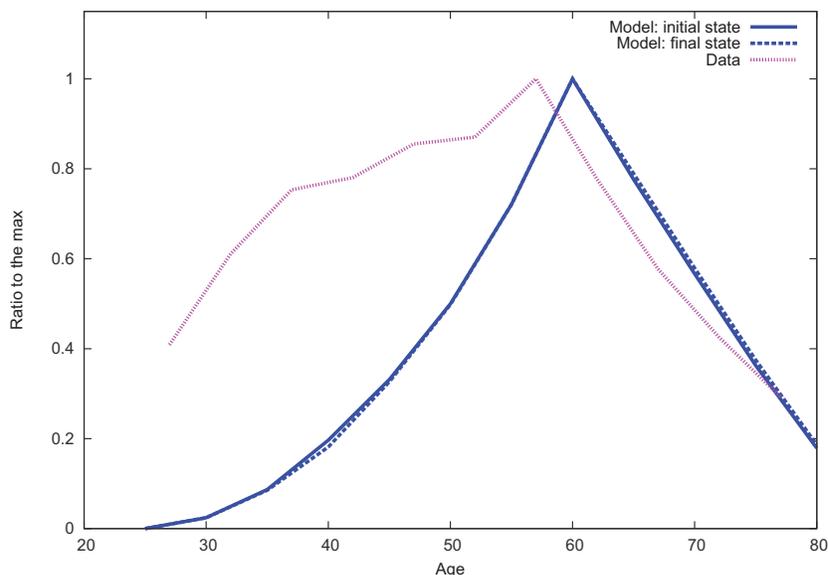


Figure 5.3: Average asset holding over lifetime: Model versus data

Source: The empirical estimates of average asset holdings over lifetime are formulated from the Korean Welfare Panel Study (wave 2 (2007) – wave 7 (2012)).

on having access to medical consumption (based on self-reported financial resources available to households). The bottom dotted line represents the transition probability from good health status to good health status conditional on having insufficient (opted out of) medical consumption due to a lack of financial resources.

Figure 5.4 shows that the fraction of population in good health declines over age both in the data and the model. However, the model underestimates the fraction of elderly in good health at the end of their life-cycle. This is largely driven by the fact that individuals of age group between 80 and 84 certainly die such that, at ages between 75 and 79, they completely disengage from preventative medicine. As a result, the model's health outcomes in the terminal period are underestimated.

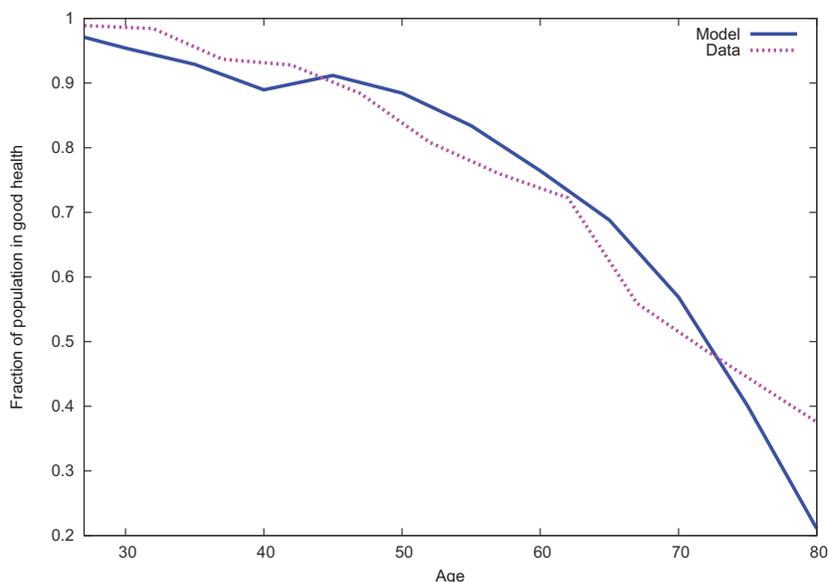


Figure 5.4: Fraction of population in good health over lifetime: Model versus data
Source: Korean Welfare Panel Study (wave 2 (2007)).

5.4.2 Welfare Analysis

Given that the model matches the main health related outcomes and wealth in the data, I now turn to examining the effect on welfare of expanding health insurance benefits. In the initial steady state, I set the benefit rate at 64 percent. Then I introduce a policy change that sets the benefit rate at 80 percent. Due to this policy change, the economy undergoes a transition to a new steady state. Before examining the transition path, I first compare the changes in macroeconomic variables from the initial steady state to the new steady state.

Table 5.3 shows the percentage change in macroeconomic variables from the initial steady state to the new steady state. In the new steady state, a higher benefit rate implies a proportionally lower co-pay rate $1 - \eta$, and thus smaller medical expenditure shocks. All individuals are now able to

Table 5.3: Macroeconomic impact of health insurance benefits, percentage change from the initial steady state to the new steady state

	% change
Output Y	-0.6
Capital K	-2.4
Labour L	+0.1
Medical spending M	+25.8
w	-0.7
r	+5.8
τ_m	+57.3
μ_{h_b}	-12.9
C.E.	+1.3%

Notes: w and r are the equilibrium wage and interest rate; τ_m is the equilibrium tax rate; μ_{h_b} represents the share of bad health in the population; C.E. is the consumption equivalence measure. The share of the elderly in the population is 36 percent.

allocate less towards precautionary savings against future health shocks, and instead increase their current consumption. As a result the aggregate capital stock decreases by 2.4 percent. This also implies that there is some positive impact for the young generations' welfare for not needing to sacrifice as much current consumption early in life as they did before the policy change.

Reducing the co-pay rate $(1 - \eta)$ increases the moral hazard effect on medical consumption, which increases the share of medical spending in output by 26 percent. Such an increase in medical consumption has two implications for welfare. First, in order to finance the increased outlays in public health insurance, the payroll tax rate needs to be increased by 57 percent. This has a negative effect on the welfare of the working-age generations. Second, a greater amount of medical consumption translates into health gains for those individuals who no longer opt out of medical

consumption. Table 5.3 shows that at a higher benefit rate the share of the population with bad health status μ_{hb} decreases by 13 percent.¹⁰ This is a direct improvement to utility for those individuals who would have opted-out of medical consumption before the policy change.

Given the positive welfare impact of improved health and the negative welfare impact of higher taxes, I assess the average welfare before and after the policy change. I measure consumption equivalence in the new steady state. Consumption equivalence captures the foregone utility (in terms of consumption) that an individual must be compensated for as a result of the policy change. It turns out that the positive effect on health outcomes fell short of the negative tax effect. Table 5.3 shows in the bottom row that individuals in the new steady state need to receive an additional 1.3 percent of consumption in order to be as well off as before the policy change. This result suggests that the policy change may not be economically justifiable as it decreases average welfare. But the steady state comparisons alone are not appropriate for this type of welfare analysis, because the difference in the impact of policy change creates winners and losers. Steady state comparisons also omit the short-run effect of the policy change on the welfare of those individuals who actually experience the policy change in their lifetime. In this vein, I consider the transition dynamics between the steady states, and especially focus on the early stages of the transition, where the most dramatic welfare changes take place.

¹⁰The population share of bad health decreases from 8.5 percent in the initial steady state to 7.4 percent in the new steady state.

Figure 5.5 shows the policy impact on the macroeconomic variables over time. Time is represented by the number of model periods. And the vertical axis represents the percentage change from the initial steady state value. Each row is in the same scale. Most variables converge to their new steady state level within 5 periods, which is equivalent to 25 calendar years. The exceptions are aggregate capital and rate of return to capital, which converge to the new steady state in about 11 periods (55 calendar years), almost a full life-cycle in calendar time. Such a slower convergence is expected because upon policy impact of an unanticipated policy change, each birth cohort born before revises the optimal saving behaviour for their remaining life.

Unlike aggregate capital, aggregate medical spending increases sharply after the policy change. The reason is that at a benefit rate of 64 percent there exist poor individuals who have opted out of medical consumption. Increasing the benefit rate increases their demand for medical consumption. The increase in medical spending also entails a mild increase in aggregate labour by 0.1 percent. The magnitude of increase in aggregate labour due to preventative medical consumption is mild in the baseline and could be made larger by specifying a larger loss in labour endowment from a negative health shock. I will discuss this implication of the analysis further in the sensitive analysis in Section 5.4.5.

To finance the increased layouts from public health insurance, the tax rate rises sharply by 57 percent immediately after the implementation of the new policy. This suggests that the negative tax effect on welfare would

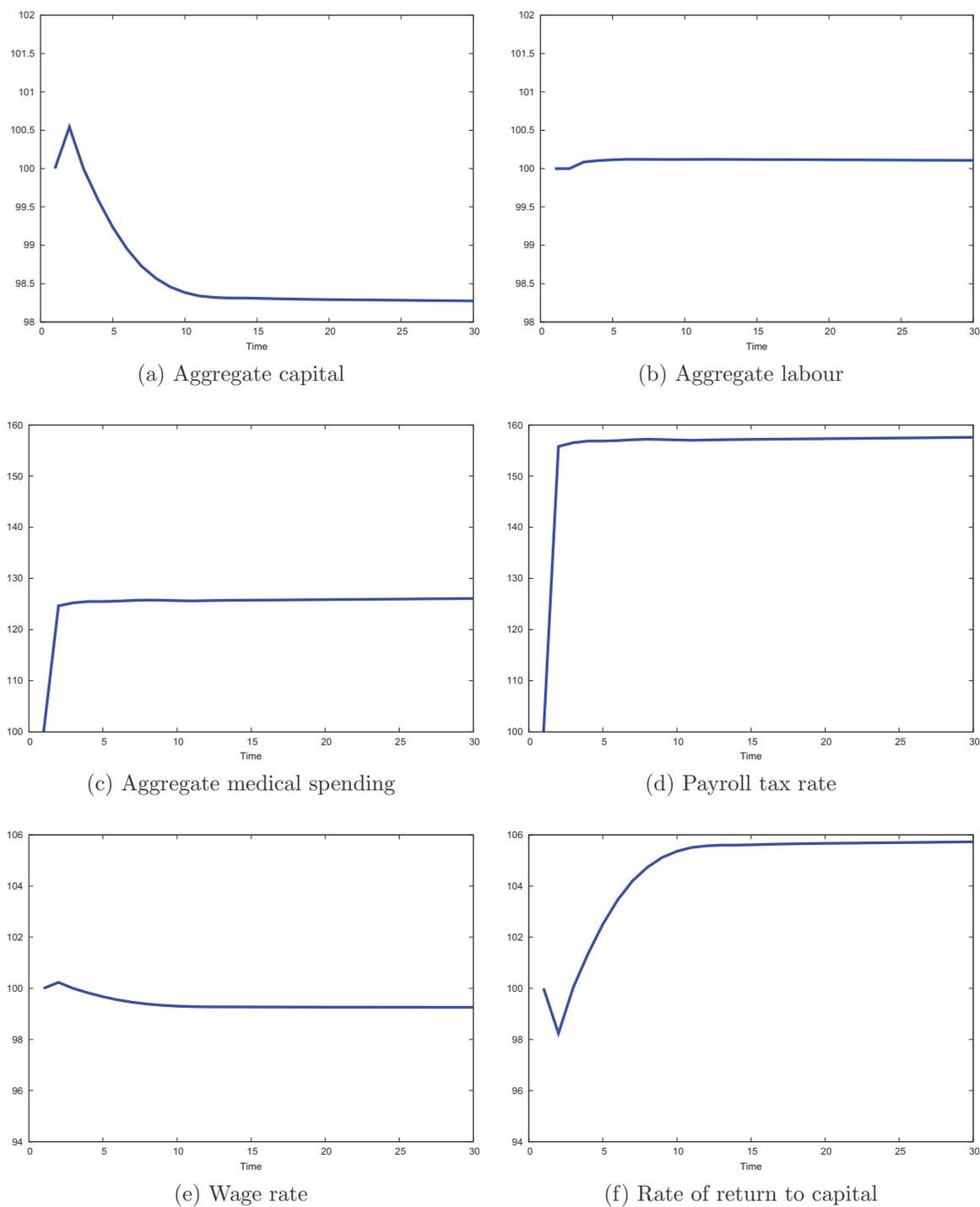
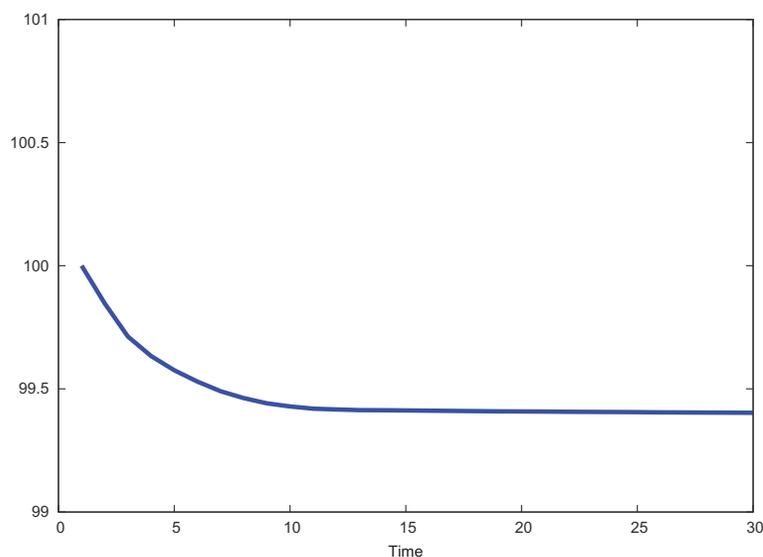


Figure 5.5: Macroeconomics variables over the transition path

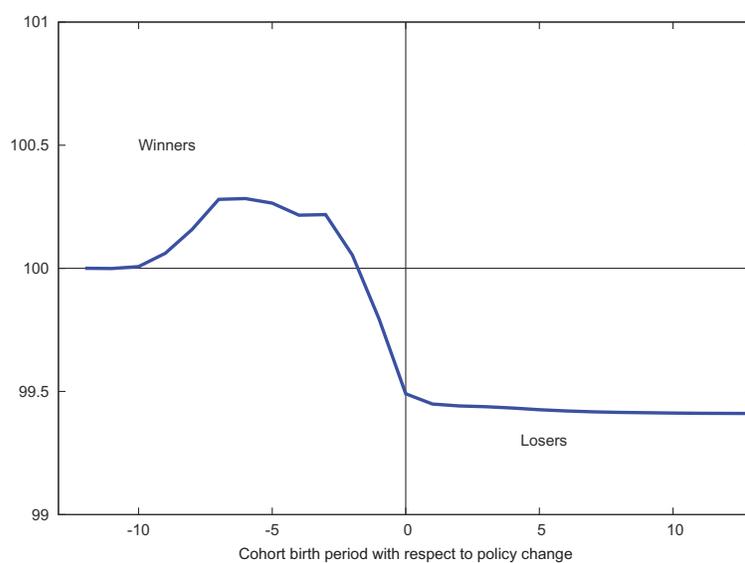
Notes: The transition dynamics is in terms of percentage change from the initial steady state value. Each time period in the horizontal axis represents 5 calendar years.

be in full force at the onset of the transition path. And this is one important factor that increases the welfare costs of the higher benefit rate in the model. The increase in the tax rate is caused largely by an increase in the demand for medical services by the elderly poor who have opted out of medical consumption before the policy change. Figure 5.5 shows that factor prices behave in a non-monotonic fashion – the rate of return to capital drops initially but rises toward its new steady state value, and the wage rate rises initially but falls to its new steady state. The wage effect is relatively small due to a small increase in L in panel (b) of Figure 5.5. The slight increase in the wage rate at the onset would increase the welfare of working-age individuals, whereas the decrease in the rate of return to capital reduces the welfare of working-age individuals who rely on capital income for their consumption.

Over the transition path, on average, welfare losses of the young exceed the welfare gains of the old. Figure 5.6a shows that the average welfare declines monotonically in the first 10 periods, and then plateaus to a new level of welfare, which is about 0.6 percent lower than the pre-reform level. This indicates that from the onset that average welfare is dominated by the negative tax effect. However, the positive effect is strongest also at the onset and gradually diminishes over time, suggesting that the welfare benefits accrue to those who were relatively old at the time of policy change. As these ‘beneficiary cohorts’ exit the economy, the welfare gains of the policy change subsides over time, whereas the welfare losses of higher tax rates remain in full force throughout the transition path.¹¹



(a) Average welfare



(b) Lifetime welfare by birth cohort

Figure 5.6: Welfare over the transition path

Notes: Each time period in the horizontal axis represents 5 calendar years.

I now turn to the impact of the policy change on the lifetime welfare by birth cohort. Figure 5.6b shows the lifetime welfare by birth cohort with respect to the pre-reform average welfare. The horizontal axis represents

¹¹The combination of subsiding welfare benefits and perpetuating welfare losses explains the monotonic decrease in welfare in the short-run.

the birth cohort with respect to the year in which the new benefit rate is introduced. For instance, the generation born 5 periods before the policy change is denoted by “-5” and these individuals would live 5 periods (25 calendar years) under the pre-reform benefit rate and 7 periods (35 calendar years) under the post-reform benefit rate. If a cohort’s lifetime welfare is above 100 (the horizontal line), they experience net-gains in welfare, whereas if a cohort’s lifetime welfare is below 100, they experience net-loss in welfare. Those who are born at least 2 periods (10 calendar years) before the policy change gain from it. In particular the retired generations at the time the new policy is introduced gain up to 0.3 percent relative to the pre-reform level of benefit rate. The losers are those who are at their early stages of the life-cycle and after the policy change experience a welfare loss of up to 0.6 percent of the pre-reform level. Although losers experience better health due to higher consumption of preventative medical care, the negative tax effect dominates their gains in health improvement. Moreover, the winners include working-age individuals at the time the policy change occurs, which means that even for some working-age adults the positive health insurance effect dominates the negative tax effect during their lifetime.

So far I have discussed the positive health insurance effect and the negative tax effect on welfare. However, the welfare analysis cannot be seen as simply measuring the conflicting effects between a tax hike and greater health insurance benefits. The reason is that, along the transition path both the rate of return to capital and wage rate also change. These

changes factor into saving and medical consumption decisions. Moreover, the changes in these factor prices (the general-equilibrium effects) have a direct influence on the welfare of individuals from different age groups and with different levels of wealth. While the increase in the rate of return to capital increases the welfare of the retired generations, the decrease in the wage rate decreases the welfare of the working-age generations.

5.4.3 Alternative Demographic Structures

Old-age dependency matters for welfare analysis for two reasons. First, it affects the share of medical spending in output. A high old-age dependency implies that there would be a relatively large share of output devoted to medical consumption. This would increase the tax rate for working-age individuals. Second, it determines the size of the tax base in the economy. A high old-age dependency implies a smaller tax base with the concrete implication that any increase in the benefit rate would lead to a relatively large increase in the tax rate. Given that demographic trends tend to be deterministic in the short-run, it is easy to see that the longer it takes to implement the policy change the greater is the negative effect on welfare. To quantify this mechanism, I consider several alternative demographic structures and check their welfare impact.

In the current model I set the old-age dependency exogenously. In the baseline model, the population share of elderly is 36 percent, which the United Nations predicts the old-age dependency would be by 2030. To assess the sensitivity of the results to alternatives, I consider three other

population share of elderly: 22, 26, and 38 percent.¹² The population shares of elderly of 22 and 26 percent represent contemporary “low” old-age dependency rates and the shares of 36 and 38 percent represent the projected “high” old-age dependency rates.¹³ The policy experiment is otherwise the same in that the benefit rate increases from 64 percent to 80 percent.

Employing a different population projection makes a large difference in the share of medical spending in output. The reason is that the demand for medical services is concentrated around the retirement age. Figure 5.7a shows that the share of medical spending in output increases with the share of elderly in the population. Between the lowest and highest age-dependencies, the difference in the increase in the output share of medical spending is about 3 percent. Because the demand for medical services is largely concentrated among the elderly, increasing the benefit rate under a high old-age dependency rate would cause a larger share of the population consuming medical services than it would under a low old-age dependency rate.

Figure 5.7b shows that the tax rate increases with old-age dependency. Between the lowest and highest old-age dependencies, the difference in the increase in the tax rates is about 4 percent. Higher old-age dependency increases the demand for medical services and lowers the tax base, which

¹²The population share of elderly at 22 percent is equivalent of the 2010 demographic structure. And the population share of elderly at 26 and 38 percent are attained by setting the average population growth rate to that of periods between 1951-1989, 2005-2010, respectively.

¹³According to the 2010 United Nations World Population data, South Korea will reach the population share of elderly of 38 percent between 2030 and 2035.

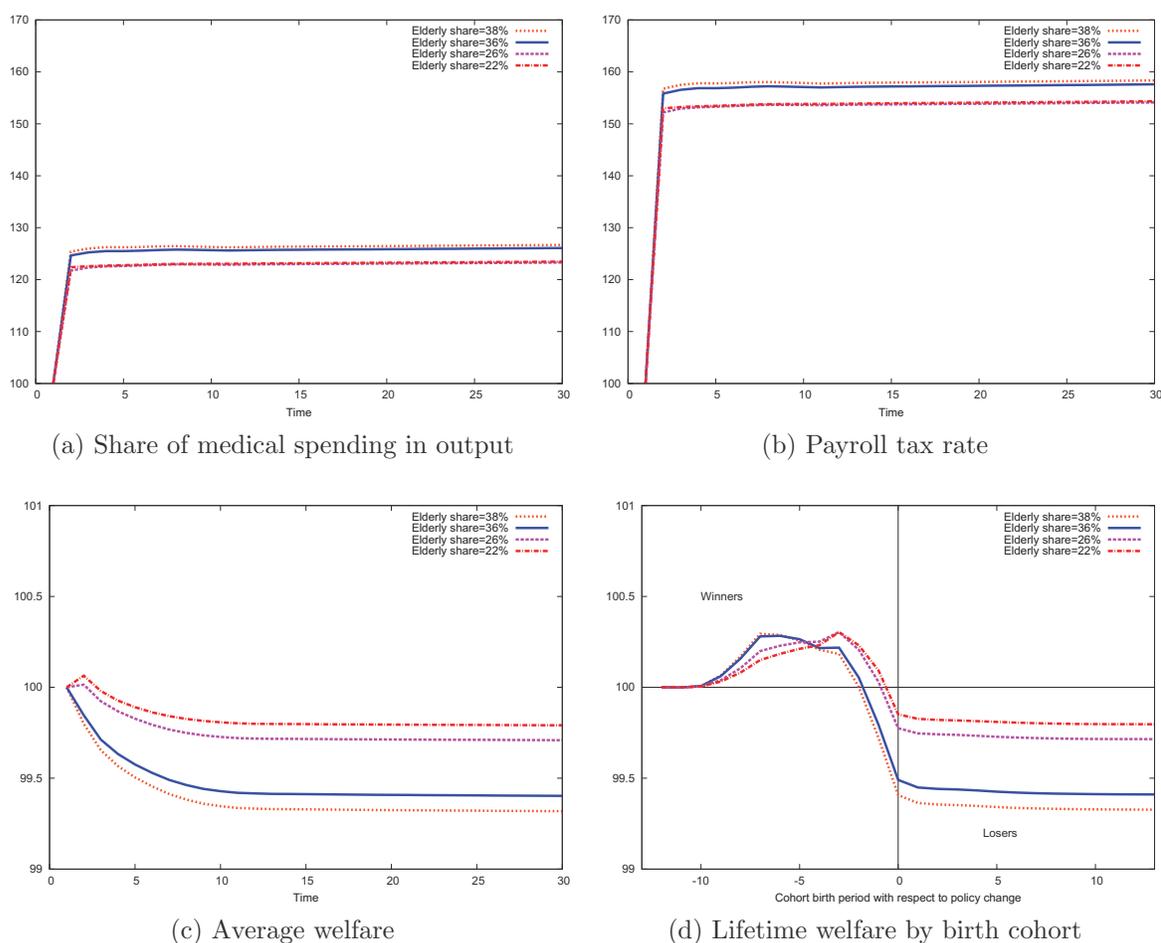


Figure 5.7: Comparing the policy impact on medical spending, payroll tax rate, and welfare by various demographic structures

Notes: Each time period in the horizontal axis represents 5 calendar years.

in turn leads to a higher tax rate. The later the policy change takes place, the greater is the negative tax effect on welfare.

As a result of these mechanisms, the welfare analysis is sensitive to the old-age dependency rate used in the analysis. Figure 5.7c shows that the *average* welfare increases at the onset of policy change for the contemporary demographic structures, while the long-run effect on welfare is negative for all demographic structures due to higher tax rates. Figure 5.7d shows that

under the contemporary demographic structures almost all cohorts born before the policy change gain from it. The key difference between the current and projected demographic structures is that the welfare gains are concentrated at different birth cohorts. For example, retirees are the primary beneficiaries in the case of high old-age dependency, while younger working-age generations are the primary beneficiaries in the case of contemporary old-age dependency. The tax rate and factor prices change and these changes account for the differences in the welfare profiles by birth cohort. Specifically, a milder tax increase in the low old-age dependency economy reduces the negative tax effect on welfare for working-age generations. Moreover, these cohorts also experience welfare gains from engaging in preventative medicine early in their lives, whereas the retired generations before the policy change have missed such opportunities. These findings suggest that the timing of policy implementation matters considerably not only for retired generations but also for working-age generations.

The findings show that implementing the proposed expansions in the contemporary demographic structures may lead to welfare improvements for a vast portion of population. The positive health effects would dominate the negative tax effects, as there would be a milder tax increase. With the current population ageing in South Korea, postponing the policy change would amount to greater welfare losses. One limitation of this analysis is that the model does not allow for population ageing along the transition path. In response to ageing population, individuals would forego additional consumption in order to pay for higher taxes in the future. This

may dampen the positive gains to average welfare in the case of demographic structures. However, even account for population ageing, it would not change the notion that welfare losses would be greater, if policy implementation were to be postponed.

5.4.4 Alternative Utility Functions

The choice of utility function matters for medical consumption across asset holdings. If an individual opts out of medical consumption, then their discounted expected marginal utility of any improvement in health must be less than the marginal utility of consumption today. With the separable utility function, the marginal utility of better health (from bad to good) is constant across consumption levels, whereas with the CES utility function it would rise with consumption when health and consumption of non-health goods are gross compliments – as I have assumed in the baseline model. In other words, medical consumption in the CES utility function is considered to be more desirable for those who hold relatively high wealth. Given that medical consumption is mainly concentrated by the wealthy, with a CES utility function would mean that all else equal, there would be greater demand for medical services than with a separable utility function.

Figure 5.8a shows that increasing the benefit rate with a separable utility function increases the share of medical spending in output, which leads to a higher tax rate (Figure 5.8b). However, these increases are smaller than those found using the baseline CES utility function. Figure 5.8a shows the the increase in the share of medical spending in output is lower in the

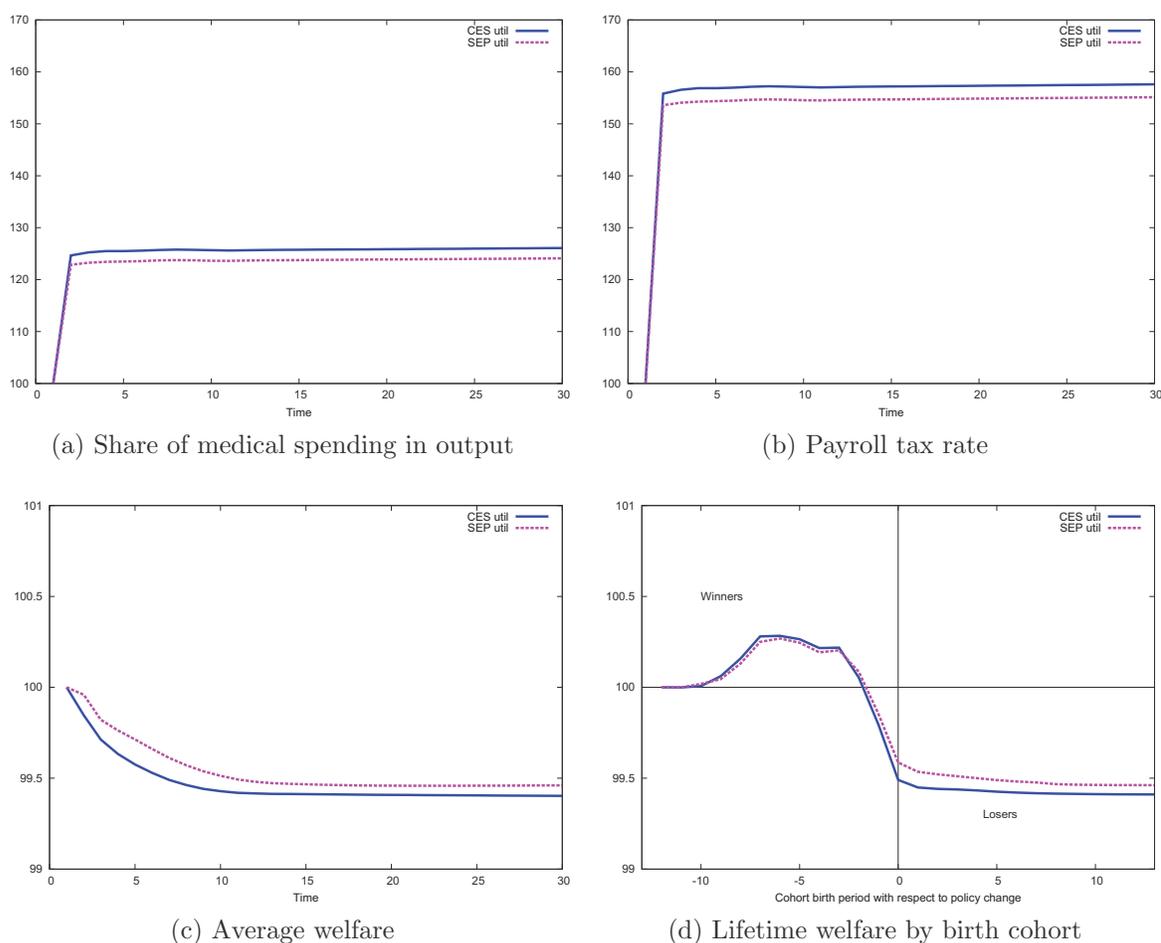


Figure 5.8: Comparing the policy impact on medical spending, payroll tax rate, and welfare between a CES utility function and a separable utility function

Notes: Each time period in the horizontal axis represents 5 calendar years. The separable utility model includes the same parametrization. The population share of elderly is also the same at 36 percent.

separable utility case by about 5 percentage points. Figure 5.8b shows that the tax rate is lower in the separable utility case by about 6 percentage points. These results suggest that using the separable utility function produces a smaller positive health effect on welfare. However, there is also a smaller negative tax effect on welfare under the separable utility function.

Figure 5.8d compares the average welfare over time between the two

alternative specifications of the utility functions. The long-run effect on average welfare of policy change is negative in both utility specifications. While the short-run effect on average welfare is also negative across utility specifications, the magnitude of welfare loss in the separable utility specification is smaller in the short-run. This is largely driven by a smaller negative tax effect. Figure 5.8d shows that the welfare loss of those who entered the economy 1-2 periods before the policy change is smaller in the separable utility specification. Overall, the model with separable utility function also shows that the policy change in a high old-age dependency would result in a net-loss in average welfare. This result suggests that the choice of utility function by itself may not affect the welfare analysis and high old-age dependency ratio may be a more important consideration.

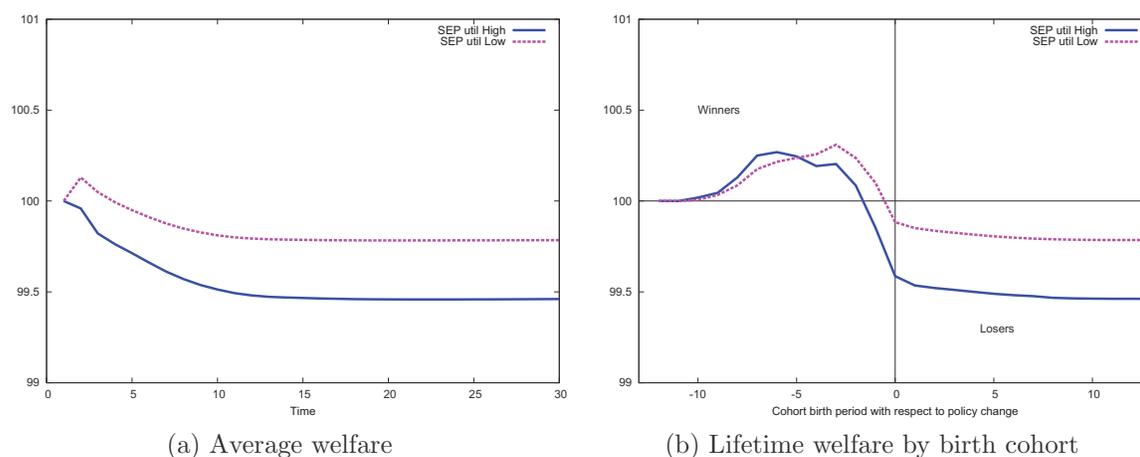


Figure 5.9: Comparing the policy impact based on various demographic structures under a separable utility specification

Notes: Each time period in the horizontal axis represents 5 calendar years. The separable utility model includes the same parametrization. “High” old-age dependency corresponds to the population share of elderly at 36 percent. “Old” old-age dependency corresponds to the population share of elderly at 26 percent.

To verify whether the old-age dependency also matters for the separable utility specification, I compare the effects on welfare of the policy change in the alternative demographic structures. I use two demographic structures: one is the baseline case, which corresponds to “high” old-age dependency ratio with the population share of elderly at 36 percent. And the other one corresponds to “low” old-age dependency ratio with the population share of elderly at 26 percent. Figure 5.9a shows that increasing the benefit rate increases the average welfare at the onset of policy change for the low old-age dependency case. Figure 5.9b shows that the short-run welfare-gains shared by almost all birth cohorts before the policy change. The largest welfare gains are given to the working-age generations, because the policy change offers them a positive health effect in their lifetime, but also a milder tax hike.

Overall, the choice of utility function does not change the impact on welfare of policy change. What seems to matter the most is the timing of the policy. By implementing the policy change in a low old-age dependency environment, I show that the short-run effect on average welfare is positive. A further delay of policy implementation to a later high old-age dependency rate would mean that the negative tax effect would dominate the positive health effect on welfare. This results are robust across alternative utility specifications.

Table 5.4: Sensitivity analysis

	% change in K/Y	% change in L	% change in M/Y
A.			
$l(h_b) = 0.5$	-2.0	+0.3	+24.2
$l(h_b) = 0.75^*$	-1.7	+0.1	+25.8
$l(h_b) = 0.85$	-1.5	+0.1	+30.0
B.			
$\nu = 0.3$	-2.4	+0.1	+28.8
$\nu = 0.5$	-1.7	+0.1	+25.8
$\nu = 1$	-1.0	+0.1	+27.1

Notes: * denotes the baseline where I set the parameter for the relative labour endowment in bad health at 0.75, and the parameter for the elasticity of intertemporal substitution at 0.5.

5.4.5 Sensitivity Analysis

While the model matches several moments of the data by calibrating certain key parameters, the parametrization nevertheless involves setting the values of two parameters rather arbitrarily: the relative labour endowment in bad health $l(h_b)$, and the parameter for the elasticity of substitution between health and consumption of non-health goods ν . In what follows, I thus check for the sensitivity of the model with respect to these parameters.

The labour endowment parameter governs the relation between health shocks and aggregate labour. It is expected that the greater is the labour endowment loss due to bad health, the greater improvement there would be due to increasing the benefit rate. Table 5.4 Panel A shows in the second column that there is a slightly higher increase in the aggregate labour supply when the loss in labour endowment due to bad health increases from 25 percent to 50 percent. However, the impact of this on the aggregate labour

supply is small because the additional demand for medical consumption is concentrated among the retired generations and higher labour supply at the individual level affects a relatively small fraction of the working-age population. Also, the decline in aggregate saving (in the first column) is larger with a greater loss in labour endowment in bad health, as the policy reduces precautionary saving against relatively large health uncertainty – this effect is economically small.

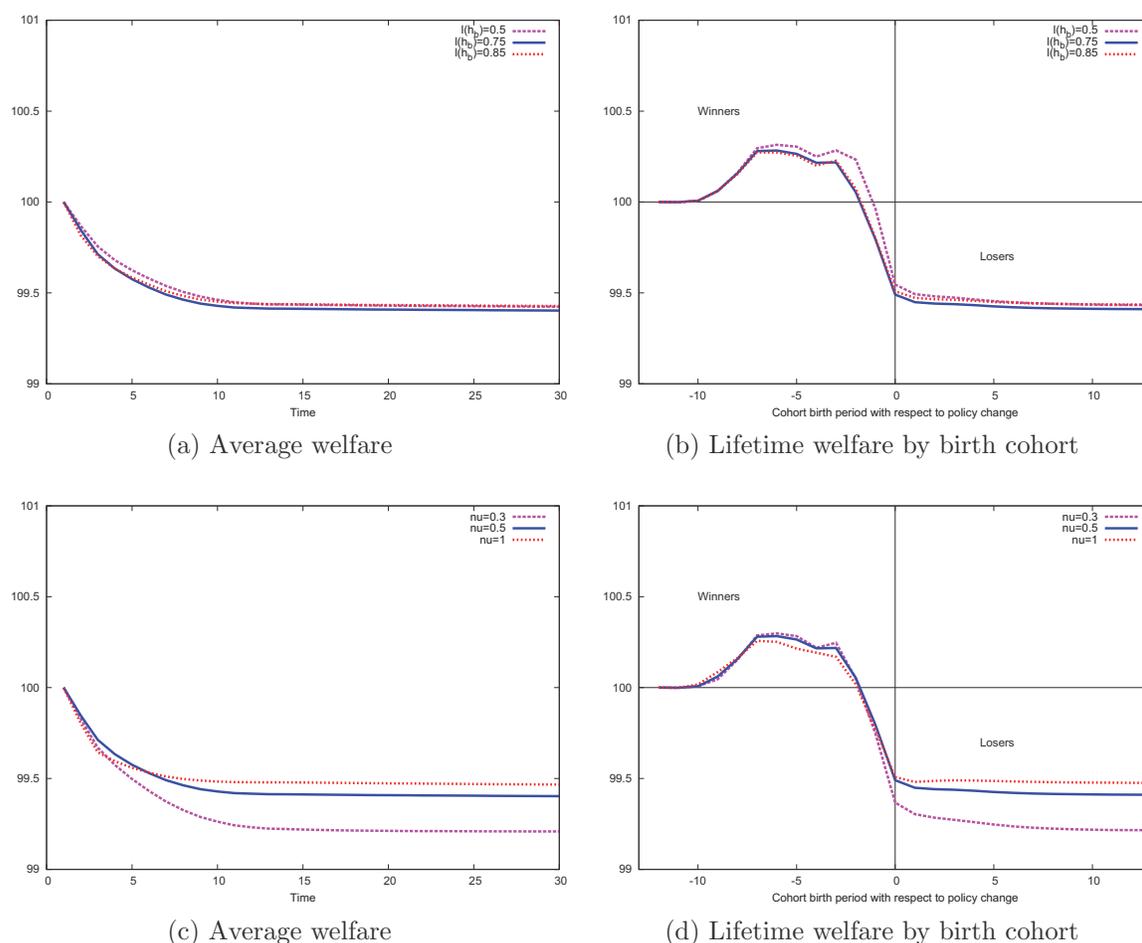


Figure 5.10: Sensitivity analysis on welfare

Notes: Each time period in the horizontal axis represents 5 calendar years. The baseline parametrization sets $l(h_b) = 0.75$, and $\nu = 0.5$. The population share of elderly is the same at 36 percent.

Finally, I check for the sensitivity of the results with respect to the value of the elasticity of substitution, which is important for individuals' medical consumption decisions. In the baseline, I set this parameter value to 0.5. And I consider two alternative values: $\nu = 0.3$ and $\nu = 1$. By setting ν at 0.3, I increase the complementarity between health and consumption of non-medical goods that the marginal utility of consumption increases with health improvement. This makes medical consumption more attractive. Table 5.4 Panel B shows in the third column that by decreasing the elasticity of substitution from $\nu = 0.5$ to $\nu = 0.3$, there is a slightly larger increase in the share of medical spending in output. However, the individual's medical consumption decision does not solely depend on the elasticity of substitution, but also depends on asset holdings. Increasing the elasticity of substitution reduces the decline in aggregate capital saving, and thus lowers the magnitude of the decline in income. Given that medical consumption is a normal good (as found in Chapter 4), individuals are on average able to purchase more medical services in the case of $\nu = 1$. Table 5.4 Panel B shows that increasing the elasticity of substitution from $\nu = 0.5$ to $\nu = 1$ reduces the decline in the capital-output ratio, while it increases the rise in the share of medical spending in output.

Figure 5.10 shows the effects on average welfare and lifetime welfare by birth cohorts with alternative parametrization. Figure 5.10a shows the impact on average welfare for alternative labour endowment parameters. It shows that there is not a noticeable deviation from the baseline. Figure 5.10b shows that increasing the negative effect of health shocks on

labour supply increases the welfare of working-age generations. Under such parametrization (with lower labour endowment in bad health), there is a greater health effect of medical consumption for working-age generations.

Figure 5.10c shows the effects on average welfare for alternative elasticities of substitution between health and consumption of non-medical goods. It shows that the decline in average welfare in the case of $\nu = 0.3$ is greater by about 0.2 percentage points than the baseline. Such a larger decline in average welfare is driven largely by the negative tax effect on working-age generations. Figure 5.10 shows that the lifetime welfare of the younger working-age generations incur a greater welfare-loss than in the baseline. This is largely driven by a higher tax hike in the case of $\nu = 0.3$.

5.5 Conclusion

This chapter examines the effects of increasing public health insurance benefits on welfare in an economy with high old-age dependency. Such a policy increases welfare by improving health outcomes and providing protection against medical expenditure shocks, which are otherwise uninsurable. However, in the range of parameter values and utility function specification considered here, the policy change also increases the tax rate due to a sharp rise in the demand for medical services by a large elderly population. This trade-off makes increasing health insurance benefits a difficult task for a country like South Korea, which is one of the fastest ageing societies.

To capture these complex mechanism, I offer a life-cycle model with

endogenous medical consumption and health outcomes, which captures the positive health effect on welfare. The results suggest that in a high old-age dependency, the negative tax effect on working-age generations cannot be compensated by the positive health effect. However, the dominance of the tax effect is weakened in the less old-age dependent demographic structures. If the policy change were to take place according to the timeline set forth by the government, it can increase the average welfare at the onset of the policy.

I want to note that the results are based on a conservative estimate on the positive effect of the policy change on health outcomes. For instance, I have excluded the positive effect of improving access to health care for the disabled and those with a chronic illness who would have opted out of medical services prior to the policy change. Moreover, individuals may develop disability because he/she have opted out of medical services in the past. The policy change may increase the labour supply and the tax base by preventing the development of disability and chronic illnesses.

To increase average welfare, one can implement a type of progressive tax. Such a tax scheme can reduce the tax rate for the younger working-age generations who is hit the hardest from the tax hike yet receives little benefit from the policy change. For the older working-age generations, it would increase their tax rate. However, the results in this chapter suggest that they are the net beneficiary of the policy change that their welfare loss due to additional tax rate can be compensated by the positive effect on their health outcomes.

Finally, there are a few limitations of the model. First, the model sets the retirement age exogenously, whereas the effective retirement age can vary according to health status. As health status improves, the effective retirement age can be raised resulting in an increase in aggregate labour and a broader tax base. Second, the model lacks the distinction between acute care and long-term care for elderly. Although the provision of long-term care in South Korea is presently underdeveloped, there are various policy initiatives to build long-term care facilities and to mandate a separate savings account for long-term health care. If such policy changes can be implemented concurrently, an increase in old-age dependency does not necessarily entail a large increase in the payroll tax rate. Third, the model assumes an unexpected policy change, whereas the policy announcement can occur prior to its implementation. This would change the people's behaviour in the anticipation of the policy change. For instance, there might be a number of individuals withholding medical consumption before the effective date of policy change. Fourth, the model assumes no change in future income due to technological advancement. Given the health as a normal good, an increase in income due to technological advancement would increase medical consumption. As observed in the welfare analysis in this chapter, the net impact on average welfare is ambiguous – depends on the magnitudes of positive health effect and negative tax effect on welfare.

Chapter 6

Conclusion

This dissertation studies the macroeconomic consequences of providing public health insurance in South Korea. Many studies show that high co-pay rates and out-of-pocket medical expenditures have forced many households in South Korea to incur large medical expenditures or opt out of medical consumption. In this vein, the South Korean government has pushed for progressive reforms to increase the public health insurance benefits. This dissertation examines the effects of expanding public health insurance on households' saving and welfare. In particular, I focus on the link between medical consumption and health outcomes at the macroeconomic level.

In the empirical analysis, I use the Korean Welfare Panel Study data to examine the effect of opting-out of medical services. I find that the marginal effect of opting-out of medical services on average decreases the odds of having good health by 10 percentage points. This finding contributes to the literature, which finds the in-hospital mortality rate is higher for individuals with low socioeconomic status, who are also prone to opt out of medical services due to financial difficulty. Expanding public health insurance benefits thus has a significant positive effect on health outcomes.

These findings provide the groundwork for exploring the link between medical consumption and health outcomes from the macroeconomic standpoint.

Expanding public health insurance has decreased households' precautionary saving motive and contributed to the decline in aggregate saving between 1989 and 2010. I develop a life-cycle model with endogenous medical consumption and health outcomes. The estimated results show that eliminating the medical expenditure risks would result in a substantial decline in precautionary saving. The model also shows that the recent expansion in public health insurance leads to a overall small decline in aggregate saving by improving the access to health care. The reason is that the policy change enhances medical consumption at the early age of the life-cycle, it would reduce the shocks to labour endowment due to bad health.

Finally, this dissertation examines the effects on welfare of the current policy proposal, which is to increase the benefit rate to the OECD average of 80 percent. I show that the policy proposal would improve the public health especially those in retirement by improving the access to health care. However, the policy proposal would also increase the payroll tax rate, which finances the outlays for public health insurance. Because South Korea is undergoing a rapid population ageing toward a hyper-aged society, the timing of policy change matters. The model estimates show that increasing the benefit rate in a high old-age dependency would sharply increase the tax rate such that the negative tax effect will dominate the positive effects on health outcomes, whereas the negative tax effect would

be dominated by the positive effect on health outcomes should the policy change is implemented now.

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Appendix A

Computation Algorithms

A.1 Algorithm: Steady State

To solve the individual's problem in steady state in Chapters 4 and 5, I follow the algorithm provide in Chapter 10 of Heer and Maussner (2008), which relates to solving stochastic OLG models. The main idea of the algorithm is to find a steady state probability distribution Γ of households over the state space X with three dimensions age, health status, and asset holdings. To find the steady state distribution, the algorithm must satisfy the steady state equilibrium conditions provided in Sections 4.2.3 and 5.3.3. I construct the following algorithm:

1. Parameterize the model to the South Korean economy and compute the aggregate employment L based on the ergodic distribution of health shocks in each working-age
2. Guess the initial condition of the economy: aggregate capital stock K , the share of each generation μ , and the tax rate τ
3. Compute the competitive factor prices w and r
4. Compute the household's policy function using backward induction
5. For a new born generation $s = 1$ with zero asset holdings, apply the policy function by forward induction until their terminal age

6. Aggregate the optimal savings, individual labour supply, medical consumption to attain the aggregate capital K , aggregate labour L , and aggregate medical consumption M , respectively
7. Update K, L, M and go back to step 3 until convergence

In Step 1, I parameterize the model according to Sections 4.2.4 and 5.3.5. Because health status is binary, the ergodic distribution of health shocks represents the steady-state distribution of good and bad health statuses for each age. I compute the ergodic distribution of good health status for each age s by solving the following

$$\text{ergo}(s) = \frac{1}{1 + \frac{(1-p_{gg}(s))}{p_{bg}(s)}}$$

where $p_{gg}(s)$ represents the transition probability of age s having good health status in period t and good health status in period $t + 1$, $p_{bg}(s)$ represents the transition probability of age s having bad health status in period t and good health status in period $t + 1$. After calculating the ergodic distribution of good health status, I compute the initial aggregate labour L by summing every working-age population's individual labour supply based on their health status.

In Step 2, I guess the initial capital stock by solving the following

$$K = \left(\frac{\alpha}{\frac{1}{\beta} - 1 + \delta} \right)^{\frac{1}{1-\alpha}} L,$$

where α represents the capital share of output, β the time discount factor, and δ the capital depreciation rate. I set the initial share of each generation

by setting the population growth rate provided by the data. I set the initial tax rate equal to 3 quarters of the benefit rate η .

In Step 3, I compute the factor prices using Equations (4.5) and (4.6).

In Step 4, I compute the household's policy function by backward induction. Since individuals in their terminal age consume all of their state space capital, we can certainly calculate the terminal period utility $V^{s=60}(k, h)$, which then can be used to find the value function for younger age $V^s(k, h)$ for $s = 83, \dots, 25$ with only one iteration. Moving backward, from each state space grid point, I look for the optimal saving and medical consumption decisions by visiting every possible grid space for asset holdings and health status.

In Step 5, I apply the policy function for a new-born generation with zero asset holdings. As the generation becomes older and next generations enter the economy, I construct the probability distribution of households.

In Step 6, I aggregate the optimal savings, medical consumption, and individual labour supply to calculate the aggregate capital stock, aggregate medical consumption, and aggregate labour, respectively.

In Step 7, I compare this new set of aggregate variables K, L, M with the previously determined set of aggregate variables. If the change in these aggregate variables exceeds the tolerance level of 0.0001 percent, I exit the program. Otherwise, I update the set of aggregate variables by bisection method (taking the middle (average) value between the new and old sets of macro variables) and return to Step 3.

A.2 Algorithm: TPI

This section provides the algorithm for solving the transition path in Chapter 5. I follow the time path iteration (TPI) method introduced by Nishiyama and Smetters (2007), which relates to finding a unique transition path for stochastic OLG models. To ensure a unique path, the TPI method assumes that all individuals have a shared belief on the future course of factor prices and tax rate.

The main goal of the following algorithm is to find the unique transition path between two steady states that are characterized by public health insurance benefit rate. Time subscript $t = 1$ represents the initial state and $t = T$ represents the final state. At $t = 2$, I introduce a policy change that increases the benefit rate from 64 percent (2010 level) to 80 percent. This would change the households' saving and medical consumption behaviour, which in turn changes the aggregate variables. The economy converges to the final state during the transition path. I construct the following algorithm:

1. Parameterize the model to the South Korean economy
2. Choose the maximum period of transition T
3. Set the initial steady state and retrieve $\{K_1, \Gamma_1, L_1, M_1, w_1, r_1, \tau_1\}$
4. Set the final steady state and retrieve $\{K_T, \Gamma_T, L_T, M_T, w_T, r_T, \tau_T\}$
5. Given the initial and final steady states, interpolate linearly to find the values of the variables over T

6. Solve the households' policy functions for $S - 1$ generations by backward induction from $t = T, T - 1, \dots, 1$
7. Apply the policy functions forward for each newly-born generation from $t = 1 - S$ to $t = T$
8. In each time period, aggregate each household's optimal savings, medical consumption, and labour supply to attain the aggregate capital, aggregate medical consumption, and aggregate labour, respectively
9. Update the aggregate variables and return to Step
10. After finding a unique transition path, check to see whether the end of transition path exhibits convergence to the final steady state. If no convergence, return to Step 2 to increase T

Several steps in this algorithm overlaps considerably with the steady state algorithm. For those parts, I simply refer them to the previous algorithm.

In Step 1, I parameterize the model according to Section 5.3.5. I adjust the calibration from one-year to 5-year to represent 1 period. For example, I adjust the time discount factor and capital depreciation rate from the annual level to the 5-year equivalent level.

In Step 2, I set T the maximum transition time period to $3 \times S$, which is three times the length of life-cycle. This describes how long it would take for the economy after the policy change to reach the new steady state. With the life-cycle of 12 periods, the maximum transition time period is

36 periods. Usually, the economy reaches the final steady state in less than 15 periods.

In Steps 3 and 4, I use the previous steady state algorithm to calculate the steady states that are characterized by the policy change. I compute the initial steady state with the benefit rate at 64 percent and the final steady state with the benefit rate at 80 percent. I store the 2 sets of macroeconomic variables $\{K_0, \Gamma_0, L_0, M_0, w_0, r_0, \tau_0\}$ and $\{K_T, \Gamma_T, L_T, M_T, w_T, r_T, \tau_T\}$, which define the beginning and the end of transition path. I also store the density distribution of households Γ_0 , which will be used to iterate forward the policy function in Step 7.

In Step 5, I guess the initial condition of the transition path to be a linear interpolation between the values from the initial and final steady states. These interpolated values set the initially shared belief on the factor prices and tax rate from $t = 2$ to $t = T - 1$. The initially guessed linear path will be replaced by a non-linear path after many iterations of Steps 6-9.

In Step 6, I apply backward inductions for terminal-aged individuals for $t = T, T - 1, \dots, 1$. Similar to the previous steady state algorithm, it is certain that the terminally-aged individuals' utility is known. But the key difference is that instead of iterating only once in the steady state backward induction, the backward induction here is done T times for each period. Another key difference is that households' decision rule in the steady state algorithm depends on a single set of factor prices and tax rate, whereas in the transition path it depends on S sets of factor prices and tax rate. This is because individuals are subject to changing values of factor prices and

tax rate in their lifetime.

In Step 7, I apply the policy function forward on a new-born generation in each period from $t = 1 - S$ to $t = T$. I begin forward iteration at $t = 1 - S$ not at $t = 1$ in order to capture the effect of policy change on those individuals who experience the policy change in the middle of their life-cycle.

In Step 8, I sum up the optimal savings, medical consumption, and labour supply in each period to attain T sets of macroeconomic variables $\{K, L, M, w, r, \tau\}$ and density distribution of households Γ .

In Step 9, I compare the new and old transition paths by comparing the T sets of macroeconomic variables K, L, M in each period. If the change in these aggregate variables exceeds the tolerance level of 0.001 percent, I exit the program. Otherwise, I update the set of aggregate variables by taking the weighted average between the new and old sets of macro variables and return to Step 9.

In Step 10, I check for the convergence of the economy to the final steady state. If the macroeconomic variables near T do not show a sign of convergence to the final steady state, return to Step 2 and increase T .

Appendix B

Health Transition Probability Estimates: Full Results

This section presents the health transition probability estimates. These estimates are used as the health transition matrices as in Equations (4.2) and (4.3). Because the health transition depends whether the individual has opted out of medical services, I use the Korean Welfare Panel data, which includes a questionnaire that asks the households whether they have missed hospital visits due to financial difficulty.

For the binary nature of health status in the model, I use the following logit model

$$L_t^i = \ln\left(\frac{p_{g,t}^i}{1 - p_{g,t}^i}\right) = \beta_1 s_t^i + \beta_2 s_t^{2i} + \beta_3 p_{g,t-1}^i + \beta_4 m_{0,t-1}^i + \epsilon_t^i, \quad (\text{B.1})$$

the superscript i indicates the individual and the subscript t indicates the time period. The dependent variable L_t^i represents the individual's odds ratio of having a good health status. s represents the individual's age, $p_{g,t-1}^i$ represents the lagged health outcomes dummy variable indicating whether the individual had a good health status at $t - 1$, $m_{0,t-1}^i$ represents the dummy variable indicating whether the household opted out of medical consumption at $t - 1$, and ϵ_t^i is a random error term. This specification yields the health transition probability over a 3-dimensional state space.

Table B.1 presents the coefficient estimates. I use these coefficient estimates to construct the odds ratio over age by previous health status and the

Table B.1: Estimation of the odds of having good health status

Variable	Coefficient
Age	-0.12*** (0.03)
Age squared	0.00** (0.00)
Previous Health	1.79*** (0.08)
Opt out of Med	-0.85*** (0.15)

Notes: Standard errors are in parentheses. I use the first two waves of the Korea Welfare Panel Study (2006, 2007). The sample size is 5087, which includes those who are of age between 25 and 84, and without disability. Control variables also include constant, which is not reported here.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

positive history of opting-out of medical consumption. This yields four sets of odds ratio over the life-cycle, which then can be used to calculate the four sets of transition probability over the life-cycle $\{p(s)_{gg}, p(s)_{bg}, q(s)_{gg}, q(s)_{bg}\}$. For example, to compute the age-specific health transition probability from good health to good health, I compute

$$p_{gg}^s = \frac{1}{\exp(-L(s)_{gg})}, \quad (\text{B.2})$$

where $L(s)_{gg}$ represents the odds of having the good health status at age s , conditional on having good health status and not opted out of medical consumption in the previous period. By calculating the health transition probability from good to good health, I can calculate the health transition probability from good to bad health $1-p_{gb}^s$. The rest of the health transition probability can be attained by applying the same computation method.

Table B.2 presents the health transition probability matrix in annual period. In Chapter 4, each period corresponds to one calendar year, whereas

in Chapter 5, each period corresponds to five calendar years. For instance, age $s = 1$ corresponds to age 25 in Chapter 4, and age $s = 1$ corresponds to ages 25-29 in Chapter 5. Thus, I adjust age accordingly from the estimates based on one-year per period to five-year per period. Table B.3 presents the health transition probability in five-year period.

Table B.2: Health transition probability matrix 1-year period

Model age	p_{gg}	q_{gg}	p_{bg}	q_{bg}
1	0.983764	0.957501	0.896698	0.763457
2	0.982402	0.954038	0.888857	0.748342
3	0.980942	0.950343	0.880578	0.732742
4	0.979378	0.946405	0.871852	0.71669
5	0.977704	0.942213	0.862675	0.700222
6	0.975915	0.937757	0.853043	0.683377
7	0.974005	0.933028	0.842955	0.6662
8	0.971967	0.928016	0.832413	0.648737
9	0.969796	0.922712	0.82142	0.631036
10	0.967485	0.917107	0.809984	0.613149
11	0.965029	0.911195	0.798112	0.595127
12	0.962421	0.904967	0.785818	0.577024
13	0.959655	0.898418	0.773117	0.558891
14	0.956725	0.891543	0.760026	0.54078
15	0.953624	0.884336	0.746565	0.522744
16	0.950347	0.876796	0.732758	0.504831
17	0.946888	0.868921	0.71863	0.487088
18	0.943242	0.860709	0.704208	0.469559
19	0.939403	0.852163	0.689524	0.452285
20	0.935367	0.843285	0.674608	0.435306
21	0.931128	0.834078	0.659493	0.418654
22	0.926682	0.824549	0.644214	0.402362
23	0.922027	0.814704	0.628806	0.386455
24	0.917157	0.804553	0.613304	0.370958
25	0.912071	0.794106	0.597746	0.355888
26	0.906766	0.783375	0.582165	0.341264
27	0.901241	0.772373	0.566598	0.327096
28	0.895495	0.761116	0.551079	0.313393
29	0.889527	0.749619	0.535642	0.300162
30	0.883338	0.737902	0.520318	0.287405
31	0.876929	0.725981	0.505138	0.275123
32	0.870302	0.713879	0.490132	0.263314
33	0.86346	0.701614	0.475325	0.251973
34	0.856406	0.689209	0.460743	0.241095
35	0.849146	0.676686	0.446408	0.230671
36	0.841683	0.664067	0.432341	0.220692
37	0.834025	0.651375	0.41856	0.211148
38	0.826177	0.638634	0.405081	0.202027
39	0.818148	0.625865	0.391918	0.193318
40	0.809946	0.613092	0.379082	0.185007
41	0.80158	0.600336	0.366582	0.177082
42	0.79306	0.58762	0.354426	0.169528
43	0.784396	0.574965	0.34262	0.162333
44	0.775599	0.56239	0.331168	0.155481
45	0.766681	0.549915	0.320071	0.14896
46	0.757653	0.537559	0.309329	0.142755
47	0.748527	0.525338	0.298943	0.136854
48	0.739318	0.513269	0.28891	0.131242
49	0.730036	0.501368	0.279226	0.125908
50	0.720696	0.489647	0.269888	0.120837
51	0.711311	0.47812	0.260889	0.116019
52	0.701894	0.466798	0.252225	0.11144
53	0.692457	0.455691	0.243889	0.10709
54	0.683016	0.444809	0.235872	0.102958
55	0.673581	0.434158	0.228169	0.099033
56	0.664167	0.423746	0.220769	0.095304
57	0.654786	0.413579	0.213666	0.091763
58	0.64545	0.40366	0.206851	0.088399
59	0.63617	0.393994	0.200315	0.085203
60	0.626959	0.384583	0.194048	0.082168

Notes: p_{gg} represents the transition probability from good to good health status with medical consumption, q_{bg} the transition probability from good to good health status with opting-out of medical consumption, p_{bg} the transition probability from bad to good health status with medical consumption, q_{bg} the transition probability from bad to good health status with opting-out of medical consumption.

Table B.3: Health transition probability matrix 5-year period

Age	p_{gg}	q_{gg}	p_{bg}	q_{bg}
1	0.983764	0.957501	0.896698	0.763457
2	0.974005	0.933028	0.842955	0.6662
3	0.959655	0.898418	0.773117	0.558891
4	0.939403	0.852163	0.689524	0.452286
5	0.912071	0.794106	0.597746	0.355889
6	0.876929	0.725982	0.505138	0.275124
7	0.834025	0.651375	0.41856	0.211148
8	0.784396	0.574965	0.34262	0.162333
9	0.730036	0.501368	0.279226	0.125908
10	0.673581	0.434158	0.228169	0.099033
11	0.617828	0.375429	0.188044	0.079285
12	0.565259	0.325897	0.157019	0.064772

Notes: p_{gg} represents the transition probability from good to good health status with medical consumption, q_{bg} the transition probability from good to good health status with opting-out of medical consumption, p_{bg} the transition probability from bad to good health status with medical consumption, q_{bg} the transition probability from bad to good health status with opting-out of medical consumption.